

# **GE Fanuc Automation**

**Computer Numerical Control Products** 

# Series 16i/18i/160i/180i/160is/180is – Model A for Lathe

**Operator's Manual** 

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# Warnings, Cautions, and Notes as Used in this Publication

# Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

#### Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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# SAFETY PRECAUTIONS

This section describes the safety precautions related to the use of CNC units. It is essential that these precautions be observed by users to ensure the safe operation of machines equipped with a CNC unit (all descriptions in this section assume this configuration). Note that some precautions are related only to specific functions, and thus may not be applicable to certain CNC units.

Users must also observe the safety precautions related to the machine, as described in the relevant manual supplied by the machine tool builder. Before attempting to operate the machine or create a program to control the operation of the machine, the operator must become fully familiar with the contents of this manual and relevant manual supplied by the machine tool builder.

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# DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

## WARNING

Applied when there is a danger of the user being injured or when there is a danger of both the user being injured and the equipment being damaged if the approved procedure is not observed.

## CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

### NOTE

The Note is used to indicate supplementary information other than Warning and Caution.

**Q** Read this manual carefully, and store it in a safe place.

# **GENERAL WARNINGS AND CAUTIONS**

# WARNING

- **1.** Never attempt to machine a workpiece without first checking the operation of the machine. Before starting a production run, ensure that the machine is operating correctly by performing a trial run using, for example, the single block, feedrate override, or machine lock function or by operating the machine with neither a tool nor workpiece mounted. Failure to confirm the correct operation of the machine may result in the machine behaving unexpectedly, possibly causing damage to the workpiece and/or machine itself, or injury to the user.
- **2.** Before operating the machine, thoroughly check the entered data. Operating the machine with incorrectly specified data may result in the machine behaving unexpectedly, possibly causing damage to the workpiece and/or machine itself, or injury to the user.
- **3.** Ensure that the specified feedrate is appropriate for the intended operation. Generally, for each machine, there is a maximum allowable feedrate. The appropriate feedrate varies with the intended operation. Refer to the manual provided with the machine to determine the maximum allowable feedrate. If a machine is run at other than the correct speed, it may behave unexpectedly, possibly causing damage to the workpiece and/or machine itself, or injury to the user.
- 4. When using a tool compensation function, thoroughly check the direction and amount of compensation.Operating the machine with incorrectly specified data may result in the machine behaving unexpectedly, possibly causing damage to the workpiece and/or machine itself, or injury to the user.
- 5. The parameters for the CNC and PMC are factory-set. Usually, there is not need to change them. When, however, there is not alternative other than to change a parameter, ensure that you fully understand the function of the parameter before making any change. Failure to set a parameter correctly may result in the machine behaving unexpectedly, possibly causing damage to the workpiece and/or machine itself, or injury to the user.
- **6.** Immediately after switching on the power, do not touch any of the keys on the MDI panel until the position display or alarm screen appears on the CNC unit. Some of the keys on the MDI panel are dedicated to maintenance or other special operations. Pressing any of these keys may place the CNC unit in other than its normal state. Starting the machine in this state may cause it to behave unexpectedly.
- **7.** The operator's manual and programming manual supplied with a CNC unit provide an overall description of the machine's functions, including any optional functions. Note that the optional functions will vary from one machine model to another. Therefore, some functions described in the manuals may not actually be available for a particular model. Check the specification of the machine if in doubt.

### WARNING

**8.** Some functions may have been implemented at the request of the machine–tool builder. When using such functions, refer to the manual supplied by the machine–tool builder for details of their use and any related cautions.

## NOTE

Programs, parameters, and macro variables are stored in nonvolatile memory in the CNC unit. Usually, they are retained even if the power is turned off. Such data may be deleted inadvertently, however, or it may prove necessary to delete all data from nonvolatile memory as part of error recovery.

To guard against the occurrence of the above, and assure quick restoration of deleted data, backup all vital data, and keep the backup copy in a safe place.

# WARNINGS AND CAUTIONS RELATED TO PROGRAMMING

This section covers the major safety precautions related to programming. Before attempting to perform programming, read the supplied operator's manual and programming manual carefully such that you are fully familiar with their contents.

#### WARNING

#### 1. Coordinate system setting

If a coordinate system is established incorrectly, the machine may behave unexpectedly as a result of the program issuing an otherwise valid move command.

Such an unexpected operation may damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### 2. Positioning by nonlinear interpolation

When performing positioning by nonlinear interpolation (positioning by nonlinear movement between the start and end points), the tool path must be carefully confirmed before performing programming.

Positioning involves rapid traverse. If the tool collides with the workpiece, it may damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### 3. Function involving a rotation axis

When programming polar coordinate interpolation or normal–direction (perpendicular) control, pay careful attention to the speed of the rotation axis. Incorrect programming may result in the rotation axis speed becoming excessively high, such that centrifugal force causes the chuck to lose its grip on the workpiece if the latter is not mounted securely.

Such mishap is likely to damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### 4. Inch/metric conversion

Switching between inch and metric inputs does not convert the measurement units of data such as the workpiece origin offset, parameter, and current position. Before starting the machine, therefore, determine which measurement units are being used. Attempting to perform an operation with invalid data specified may damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### 5. Constant surface speed control

When an axis subject to constant surface speed control approaches the origin of the workpiece coordinate system, the spindle speed may become excessively high. Therefore, it is necessary to specify a maximum allowable speed. Specifying the maximum allowable speed incorrectly may damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### WARNING

#### 6. Stroke check

After switching on the power, perform a manual reference position return as required. Stroke check is not possible before manual reference position return is performed. Note that when stroke check is disabled, an alarm is not issued even if a stroke limit is exceeded, possibly damaging the tool, the machine itself, the workpiece, or causing injury to the user.

#### 7. Tool post interference check

A tool post interference check is performed based on the tool data specified during automatic operation. If the tool specification does not match the tool actually being used, the interference check cannot be made correctly, possibly damaging the tool or the machine itself, or causing injury to the user.

After switching on the power, or after selecting a tool post manually, always start automatic operation and specify the tool number of the tool to be used.

#### 8. Absolute/incremental mode

If a program created with absolute values is run in incremental mode, or vice versa, the machine may behave unexpectedly.

#### 9. Plane selection

If an incorrect plane is specified for circular interpolation, helical interpolation, or a canned cycle, the machine may behave unexpectedly. Refer to the descriptions of the respective functions for details.

#### 10. Torque limit skip

Before attempting a torque limit skip, apply the torque limit. If a torque limit skip is specified without the torque limit actually being applied, a move command will be executed without performing a skip.

#### 11. Programmable mirror image

Note that programmed operations vary considerably when a programmable mirror image is enabled.

#### 12. Compensation function

If a command based on the machine coordinate system or a reference position return command is issued in compensation function mode, compensation is temporarily canceled, resulting in the unexpected behavior of the machine.

Before issuing any of the above commands, therefore, always cancel compensation function mode.

# WARNINGS AND CAUTIONS RELATED TO HANDLING

This section presents safety precautions related to the handling of machine tools. Before attempting to operate your machine, read the supplied operator's manual and programming manual carefully, such that you are fully familiar with their contents.

## WARNING

#### 1. Manual operation

When operating the machine manually, determine the current position of the tool and workpiece, and ensure that the movement axis, direction, and feedrate have been specified correctly. Incorrect operation of the machine may damage the tool, the machine itself, the workpiece, or cause injury to the operator.

#### 2. Manual reference position return

After switching on the power, perform manual reference position return as required. If the machine is operated without first performing manual reference position return, it may behave unexpectedly. Stroke check is not possible before manual reference position return is performed. An unexpected operation of the machine may damage the tool, the machine itself, the workpiece, or cause injury to the user.

#### 3. Manual numeric command

When issuing a manual numeric command, determine the current position of the tool and workpiece, and ensure that the movement axis, direction, and command have been specified correctly, and that the entered values are valid.

Attempting to operate the machine with an invalid command specified may damage the tool, the machine itself, the workpiece, or cause injury to the operator.

#### 4. Manual handle feed

In manual handle feed, rotating the handle with a large scale factor, such as 100, applied causes the tool and table to move rapidly. Careless handling may damage the tool and/or machine, or cause injury to the user.

#### 5. Disabled override

If override is disabled (according to the specification in a macro variable) during threading, rigid tapping, or other tapping, the speed cannot be predicted, possibly damaging the tool, the machine itself, the workpiece, or causing injury to the operator.

#### 6. Origin/preset operation

Basically, never attempt an origin/preset operation when the machine is operating under the control of a program. Otherwise, the machine may behave unexpectedly, possibly damaging the tool, the machine itself, the tool, or causing injury to the user.

### WARNING

#### 7. Workpiece coordinate system shift

Manual intervention, machine lock, or mirror imaging may shift the workpiece coordinate system. Before attempting to operate the machine under the control of a program, confirm the coordinate system carefully.

If the machine is operated under the control of a program without making allowances for any shift in the workpiece coordinate system, the machine may behave unexpectedly, possibly damaging the tool, the machine itself, the workpiece, or causing injury to the operator.

#### 8. Software operator's panel and menu switches

Using the software operator's panel and menu switches, in combination with the MDI panel, it is possible to specify operations not supported by the machine operator's panel, such as mode change, override value change, and jog feed commands.

Note, however, that if the MDI panel keys are operated inadvertently, the machine may behave unexpectedly, possibly damaging the tool, the machine itself, the workpiece, or causing injury to the user.

#### 9. Manual intervention

If manual intervention is performed during programmed operation of the machine, the tool path may vary when the machine is restarted. Before restarting the machine after manual intervention, therefore, confirm the settings of the manual absolute switches, parameters, and absolute/incremental command mode.

#### 10. Feed hold, override, and single block

The feed hold, feedrate override, and single block functions can be disabled using custom macro system variable #3004. Be careful when operating the machine in this case.

#### 11. Dry run

Usually, a dry run is used to confirm the operation of the machine. During a dry run, the machine operates at dry run speed, which differs from the corresponding programmed feedrate. Note that the dry run speed may sometimes be higher than the programmed feed rate.

#### 12. Cutter and tool nose radius compensation in MDI mode

Pay careful attention to a tool path specified by a command in MDI mode, because cutter or tool nose radius compensation is not applied. When a command is entered from the MDI to interrupt in automatic operation in cutter or tool nose radius compensation mode, pay particular attention to the tool path when automatic operation is subsequently resumed. Refer to the descriptions of the corresponding functions for details.

#### 13. Program editing

If the machine is stopped, after which the machining program is edited (modification, insertion, or deletion), the machine may behave unexpectedly if machining is resumed under the control of that program. Basically, do not modify, insert, or delete commands from a machining program while it is in use.

# WARNINGS RELATED TO DAILY MAINTENANCE

# WARNING

#### 1. Memory backup battery replacement

Only those personnel who have received approved safety and maintenance training may perform this work.

When replacing the batteries, be careful not to touch the high–voltage circuits (marked  $\triangle$  and fitted with an insulating cover).

Touching the uncovered high-voltage circuits presents an extremely dangerous electric shock hazard.

## NOTE

The CNC uses batteries to preserve the contents of its memory, because it must retain data such as programs, offsets, and parameters even while external power is not applied.

If the battery voltage drops, a low battery voltage alarm is displayed on the machine operator's panel or CRT screen.

When a low battery voltage alarm is displayed, replace the batteries within a week. Otherwise, the contents of the CNC's memory will be lost.

Refer to the maintenance section of the operator's manual or programming manual for details of the battery replacement procedure.

## WARNING

#### 2. Absolute pulse coder battery replacement

Only those personnel who have received approved safety and maintenance training may perform this work.

When replacing the batteries, be careful not to touch the high–voltage circuits (marked  $\triangle$  and fitted with an insulating cover).

Touching the uncovered high-voltage circuits presents an extremely dangerous electric shock hazard.

## NOTE

The absolute pulse coder uses batteries to preserve its absolute position.

If the battery voltage drops, a low battery voltage alarm is displayed on the machine operator's panel or CRT screen.

When a low battery voltage alarm is displayed, replace the batteries within a week. Otherwise, the absolute position data held by the pulse coder will be lost.

Refer to the FANUC SERVO MOTOR AMPLIFIER  $\alpha$  series maintenance manual for details of the battery replacement procedure.

# WARNING

#### 3. Fuse replacement

Before replacing a blown fuse, however, it is necessary to locate and remove the cause of the blown fuse.

For this reason, only those personnel who have received approved safety and maintenance training may perform this work.

When replacing a fuse with the cabinet open, be careful not to touch the high–voltage circuits (marked  $\blacktriangle$  and fitted with an insulating cover).

Touching an uncovered high-voltage circuit presents an extremely dangerous electric shock hazard.

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# I. GENERAL

This manual consists of the following parts:

# GENERAL

About this manual

#### I. GENERAL

Describes chapter organization, applicable models, related manuals, and notes for reading this manual.

#### **II. PROGRAMMING**

Describes each function: Format used to program functions in the NC language, characteristics, and restrictions. When a program is created through conversational automatic programming function, refer to the manual for the conversational automatic programming function (Table1).

#### **III. OPERATION**

Describes the manual operation and automatic operation of a machine, procedures for inputting and outputting data, and procedures for editing a program.

#### **IV. MAINTENANCE**

Describes procedures for replacing batteries.

#### V. APPENDIX

Lists tape codes, valid data ranges, and error codes.

Some functions described in this manual may not be applied to some products. For detail, refer to the DESCRIPTIONS manual (B–63002EN).

This manual does not describe parameters in detail. For details on parameters mentioned in this manual, refer to the manual for parameters (B-63010EN).

This manual describes all optional functions. Look up the options incorporated into your system in the manual written by the machine tool builder.

| Product name                   | Product name Abbreviations |                       |  |
|--------------------------------|----------------------------|-----------------------|--|
| FANUC Series 16 <i>i</i> -TA   | 16 <i>i</i> –TA            | Series 16 <i>i</i>    |  |
| FANUC Series 18 <i>i</i> -TA   | 18 <i>i</i> –TA            | Series 18 <i>i</i>    |  |
| FANUC Series 160 <i>i</i> -TA  | 160 <i>i</i> –TA           | Series 160 <i>i</i>   |  |
| FANUC Series 180 <i>i</i> -TA  | 180 <i>i</i> –TA           | Series 180 <i>i</i>   |  |
| FANUC Series 160 <i>i</i> s-TA | 160 <i>i</i> s–TA          | Series 160 <i>i</i> s |  |
| FANUC Series 180 <i>i</i> s-TA | 180 <i>i</i> s–TA          | Series 180 <i>i</i> s |  |

The models covered by this manual, and their abbreviations are:

GENERAL

| Special symbols | This manual uses the following symbols:   |
|-----------------|---|
|                 | <ul> <li>IP_ : Indicates a combination of axes such as X_ Y_ Z<br/>(used in PROGRAMMING.).</li> <li>; : Indicates the end of a block. It actually corresponds to<br/>the ISO code LF or EIA code CR.</li> </ul> |
| Related manuals | The table below lists manuals related to MODEL C of Series 16 <i>i</i> , Series   |

The table below lists manuals related to MODEL C of Series 16*i*, Seri 18*i*, Series 160*i* and Series 180*i*. In the table, this manual is marked with an asterisk (\*).

| Manual name   | Specification number |   |
|---|----------------------|---|
| DESCRIPTIONS  | B-63002EN            |   |
| CONNECTION MANUAL (HARDWARE)  | B-63003EN            |   |
| CONNECTION MANUAL (FUNCTION)  | B-63003EN-1          |   |
| OPERATOR'S MANUAL (For LATHE)   | B-63004EN            | * |
| OPERATOR'S MANUAL (For MACHINING CENTER)  | B-63014EN            |   |
| MAINTENANCE MANUAL  | B-63005EN            |   |
| PARAMETER MANUAL  | B-63010EN            |   |
| CONNECTION MANUAL (LOADER CONTROL)  | B-62443EN-2          |   |
| PROGRAMMING MANUAL<br>(Macro Compiler / Macro Executer)                         | B-61803E-1           |   |
| FAPT MACRO COMPILER PROGRAMMING MANUAL  | B-66102E             |   |
| FAPT LADDER-II OPERATOR'S MANUAL  | B–66184EN            |   |
| FANUC PMC–MODEL SAI/SAS PROGRAMMING<br>MANUAL (LADDER LANGUAGE)                 | B-61863E             |   |
| FANUC PMC–MODEL SC/NB PROGRAMMING<br>MANUAL (C LANGUAGE)                        | B-61863E-1           |   |
| FANUC Super CAP T/I T OPERATOR'S MANUAL   | B-62444E-1           |   |
| FANUC Super CAP M/II M OPERATOR'S MANUAL  | B–62154E             |   |
| CONVERSATIONAL AUTOMATIC PROGRAMMING<br>FUNCTION II FOR LATHE OPERATOR'S MANUAL | B–62153E             |   |
| CONVERSATIONAL AUTOMATIC PROGRAMMING<br>FUNCTION II FOR LATHE OPERATOR'S MANUAL | B-61804E-2           |   |
| FANUC Symbol CAPi T OPERATOR'S MANUAL   | B-63304EN            |   |
| FANUC Super CAPi T OPERATOR'S MANUAL  | B-63284EN            |   |
| FANUC Super CAPi M OPERATOR'S MANUAL  | B-63294EN            |   |

#### Table 1 Related Manuals

# Related manuals of SERVO MOTOR $\alpha$ series, $\beta$ series

#### Related manuals of SERVO MOTOR $\alpha$ series, $\beta$ series

| Manual name  | Specification<br>number |
|--|-------------------------|
| FANUC AC SERVO MOTOR $\alpha$ series DESCRIPTIONS                        | B–65142E                |
| FANUC AC SERVO MOTOR $\alpha$ series PARAMETER MANUAL                    | B-65150E                |
| FANUC AC SPINDLE MOTOR $\alpha$ series DESCRIPTIONS                      | B–65152E                |
| FANUC AC SPINDLE MOTOR $\alpha$ series PARAMETER MANUAL                  | B-65160E                |
| FANUC SERVO AMPLIFIER $\alpha$ series DESCRIPTIONS                       | B–65162E                |
| FANUC SERVO $\alpha$ series MAINTENANCE MANUAL                           | B–65165E                |
| FANUC SERVO MOTOR $\beta$ series DESCRIPTIONS                            | B–65232EN               |
| FANUC SERVO MOTOR $\beta$ series MAINTENANCE MANUAL                      | B–65235EN               |
| FANUC SERVO MOTOR $\beta$ series (I/O Link Option)<br>MAINTENANCE MANUAL | B–65245EN               |

# Related manuals of I/O–Unit and other

#### Related manuals of I/O-Unit and other

| Manual name   | Specification<br>number |
|---|-------------------------|
| FANUC PROFIBUS-DP Board OPERATOR'S MANUAL                   | B–62924EN               |
| FANUC Ethernet Board/DATA SERVER BOARD<br>OPERATOR'S MANUAL | B–63354EN               |
| FANUC FL-net Board OPERATOR'S MANUAL                        | B–63434EN               |
| FANUC Devicenet BOARD OPERATOR'S MANUAL                     | B–63404EN               |
| FANUC I/O Unit-MODEL A CONNECTION/MAINTENANCE<br>MANUAL     | B–61813E                |
| FANUC I/O Unit-MODEL B CONNECTION/MAINTENANCE<br>MANUAL     | B–62163E                |
| FANUC I/O Link-II CONNECTION MANUAL                         | B–62714EN               |
| FANUC DNC1 DESCRIPTIONS                                     | B–61782E                |
| FANUC DNC2 DESCRIPTIONS                                     | B–61992E                |

# Related manuals of OPEN CNC

#### **Related manuals of OPEN CNC**

| Manual name   | Specification<br>number |
|---|-------------------------|
| FANUC OPEN CNC OPERATOR'S MANUAL<br>(LADDER EDITING PACKAGE)                        | B–62884EN               |
| FANUC OPEN CNC OPERATOR'S MANUAL<br>(Basic Operation Package 1 (for Windows 95/NT)) | B–62994EN               |
| FANUC OPEN CNC OPERATOR'S MANUAL<br>(CNC Screen Display Function)                   | B–63164EN               |

# 1.1 GENERAL FLOW OF OPERATION OF CNC MACHINE TOOL

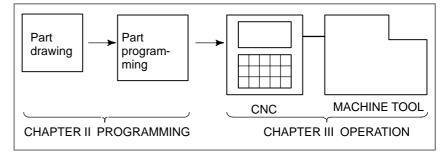
When machining the part using the CNC machine tool, first prepare the program, then operate the CNC machine by using the program.

1) First, prepare the program from a part drawing to operate the CNC machine tool.

How to prepare the program is described in the Chapter II. PROGRAMMING.

2) The program is to be read into the CNC system. Then, mount the workpieces and tools on the machine, and operate the tools according to the programming. Finally, execute the machining actually. How to operate the CNC system is described in the Chapter III.

OPERATION.



Before the actual programming, make the machining plan for how to machine the part.

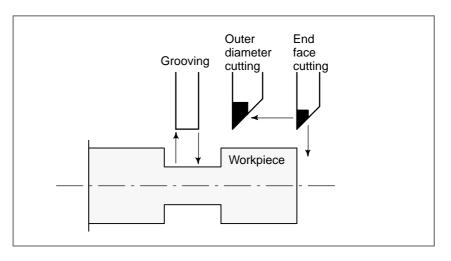
Machining plan

- 1. Determination of workpieces machining range
- 2. Method of mounting workpieces on the machine tool
- 3. Machining sequence in every cutting process
- 4. Cutting tools and cutting conditions

Decide the cutting method in every cutting process.

| Cutting process                                      | 1                   | 2                      | 3        |
|--|---------------------|------------------------|----------|
| Cutting procedure                                    | End face<br>cutting | Outer diameter cutting | Grooving |
| 1. Cutting method<br>: Rough<br>Semi<br>Finish       |                     |                        |          |
| 2. Cutting tools                                     |                     |                        |          |
| 3. Cutting conditions<br>: Feedrate<br>Cutting depth |                     |                        |          |
| 4. Tool path   |                     |                        |          |

— 8 —



Prepare the program of the tool path and cutting condition according to the workpiece figure, for each cutting.

# 1.2 NOTES ON READING THIS MANUAL

#### NOTE

- 1 The function of an CNC machine tool system depends not only on the CNC, but on the combination of the machine tool, its magnetic cabinet, the servo system, the CNC, the operator's panels, etc. It is too difficult to describe the function, programming, and operation relating to all combinations. This manual generally describes these from the stand-point of the CNC. So, for details on a particular CNC machine tool, refer to the manual issued by the machine tool builder, which should take precedence over this manual.
- 2 Headings are placed in the left margin so that the reader can easily access necessary information. When locating the necessary information, the reader can save time by searching though these headings.
- 3 Machining programs, parameters, variables, etc. are stored in the CNC unit internal non-volatile memory. In general, these contents are not lost by the switching ON/OFF of the power. However, it is possible that a state can occur where precious data stored in the non-volatile memory has to be deleted, because of deletions from a maloperation, or by a failure restoration. In order to restore rapidly when this kind of mishap occurs, it is recommended that you create a copy of the various kinds of data beforehand.
- 4 This manual describes as many reasonable variations in equipment usage as possible. It cannot address every combination of features, options and commands that should not be attempted.

If a particular combination of operations is not described, it should not be attempted.

# II. PROGRAMMING

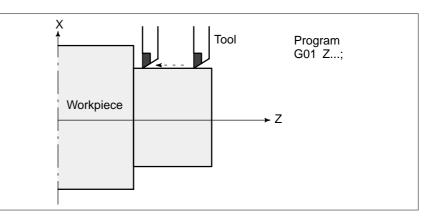
# GENERAL

# 1.1 TOOL MOVEMENT ALONG WORKPIECE PARTS FIGURE-INTERPOLATION

Explanations

• Tool movement along a straight line

The tool moves along straight lines and arcs constituting the workpiece parts figure (See II–4).



#### Fig.1.1 (a) Tool movement along the straight line which is parallel to Z-axis

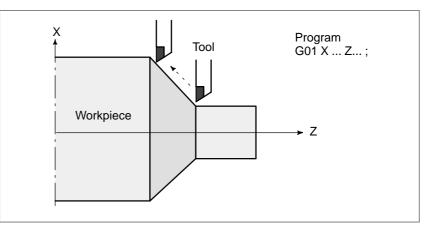
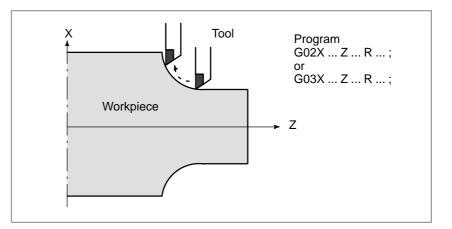


Fig.1.1 (b) Tool movement along the taper line

• Tool movement along an arc



#### Fig. 1.1 (c) Tool movement along an arc

The term interpolation refers to an operation in which the tool moves along a straight line or arc in the way described above.

Symbols of the programmed commands G01, G02, ... are called the preparatory function and specify the type of interpolation conducted in the control unit.

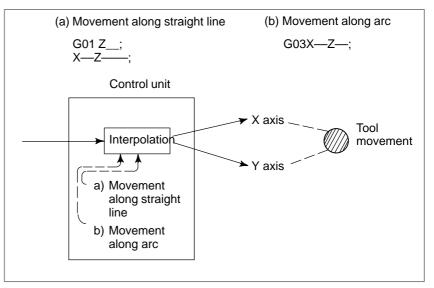


Fig. 1.1 (d) Interpolation function

#### NOTE

Some machines move tables instead of tools but this manual assumes that tools are moved against workpieces.

• Thread cutting

Threads can be cut by moving the tool in synchronization with spindle rotation. In a program, specify the thread cutting function by G32.

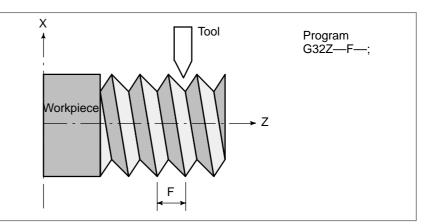


Fig. 1.1 (e) Straight thread cutting

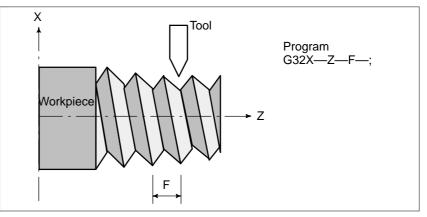


Fig. 1.1 (f) Taper thread cutting

# 1.2 FEED-FEED FUNCTION

Movement of the tool at a specified speed for cutting a workpiece is called the feed.

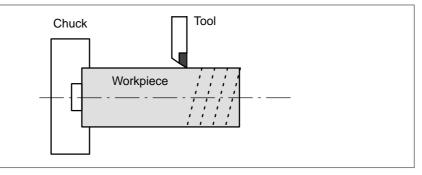


Fig. 1.2 (a) Feed function

Feedrates can be specified by using actual numerics.

For example, the following command can be used to feed the tool 2 mm while the workpiece makes one turn :

#### F2.0

The function of deciding the feed rate is called the feed function (See II-5).

#### B-63004EN/02

# 1.3 PART DRAWING AND TOOL MOVEMENT

1.3.1 Reference Position (Machine–Specific Position) A CNC machine tool is provided with a fixed position. Normally, tool change and programming of absolute zero point as described later are performed at this position. This position is called the reference position.

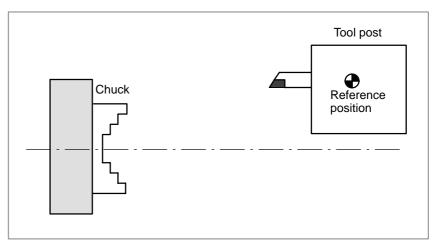


Fig. 1.3.1 (a) Reference position

Explanations

The tool can be moved to the reference position in two ways:

- 1. Manual reference position return (See III–3.1) Reference position return is performed by manual button operation.
- 2. Automatic reference position return (See II–6) In general, manual reference position return is performed first after the power is turned on. In order to move the tool to the reference position for tool change thereafter, the function of automatic reference position return is used.

#### 1.3.2

Coordinate System on Part Drawing and Coordinate System Specified by CNC – Coordinate System

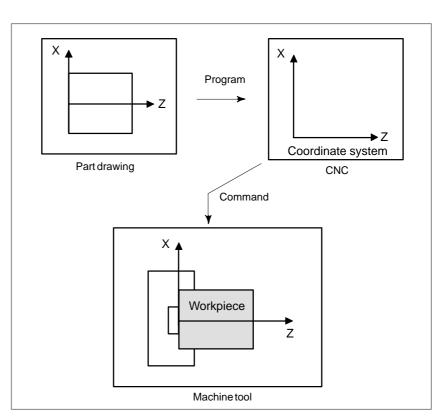


Fig. 1.3.2 (a) Coordinate system

#### **Explanations**

• Coordinate system

The following two coordinate systems are specified at different locations: (See II–7)

- 1. Coordinate system on part drawing The coordinate system is written on the part drawing. As the program data, the coordinate values on this coordinate system are used.
- 2. Coordinate system specified by the CNC The coordinate system is prepared on the actual machine tool. This can be achieved by programming the distance from the current position of the tool to the zero point of the coordinate system to be set.

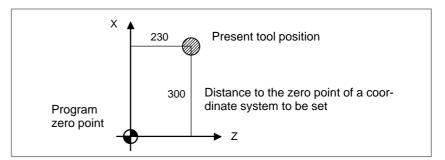


Fig. 1.3.2 (b) Coordinate system specified by the CNC

— 19 —

The tool moves on the coordinate system specified by the CNC in accordance with the command program generated with respect to the coordinate system on the part drawing, and cuts a workpiece into a shape on the drawing.

Therefore, in order to correctly cut the workpiece as specified on the drawing, the two coordinate systems must be set at the same position.

The following method is usually used to define two coordinate systems at the same location.

1. When coordinate zero point is set at chuck face

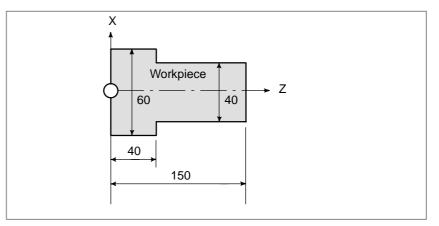


Fig. 1.3.2 (c) Coordinates and dimensions on part drawing

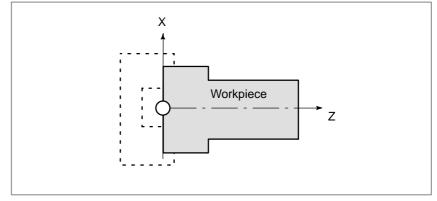


Fig. 1.3.2 (d) Coordinate system on lathe as specified by CNC (made to coincide with the coordinate system on part drawing)

 Methods of setting the two coordinate systems in the same position 2. When coordinate zero point is set at work end face.

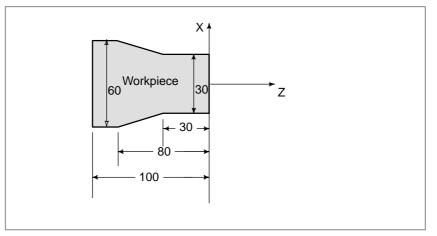


Fig. 1.3.2 (e) Coordinates and dimensions on part drawing

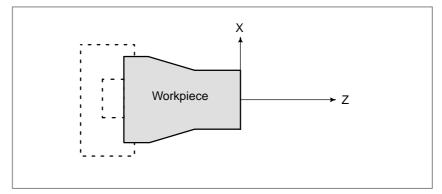


Fig. 1.3.2 (f) Coordinate system on lathe as specified by CNC (made to coincide with the coordinate system on part drawing)

### 1.3.3

How to Indicate Command Dimensions for Moving the Tool – Absolute, Incremental Commands

**Explanations** 

• Absolute command

Methods of command for moving the tool can be indicated by absolute or incremental designation (See II–8.1).

The tool moves to a point at "the distance from zero point of the coordinate system" that is to the position of the coordinate values.

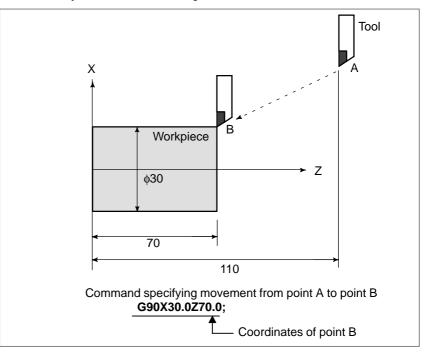
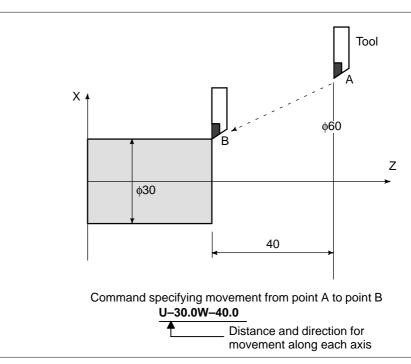


Fig. 1.3.3 (a) Absolute command

position.



Specify the distance from the previous tool position to the next tool

#### Incremental command

Fig. 1.3.3 (b) Incremental command

Dimensions of the X axis can be set in diameter or in radius. Diameter programming or radius programming is employed independently in each machine.

1. Diameter programming

In diameter programming, specify the diameter value indicated on the drawing as the value of the X axis.

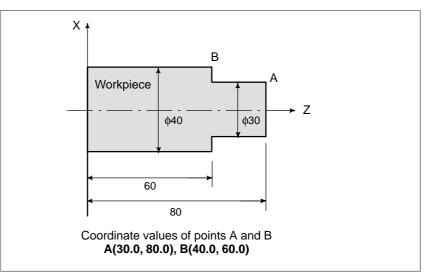


Fig. 1.3.3 (c) Diameter programming

• Diameter programming / radius programming

#### 2. Radius programming

In radius programming, specify the distance from the center of the workpiece, i.e. the radius value as the value of the X axis.

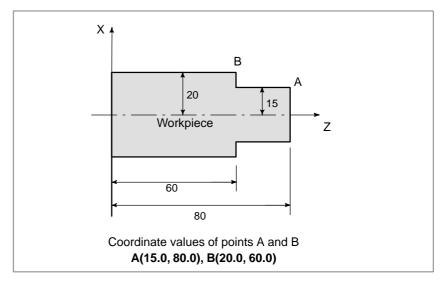


Fig. 1.3.3 (d) Radius programming

# 1.4 CUTTING SPEED – SPINDLE SPEED FUNCTION

The speed of the tool with respect to the workpiece when the workpiece is cut is called the cutting speed.

As for the CNC, the cutting speed can be specified by the spindle speed in rpm unit.

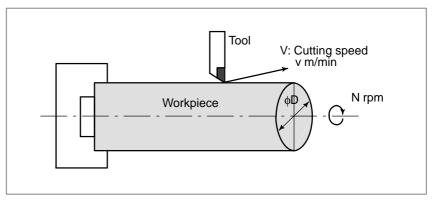


Fig. 1.4 Cutting speed

<When a workpiece 200 mm in diameter should be machined at a cutting speed of 300 m/min. >

The spindle speed is approximately 478 rpm, which is obtained from N=1000v/ $\pi$ D. Hence the following command is required:

#### S478;

Commands related to the spindle speed are called the spindle speed function (See II-9).

The cutting speed v (m/min) can also be specified directly by the speed value. Even when the workpiece diameter is changed, the CNC changes the spindle speed so that the cutting speed remains constant.

This function is called the constant surface speed control function (See II–9.3).

#### **Examples**

# 1.5 SELECTION OF TOOL USED FOR VARIOUS MACHINING – TOOL FUNCTION

When drilling, tapping, boring, milling or the like, is performed, it is necessary to select a suitable tool. When a number is assigned to each tool and the number is specified in the program, the corresponding tool is selected.

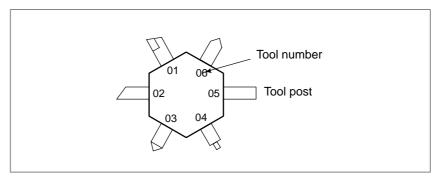


Fig. 1.5 Tool used for various machining

**Examples** 

<When No.01 is assigned to a roughing tool>

When the tool is stored at location 01 of the tool post, the tool can be selected by specifying **T0101**.

This is called the tool function (See II–10).

# 1.6 COMMAND FOR MACHINE OPERATIONS – MISCELLANEOUS FUNCTION

When machining is actually started, it is necessary to rotate the spindle, and feed coolant. For this purpose, on–off operations of spindle motor and coolant valve should be controlled (See II–11).

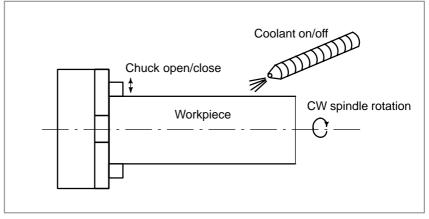


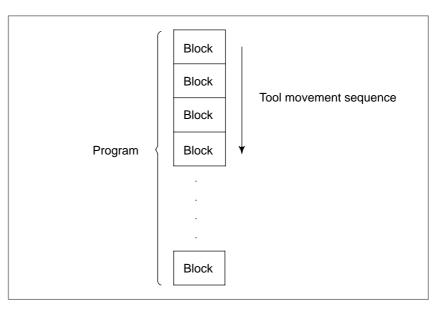
Fig. 1.6 Command for machine operations

The function of specifying the on–off operations of the components of the machine is called the miscellaneous function. In general, the function is specified by an M code.

For example, when M03 is specified, the spindle is rotated clockwise at the specified spindle speed.

# 1.7 PROGRAM CONFIGURATION

A group of commands given to the CNC for operating the machine is called the program. By specifying the commands, the tool is moved along a straight line or an arc, or the spindle motor is turned on and off. In the program, specify the commands in the sequence of actual tool movements.



#### Fig. 1.7 (a) Program configuration

A group of commands at each step of the sequence is called the block. The program consists of a group of blocks for a series of machining. The number for discriminating each block is called the sequence number, and the number for discriminating each program is called the program number (See II–12).

#### **Explanations**

#### Block

The block and the program have the following configurations.

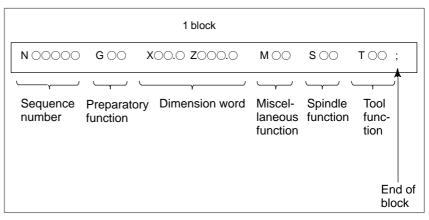


Fig. 1.7 (b) Block configuration

A block begins with a sequence number that identifies that block and ends with an end–of–block code.

This manual indicates the end–of–block code by ; (LF in the ISO code and CR in the EIA code).

Program

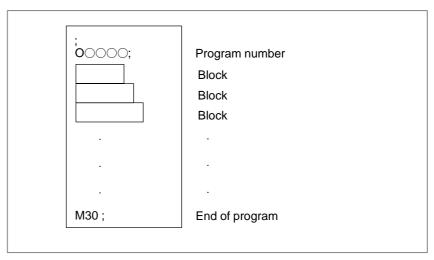
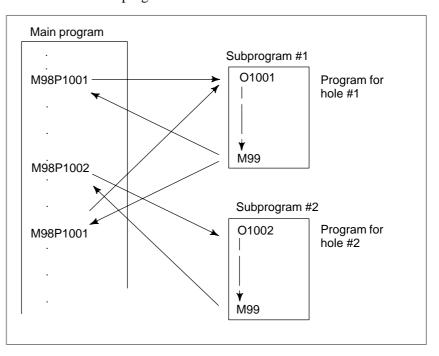


Fig. 1.7 (c) Program configuration

Normally, a program number is specified after the end–of–block (;) code at the beginning of the program, and a program end code (M02 or M30) is specified at the end of the program.

 Main program and subprogram When machining of the same pattern appears at many portions of a program, a program for the pattern is created. This is called the subprogram. On the other hand, the original program is called the main program. When a subprogram execution command appears during execution of the main program, commands of the subprogram are executed. When execution of the subprogram is finished, the sequence returns to the main program.



## 1.8 TOOL FIGURE AND TOOL MOTION BY PROGRAM

#### **Explanations**

 Machining using the end of cutter – Tool length compensation function (See II–15.1) Usually, several tools are used for machining one workpiece. The tools have different tool length. It is very troublesome to change the program in accordance with the tools.

Therefore, the length of each tool used should be measured in advance. By setting the difference between the length of the standard tool and the length of each tool in the CNC (data display and setting : see III–11), machining can be performed without altering the program even when the tool is changed. This function is called tool length compensation.

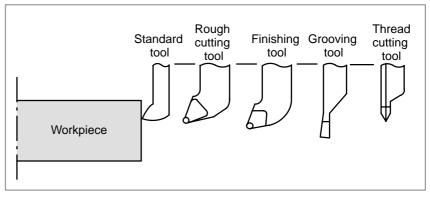
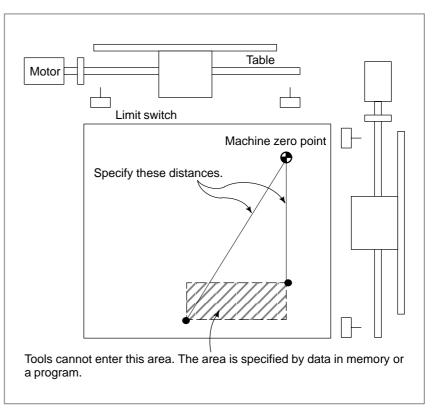


Fig. 1.8 Tool offset

# 1.9 TOOL MOVEMENT RANGE – STROKE

Limit switches are installed at the ends of each axis on the machine to prevent tools from moving beyond the ends. The range in which tools can move is called the stroke. Besides the stroke limits, data in memory can be used to define an area which tools cannot enter.



Besides strokes defined with limit switches, the operator can define an area which the tool cannot enter using a program or data in memory. This function is called stroke check.



# 2.1 CONTROLLED AXES

Series 16*i* Series 160*i* 

| Item  | 16 <i>i</i> –TA<br>160 <i>i</i> –TA  | 16 <i>i</i> –TA, 160 <i>i</i> –TA<br>(two–path control) |
|---|--------------------------------------|---|
| Number of basic<br>controlled axes                  | 2 axes                               | 2 axes for each tool post<br>(4 axes in total)          |
| Controlled axis expansion (total)                   | Max. 8 axes<br>(Included in Cs axis) | Max. 6 axes for each tool post +Cs axis (Note)          |
| Number of basic simulta-<br>neously controlled axes | 2 axes                               | 2 axes for each tool post<br>(4 axes in total)          |
| Simultaneously controlled axis expansion (total)    | Max. 6 axes                          | Max. 4 axes for each tool post                          |

#### NOTE

- 1 A two-path control system with the 7.2"/8.4" LCD has up to eight controlled axes.
- 2 The number of simultaneously controllable axes for manual operation (jog feed, incremental feed, or manual handle feed) is 1 or 3 (1 when bit 0 (JAX) of parameter 1002 is set to 0 and 3 when it is set to 1).

Series 18*i* Series 180*i* 

| Item  | 18 <i>i</i> –TA<br>180 <i>i</i> –TA  | 18 <i>i</i> –TA, 180 <i>i</i> –TA<br>(two–path control) |
|---|--------------------------------------|---|
| Number of basic<br>controlled axes                  | 2 axes                               | 2 axes for each tool post<br>(4 axes in total)          |
| Controlled axis expansion (total)                   | Max. 6 axes<br>(Included in Cs axis) | Max. 4 axes for each tool post +Cs axis (Note)          |
| Number of basic simulta-<br>neously controlled axes | 2 axes                               | 2 axes for each tool post<br>(4 axes in total)          |
| Simultaneously controlled axis expansion (total)    | Max. 4 axes                          | Max. 4 axes for each tool post                          |

#### NOTE

- 1 A two-path control system with the 7.2"/8.4" LCD has up to eight controlled axes.
- 2 The number of simultaneously controllable axes for manual operation (jog feed, incremental feed, or manual handle feed) is 1 or 3 (1 when bit 0 (JAX) of parameter 1002 is set to 0 and 3 when it is set to 1).

| 2.2<br>NAMES OF AXES                  | The names of two basic axes are always X and Z; the names of additional axes can be optionally selected from A, B, C, U, V, W, and Y by using parameter No.1020.<br>Each axis name is determined according to parameter No. 1020. If the parameter specifies 0 or anything other than the nine letters, the axis name defaults to a number from 1 to 8.<br>With two–path control, the names of two basic axes for one tool post are always X and Z; the names of additional axes can be optionally selected from A, B, C, U, V, W, and Y by using parameter No. 1020. For one tool post, the same axis name cannot be assigned to multiple axes, but the same axis name can be used with the other tool post.  |  |
|---------------------------------------|--|--|
| Limitations                           |  |  |
| <ul> <li>Default axis name</li> </ul> | When a default axis name (1 to 8) is used, the system cannot operate in MEM or MDI mode.   |  |
| • Duplicate axis name                 | <ul> <li>If the parameter specifies an axis name more than once, only the first axis to be assigned that axis name becomes operable.</li> <li><b>NOTE</b> <ol> <li>When G code system A is used, the letters U, V, and W cannot be used as an axis name (hence, the maximum of six controlled axes), because these letters are used as incremental commands for X, Y, and Z. To use the letters U, V, and W as axis names, the G code system must be B or C. Likewise, letter H is used as an incremental command for C, thus incremental commands cannot be used if A or B is used as an axis name.</li> <li>With two–path control, when information (such as the current position) about each axis is displayed on the screen, an axis name may be followed by a subscript to indicate a tool post number (e.g., X1 and X2). This is axis name to help the user to easily understand which tool post an axis belongs to. When writing a program, the user must specify X, Y, Z, U, V, W, A, B, and C without attaching a subscript.</li> <li>In G76 (multiple–thread cutting), the A address in a block specifies the tool nose angle instead of a command for axis A.</li> <li>If C or A is used as an axis name, C or A cannot be used as an angle command for a straight line in chamfering or direct drawing dimension programming. Therefore, C and A should be used according to bit 4 (CCR) of parameter No. 3405.</li> </ol> </li> </ul> |  |

# 2.3 INCREMENT SYSTEM

The increment system consists of the least input increment (for input) and least command increment (for output). The least input increment is the least increment for programming the travel distance. The least command increment is the least increment for moving the tool on the machine. Both increments are represented in mm, inches, or degrees.

The increment system is classified into IS–B and IS–C (Tables 2.3 (a) and 2.3 (b)). Select IS–B or IS–C using bit 1 (ISC) of parameter 1004. When the IS–C increment system is selected, it is applied to all axes and the 1/10 increment system option is required.

|               |       | Least input increment  | Least command increment |
|---------------|-------|------------------------|-------------------------|
| Metric        | mm    | 0.001 mm (Diameter)    | 0.0005 mm               |
| system<br>ma- | input | 0.001 mm (Radius)      | 0.001 mm                |
| chine         |       | 0.001 deg              | 0.001 deg               |
|               | inch  | 0.0001 inch (Diameter) | 0.0005 inch             |
|               | input | 0.0001 inch (Radius)   | 0.001 inch              |
|               |       | 0.001 deg              | 0.001 deg               |
| Inch          | mm    | 0.001 mm (Diameter)    | 0.00005 mm              |
| ma-<br>chine  | input | 0.001 mm (Radius)      | 0.0001 mm               |
| system        |       | 0.001 deg              | 0.001 deg               |
|               | inch  | 0.0001 inch (Diameter) | 0.00005 inch            |
|               | input | 0.0001 inch (Radius)   | 0.0001 inch             |
|               |       | 0.001 deg              | 0.001 deg               |

| Table 2.3 (a) | Increment system | IS-B |
|---------------|------------------|------|
|---------------|------------------|------|

| Table 2.3 (b) | Increment system IS-0 | 2 |
|---------------|-----------------------|---|
|---------------|-----------------------|---|

|                    |               | Least input increment   | Least command increment |
|--------------------|---------------|-------------------------|-------------------------|
| Metric             | mm            | 0.0001 mm (Diameter)    | 0.00005 mm              |
| system<br>ma-      | input         | 0.0001 mm (Radius)      | 0.0001 mm               |
| chine              |               | 0.0001 deg 0.0001 deg   |                         |
|                    | inch          | 0.00001 inch (Diameter) | 0.00005 inch            |
| input              |               | 0.00001 inch (Radius)   | 0.0001 inch             |
|                    |               | 0.0001 deg              | 0.0001 deg              |
| Inch               | mm            | 0.0001 mm (Diameter)    | 0.000005 mm             |
| ma- input<br>chine |               | 0.0001 mm (Radius)      | 0.00001 mm              |
| system             |               | 0.0001 deg              | 0.0001 deg              |
|                    | inch<br>input | 0.00001 inch (Diameter) | 0.000005 inch           |
|                    |               | 0.00001 inch (Radius)   | 0.00001 inch            |
|                    |               | 0.0001 deg              | 0.0001 deg              |

# 2.4 MAXIMUM STROKES

The maximum stroke controlled by this CNC is shown in the table below: Maximum stroke = Least command increment  $\pm$  999999999.

| Increment system |                       | Maximum strokes                     |
|------------------|-----------------------|-------------------------------------|
| IS-B             | Metric machine system | ± 99999.999 mm<br>± 99999.999 deg   |
|                  | Inch machine system   | ± 9999.9999 inch<br>± 99999.999 deg |
| IS–C             | Metric machine system | ± 9999.9999 mm<br>± 9999.9999 deg   |
|                  | Inch machine system   | ± 999.99999 inch<br>± 9999.9999 deg |

#### NOTE

- 1 The unit in the table is a diameter value with diameter programming and a radius value in radius programming.
- 2 A command exceeding the maximum stroke cannot be specified.
- 3 The actual stroke depends on the machine tool.

# 3

# **PREPARATORY FUNCTION (G FUNCTION)**

A number following address G determines the meaning of the command for the concerned block.

G codes are divided into the following two types.

| Туре            | Meaning  |
|-----------------|--|
| One-shot G code | The G code is effective only in the block in which it is specified           |
| Modal G code    | The G code is effective until another G code of the same group is specified. |

(Example)

G01 and G00 are modal G codes.



There are three G code systems : A,B, and C (Table 3). Select a G code system using bits 6 (GSB) and 7 (GSC) of parameter 3401. Generally, this manual describes the use of G code system A, except when the described item can use only G code system B or C. In such cases, the use of G code system B or C is described.

| Explanations 1 | . If the CNC enters the clear state (see bit 6 (CLR) of parameter 3402) when the power is turned on or the CNC is reset, the modal G codes change as follows.  |
|----------------|--|
|                | (1)G codes marked with $\checkmark$ in Table 3 are enabled.  |
|                | (2) When the system is cleared due to power–on or reset, whichever specified, either G20 or G21, remains effective.  |
|                | (3) Bit 7 of parameter No. 3402 can be used to specify whether G22 or G23 is selected upon power–on. Resetting the CNC to the clear state does not affect the selection of G22 or G23.                                     |
|                | (4) Setting bit 0 (G01) of parameter 3402 determines which code, either G00 or G01, is effective.  |
|                | (5) Setting bit 3 (G91) of parameter 3402 determines which code, either G90 or G91, is effective.  |
| 2              | . G codes of group 00 except G10 and G11 are single-shot G codes.  |
| 3              | 5. P/S larm (No.010) is displayed when a G code not listed in the G code list is specified or a G code without a corresponding option is specified.  |
| 4              | •. G codes of different groups can be specified in the same block.<br>If G codes of the same group are specified in the same block, the G code specified last is valid.  |
| 5              | 5. If a G code of group 01 is specified in a canned cycle, the canned cycle is canceled in the same way as when a G80 command is specified. G codes of group 01 are not affected by G codes for specifying a canned cycle. |
| 6              | 5. When G code system A is used for a canned cycle, only the initial level is provided at the return point.  |
| 7              | . G codes are displayed for each group number.   |

#### 3. PREPARATORY FUNCTION (G FUNCTION)

| G code          |                 |                 |       |   |
|-----------------|-----------------|-----------------|-------|---|
| Α               | B               | С               | Group | Function  |
| G00             | G00             | G00             |       | Positioning (Rapid traverse)                            |
| G01             | G01             | G01             | 01    | Linear interpolation (Cutting feed)                     |
| G02             | G02             | G02             | 01    | Circular interpolation CW or Helical interpolation CW   |
| G03             | G03             | G03             |       | Circular interpolation CCW or Helical interpolation CCW |
| G04             | G04             | G04             | 00    | Dwell   |
| G05             | G05             | G05             | 00    | High speed cycle cutting                                |
| G07             | G07             | G07             | 00    | Hypothetical axis interpolation                         |
| G07.1<br>(G107) | G07.1<br>(G107) | G07.1<br>(G107) |       | Cylindrical interpolation                               |
| G10             | G10             | G10             | 00    | Programmable data input                                 |
| G10.6           | G10.6           | G10.6           |       | Tool retract & recover                                  |
| G11             | G11             | G11             |       | Programmable data input cancel                          |
| G12.1<br>(G112) | G12.1<br>(G112) | G12.1<br>(G112) | 21    | Polar coordinate interpolation mode                     |
| G13.1<br>(G113) | G13.1<br>(G113) | G13.1<br>(G113) |       | Polar coordinate interpolation cancel mode              |
| G17             | G17             | G17             |       | XpYp plane selection                                    |
| G18             | G18             | G18             | 16    | ZpXp plane selection                                    |
| G19             | G19             | G19             |       | YpZp plane selection                                    |
| G20             | G20             | G70             | 06    | Input in inch   |
| G21             | G21             | G71             |       | Input in mm   |
| G22             | G22             | G22             | 09    | Stored stroke check function on                         |
| G23             | G23             | G23             |       | Stored stroke check function off                        |
| G25             | G25             | G25             | 08    | Spindle speed fluctuation detection off                 |
| G26             | G26             | G26             |       | Spindle speed fluctuation detection on                  |
| G27             | G27             | G27             |       | Reference position return check                         |
| G28             | G28             | G28             |       | Return to reference position                            |
| G30             | G30             | G30             | 00    | 2nd, 3rd and 4th reference position return              |
| G30.1           | G30.1           | G30.1           |       | Floating reference point return                         |
| G31             | G31             | G31             |       | Skip function   |
| G32             | G33             | G33             |       | Thread cutting  |
| G34             | G34             | G34             | 01    | Variable-lead thread cutting                            |
| G35             | G35             | G35             | -     | Circular threading (clockwise)                          |
| G36             | G36             | G36             |       | Circular threading (counterclockwise)                   |
| G36             | G36             | G36             |       | Automatic tool compensation X                           |
| G37             | G37             | G37             | 00    | Automatic tool compensation Z                           |
| G39             | G39             | G39             |       | Corner circular interpolation                           |
| G40             | G40             | G40             |       | Tool nose radius compensation cancel                    |
| G41             | G41             | G41             | 07    | Tool nose radius compensation left                      |
| G42             | G42             | G42             |       | Tool nose radius compensation right                     |
| G50             | G92             | G92             | 00    | Coordinate system setting or max. spindle speed setting |
| G50.3           | G92.1           | G92.1           |       | Workpiece coordinate system preset                      |

#### Table 3 G code list (1/3)

| G code          |                 |                 |   | Function.  |  |
|-----------------|-----------------|-----------------|---|--|--|
| Α               | В               | С               | Group                                     | Function   |  |
| G50.2<br>(G250) | G50.2<br>(G250) | G50.2<br>(G250) | 20  | Polygonal turning cancel   |  |
| G51.2<br>(G251) | G51.2<br>(G251) | G51.2<br>(G251) |   | Polygonal turning  |  |
| G52             | G52             | G52             | 00  | Local coordinate system setting  |  |
| G53             | G53             | G53             | 00  | Machine coordinate system setting  |  |
| G54             | G54             | G54             |   | Workpiece coordinate system 1 selection                                    |  |
| G55             | G55             | G55             |   | Workpiece coordinate system 2 selection                                    |  |
| G56             | G56             | G56             | 14  | Workpiece coordinate system 3 selection                                    |  |
| G57             | G57             | G57             |   | Workpiece coordinate system 4 selection                                    |  |
| G58             | G58             | G58             |   | Workpiece coordinate system 5 selection                                    |  |
| G59             | G59             | G59             |   | Workpiece coordinate system 6 selection                                    |  |
| G65             | G65             | G65             | 00  | 0 Macro calling  |  |
| G66             | G66             | G66             | 40  | Macro modal call   |  |
| <b>G</b> 67     | G67             | G67             | 12  | Macro modal call cancel  |  |
| G68             | G68             | G68             | 04  | Mirror image for double turrets ON or balance cut mode                     |  |
| <b>G</b> 69     | <b>G</b> 69     | G69             | 04  | Mirror image for double turrets OFF or balance cut mode cancel             |  |
| G70             | G70             | G72             |   | Finishing cycle  |  |
| G71             | G71             | G73             |   | Stock removal in turning   |  |
| G72             | G72             | G74             | 00  | Stock removal in facing  |  |
| G73             | G73             | G75             |   | Pattern repeating  |  |
| G74             | G74             | G76             |   | End face peck drilling   |  |
| G75             | G75             | G77             | Outer diameter/internal diameter drilling |  |  |
| G76             | G76             | G78             |   | Multiple threading cycle   |  |
| G71             | G71             | G72             |   | Traverse grinding cycle (for grinding machine)                             |  |
| G72             | G72             | G73             | 01  | Traverse direct constant-dimension grinding cycle (for grinding machine)   |  |
| G73             | G73             | G74             |   | Oscilation grinding cycle (for grinding machine)                           |  |
| G74             | G74             | G75             |   | Oscilation direct constant–dimension grinding cycle (for grinding machine) |  |
| G80             | G80             | G80             |   | Canned cycle for drilling cancel   |  |
| G83             | G83             | G83             |   | Cycle for face drilling  |  |
| G84             | G84             | G84             | 10  | Cycle for face tapping   |  |
| G85             | G85             | G85             |   | Cycle for face boring  |  |
| G87             | G87             | G87             |   | Cycle for side drilling  |  |
| G88             | G88             | G88             |   | Cycle for side tapping   |  |
| G89             | G89             | G89             |   | Cycle for side boring  |  |
| G90             | G77             | G20             |   | Outer diameter/internal diameter cutting cycle                             |  |
| G92             | G78             | G21             | 01  | Thread cutting cycle   |  |
| G94             | G79             | G24             |   | Endface turning cycle  |  |
| G96             | G96             | G96             |   | Constant surface speed control   |  |
| G97             | G97             | G97             | 02  | Constant surface speed control cancel                                      |  |

#### Table 3 G code list (2/3)

#### 3. PREPARATORY FUNCTION (G FUNCTION)

| G code |     |     | Group | Function                                     |  |  |  |
|--------|-----|-----|-------|--|--|--|--|
| Α      | В   | С   | Group | Function                                     |  |  |  |
| G98    | G94 | G94 | 05    | Per minute feed                              |  |  |  |
| G99    | G95 | G95 | 05    | Per revolution feed                          |  |  |  |
| _      | G90 | G90 | 03    | Absolute programming                         |  |  |  |
| _      | G91 | G91 | 05    | Incremental programming                      |  |  |  |
| _      | G98 | G98 | 11    | Return to initial level (See Explanations 6) |  |  |  |
| _      | G99 | G99 |       | Return to R point level (See Explanations 6) |  |  |  |

#### Table 3 G code list (3/3)



# 4.1 The G00 command moves a tool to the position in the workpiece system specified with an absolute or an incremental command at a rapid traverse rate. (G00) In the absolute command, coordinate value of the end point is programmed.

In the incremental command the distance the tool moves is programmed.

#### G00IP\_;

IP\_: For an absolute command, the coordinates of an end position, and for an incremental command, the distance the tool moves.

Explanations

Format

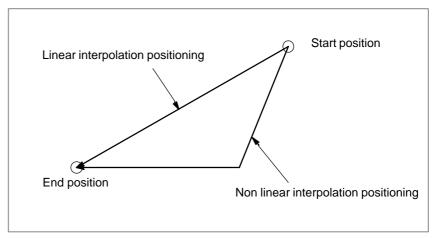
Either of the following tool paths can be selected according to bit 1 (LRP) of parameter No. 1401.

• Nonlinear interpolation positioning

The tool is positioned with the rapid traverse rate for each axis separately. The tool path is normally straight.

• Linear interpolation positioning

The tool path is the same as in linear interpolation (G01). The tool is positioned within the shortest possible time at a speed that is not more than the rapid traverse rate for each axis.

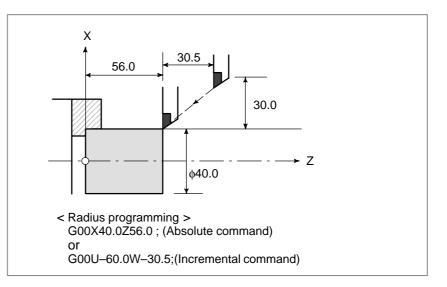


The rapid traverse rate in the G00 command is set to the parameter No. 1420 for each axis independently by the machine tool builder. In the positioning mode actuated by G00, the tool is accelerated to a predetermined speed at the start of a block and is decelerated at the end of a block. Execution proceeds to the next block after confirming the in–position.

"In-position" means that the feed motor is within the specified range.

This range is determined by the machine tool builder by setting to parameter No. 1826.

#### **Examples**



#### Restrictions

The rapid traverse rate cannot be specified in the address F.

Even if linear interpolation positioning is specified, nonlinear interpolation positioning is used in the following cases. Therefore, be careful to ensure that the tool does not foul the workpiece.

- G28 specifying positioning between the reference and intermediate positions.
- G53

# 4.2 LINEAR INTERPOLATION (G01)

Format

Tools can move along a line.

G01 IP\_F\_;
IP\_: For an absolute command, the coordinates of an end point , and for an incremental command, the distance the tool moves.
F\_: Speed of tool feed (Feedrate)

**Explanations** 

A tools move along a line to the specified position at the feedrate specified in F.

The feedrate specified in F is effective until a new value is specified. It need not be specified for each block.

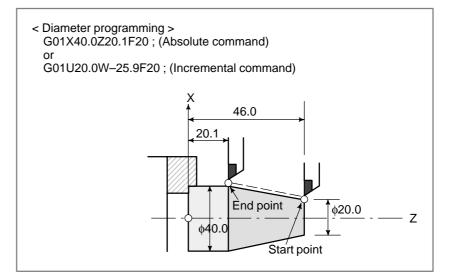
The feedrate commanded by the F code is measured along the tool path. If the F code is not commanded, the feedrate is regarded as zero.

For feed–per–minute mode under 2–axis simultaneous control, the feedrate for a movement along each axis as follows :

**G01** $\alpha \underline{\alpha} \beta \underline{\beta}$  *F***<u>f</u>;** Feed rate of  $\alpha$  axis direction :  $F\alpha = \frac{\alpha}{L} \times f$ Feed rate of  $\beta$  axis direction :  $F_{\beta} = \frac{\beta}{L} \times f$  $L = \sqrt{\alpha^2 + \beta^2}$ 

#### **Examples**

• Linear interpolation



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The command below will move a tool along a circular arc.

# 4.3 CIRCULAR INTERPOLATION (G02, G03)

Format

Arc in the XpYp plane  $G17 \begin{cases} G02\\G03 \end{cases} Xp_Yp_- \begin{cases} I_J_-\\R_- \end{cases} F_-$ Arc in the ZpXp plane  $G18 \begin{cases} G02\\G03 \end{cases} Xp_Zp_- \begin{cases} I_K_-\\R_- \end{cases} F_-$ Arc in the YpZp plane  $G19 \begin{cases} G02\\G03 \end{cases} Yp_Zp_- \begin{cases} J_K_-\\R_- \end{cases} F_-$ 

| Command         | Description  |  |  |  |  |
|-----------------|--|--|--|--|--|
| G17             | Specification of arc on XpYp plane   |  |  |  |  |
| G18             | Specification of arc on ZpXp plane   |  |  |  |  |
| G19             | Specification of arc on YpZp plane   |  |  |  |  |
| G02             | Circular Interpolation Clockwise direction (CW)  |  |  |  |  |
| G03             | Circular Interpolation Counterclockwise direction (CCW)  |  |  |  |  |
| X <sub>p_</sub> | Command values of X axis or its parallel axis (set by parameter No. 1022)                            |  |  |  |  |
| Y <sub>p_</sub> | Command values of Y axis or its parallel axis (set by parameter No. 1022)                            |  |  |  |  |
| Z <sub>p_</sub> | Command values of Z axis or its parallel axis (set by parameter No. 1022)                            |  |  |  |  |
| I_              | $X_{\mbox{p}}$ axis distance from the start point to the center of an arc with sign, radius value    |  |  |  |  |
| J_              | ${\rm Y}_{\rm p}$ axis distance from the start point to the center of an arc with sign, radius value |  |  |  |  |
| k_              | ${\sf Z}_p$ axis distance from the start point to the center of an arc with sign, radius value       |  |  |  |  |
| R_              | Arc radius with no sign (always with radius value)   |  |  |  |  |
| F_              | Feedrate along the arc   |  |  |  |  |

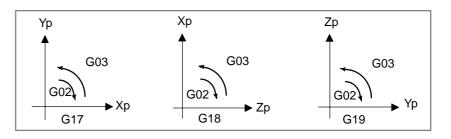
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#### NOTE

The U–, V–, and W–axes (parallel with the basic axis) can be used with G–codes B and C.

#### **Explanations**

 Direction of the circular interpolation "Clockwise" (G02) and "counterclockwise" (G03) on the  $X_pY_p$  plane ( $Z_pX_p$  plane or  $Y_pZ_p$  plane) are defined when the  $X_pY_p$  plane is viewed in the positive-to-negative direction of the  $Z_p$  axis ( $Y_p$  axis or  $X_p$  axis, respectively) in the Cartesian coordinate system. See the figure below.

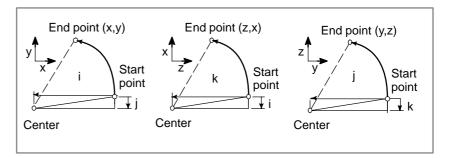


- Distance moved on an arc
- Distance from the start point to the center of arc

The end point of an arc is specified by address Xp, Yp or Zp, and is expressed as an absolute or incremental value according to G90 or G91. For the incremental value, the distance of the end point which is viewed from the start point of the arc is specified.

The arc center is specified by addresses I, J, and K for the Xp, Yp, and Zp axes, respectively. The numerical value following I, J, or K, however, is a vector component in which the arc center is seen from the start point, and is always specified as an incremental value irrespective of G90 and G91, as shown below.

I, J, and K must be signed according to the direction.



I0, J0, and K0 can be omitted.

If the difference between the radius at the start point and that at the end point exceeds the value in a parameter (No. 3410), an P/S alarm (No. 020) occurs.

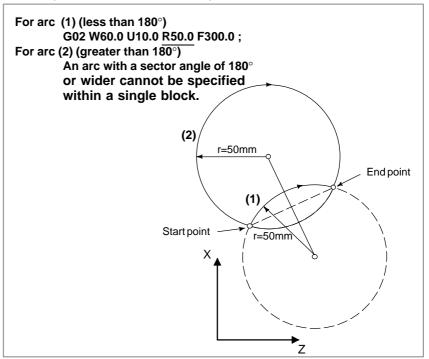
• Full-circle programming

When  $X_p$ ,  $Y_p$ , and  $Z_p$  are omitted (the end point is the same as the start point) and the center is specified with I, J, and K, a 360° arc (circle) is specified.

#### Arc radius

The distance between an arc and the center of a circle that contains the arc can be specified using the radius, R, of the circle instead of I, J, and K. In this case, one arc is less than  $180^{\circ}$ , and the other is more than  $180^{\circ}$  are considered. An arc with a sector angle of  $180^{\circ}$  or wider cannot be specified. If Xp, Yp, and Zp are all omitted, if the end point is located at the same position as the start point and when R is used, an arc of  $0^{\circ}$  is programmed

G02R ; (The cutter does not move.)



# • Expanded valid range of arc radius

When the option for specifying arc radius R with nine digits is selected, the valid radius range for circular interpolation is expanded as follows:

|                |      | Input increments        |                            |  |  |
|----------------|------|-------------------------|----------------------------|--|--|
|                |      | Metric input            | Inch input                 |  |  |
| Incre-<br>ment | IS–B | 0.001 to 999999.999 mm  | 0.0001 to 99999.9999 inch  |  |  |
| system         | IS–C | 0.0001 to 99999.9999 mm | 0.00001 to 9999.99999 inch |  |  |

#### NOTE

1 Specifying an arc center with addresses I, K, and J When the distance from the arc start point to the arc center is specified with addresses I, K, and J, a P/S alarm (No. 5059) is issued if: Maximum value which can be specified  $< \sqrt{I^2 + K^2}$ Example: When IS-B and metric input are selected, issuing the following command (radius specification) will result in a P/S alarm (No. 5059): G50 X0 Z0; G18G02X11.250 Z10. I-800000.000 K900000.000 F5.0;  $\sqrt[1]{} \sqrt{I^2 + K^2} = \sqrt{(-800000.000)^2 + 900000.000^2}$ = 1204159.458> 999999.999 2 Tool nose radius compensation In tool nose radius compensation mode, a P/S alarm (No. 5059) is issued if the distance from the tool nose radius center to the arc center exceeds the maximum value which can be specified.

#### • Feedrate

The feedrate in circular interpolation is equal to the feed rate specified by the F code, and the feedrate along the arc (the tangential feedrate of the arc) is controlled to be the specified feedrate.

The error between the specified feedrate and the actual tool feedrate is  $\pm 2\%$  or less. However, this feed rate is measured along the arc after the tool nose radius compensation is applied

#### Restrictions

- Simultaneously specifying R with I, J, and K
- and K
  Specifying an axis that is not contained in the specified plane

• Difference in the radius between the start and end points

 Specifying a semicircle with R If I, J, K, and R addresses are specified simultaneously, the arc specified by address R takes precedence and the other are ignored.

If an axis not contained in the specified plane is commanded, an alarm is displayed.

For example, when a ZX plane is specified in G-code B or C, specifying the X-axis or U-axis (parallel to the X-axis) causes P/S alarm No. 028 to be generated.

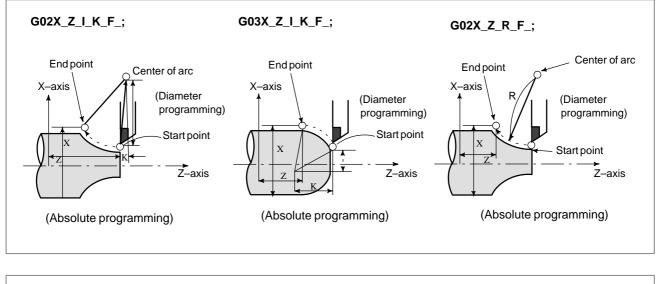
If the difference in the radius between the start and end points of the arc exceeds the value specified in parameter No. 3410, P/S alarm No. 020 is generated.

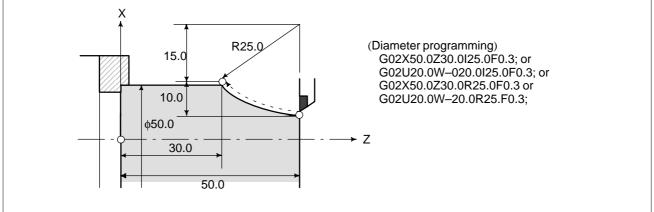
If the end point is not on the arc, the tool moves in a straight line along one of the axes after reaching the end point.

If an arc having a central angle approaching 180 is specified with R, the calculation of the center coordinates may produce an error. In such a case, specify the center of the arc with I, J, and K.

#### Examples

• Command of circular interpolation X, Z





## 4.4 HELICAL INTERPOLATION (G02, G03)

Format

**Explanations** 

Helical interpolation which moved helically is enabled by specifying up to two other axes which move synchronously with the circular interpolation by circular commands.

Synchronously with arc of XpYp plane

$$G17 \left\{ \begin{array}{c} G02\\G03 \end{array} \right\} \hspace{0.1cm} Xp\_Yp\_ \hspace{0.1cm} \left\{ \begin{array}{c} I\_J\_\\R\_ \end{array} \right\} \hspace{0.1cm} a\_(b\_)F\_;$$

Synchronously with arc of ZpXp plane

$$\begin{array}{c} \mathbf{G18} \left\{ \begin{array}{c} \mathbf{G02} \\ \mathbf{G03} \end{array} \right\} \ \mathbf{Xp}_{\mathbf{Z}}\mathbf{Zp}_{-} \ \left\{ \begin{array}{c} \mathbf{I}_{-}\mathbf{K}_{-} \\ \mathbf{R}_{-} \end{array} \right\} \ \mathbf{a}_{-}(\mathbf{b}_{-})\mathbf{F}_{-}; \end{array}$$

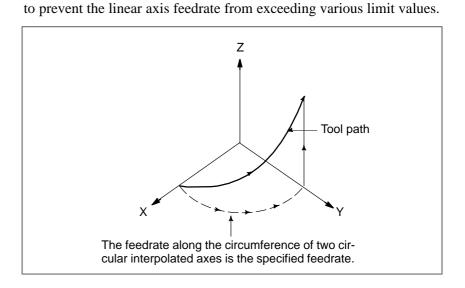
Synchronously with arc of YpZp plane

$$\begin{array}{c} \textbf{G19} \left\{ \begin{array}{c} \textbf{G02} \\ \textbf{G03} \end{array} \right\} \hspace{0.1cm} \textbf{Yp}\_\textbf{Zp}\_\hspace{0.1cm} \left\{ \begin{array}{c} \textbf{J}\_\textbf{K}\_ \\ \textbf{R}\_ \end{array} \right\} \hspace{0.1cm} \textbf{a}\_(\textbf{b}\_)\textbf{F}\_; \\ \end{array}$$

 $\alpha,\,\beta$  : Any one axis where circular interpolation is not applied. Up to two other axes can be specified.

The command method is to simply or secondary add a move command axis which is not circular interpolation axes. An F command specifies a feed rate along a circular arc. Therefore, the feed rate of the linear axis is as follows:

Determine the feed rate so the linear axis feed rate does not exceed any of the various limit values. Bit 0 (HFC) of parameter No. 1404 can be used



#### Limitations

- Cutter compensation is applied only for a circular arc.
- Tool offset and tool length compensation cannot be used in a block in which a helical interpolation is commanded.

PROGRAMMING

## 4.5 POLAR COORDINATE INTERPOLATION (G12.1, G13.1)

Polar coordinate interpolation is a function that exercises contour control in converting a command programmed in a Cartesian coordinate system to the movement of a linear axis (movement of a tool) and the movement of a rotary axis (rotation of a workpiece). This method is useful in cutting a front surface and grinding a cam shaft on a lathe.

#### Format

• Specify G12.1 and G13.1 in Separate Blocks.

| G12.1 ; | Starts polar coordinate interpolation mode (enables<br>polar coordinate interpolation)<br>Specify linear or circular interpolation using coordinates<br>in a Cartesian coordinate system consisting of a linear<br>axis and rotary axis (virtual axis). |
|---------|---|
| G13.1;  | Polar coordinate interpolation mode is cancelled (for not performing polar coordinate interpolation)  |
|         | G112 and G113 can be used in place of G12.1 and G13.1, respectively.  |

#### **Explanations**

 Polar coordinate interpolation plane G12.1 starts the polar coordinate interpolation mode and selects a polar coordinate interpolation plane (Fig. 4.5 (a)). Polar coordinate interpolation is performed on this plane.

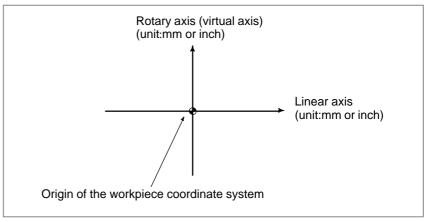


Fig. 4.5 (a) Polar coordinate interpolation plane.

When the power is turned on or the system is reset, polar coordinate interpolation is canceled (G13.1).

The linear and rotation axes for polar coordinate interpolation must be set in parameters (No. 5460 and 5461) beforehand.

#### CAUTION

The plane used before G12.1 is specified (plane selected by G17, G18, or G19) is canceled. It is restored when G13.1 (canceling polar coordinate interpolation) is specified. When the system is reset, polar coordinate interpolation is canceled and the plane specified by G17, G18, or G19 is used.

#### 4. INTERPOLATION FUNCTIONS

 Distance moved and feedrate for polar coordinate interpolation

> The unit for coordinates on the hypothetical axis is the same as the unit for the linear axis (mm/inch)

The unit for the feedrate is mm/min or inch/min

- G codes which can be specified in the polar coordinate interpolation mode
- Circular interpolation in the polar coordinate plane

- Movement along axes not in the polar coordinate interpolation plane in the polar coordinate interpolation mode
- Current position display in the polar coordinate interpolation mode

In the polar coordinate interpolation mode, program commands are specified with Cartesian coordinates on the polar coordinate interpolation plane. The axis address for the rotation axis is used as the axis address for the second axis (virtual axis) in the plane. Whether a diameter or radius is specified for the first axis in the plane is the same as for the rotation axis regardless of the specification for the first axis in the plane. The virtual axis is at coordinate 0 immediately after G12.1 is specified. Polar interpolation is started assuming the angle of 0 for the position of the tool when G12.1 is specified.

Specify the feedrate as a speed (relative speed between the workpiece and tool) tangential to the polar coordinate interpolation plane (Cartesian coordinate system) using F.

The addresses for specifying the radius of an arc for circular interpolation (G02 or G03) in the polar coordinate interpolation plane depend on the first axis in the plane (linear axis).

- I and J in the Xp–Yp plane when the linear axis is the X–axis or an axis parallel to the X–axis.
- J and K in the Yp–Zp plane when the linear axis is Y–axis or an axis parallel to the Y–axis.
- K and I in the Zp–Xp plane when the linear axis is the Z–axis or an axis parallel to the Z–axis.

The radius of an arc can be specified also with an R command.

#### NOTE

The U–, V–, and W–axes (parallel with the basic axis) can be used with G–codes B and C.

The tool moves along such axes normally, independent of polar coordinate interpolation.

Actual coordinates are displayed. However, the remaining distance to move in a block is displayed based on the coordinates in the polar coordinate interpolation plane (Cartesian coordinates).

#### Restrictions

- Coordinate system for the polar coordinate interpolation
- Tool nose radius compensation command
- Program restart

WARNING

• Cutting feedrate for the rotation axis

Before G12.1 is specified, a workpiece coordinate system) where the center of the rotary axis is the origin of the coordinate system must be set. In the G12.1 mode, the coordinate system must not be changed (G92, G52, G53, relative coordinate reset, G54 through G59, etc.).

The polar coordinate interpolation mode cannot be started or terminated (G12.1 or G13.1) in the tool nose radius compensation mode (G41 or G42). G12.1 or G13.1 must be specified in the tool nose radius compensation canceled mode (G40).

For a block in the G12.1 mode, the program cannot be restarted.

Polar coordinate interpolation converts the tool movement for a figure programmed in a Cartesian coordinate system to the tool movement in the rotation axis (C–axis) and the linear axis (X–axis). When the tool moves closer to the center of the workpiece, the C–axis component of the feedrate becomes larger and may exceed the maximum cutting feedrate for the C–axis (set in parameter (No. 1422)), causing an alarm (see the figure below). To prevent the C–axis component from exceeding the maximum cutting feedrate for the C–axis, reduce the feedrate specified with address F or create a program so that the tool (center of the tool when tool nose radius compensation is applied) does not move close to the center of the workpiece.

# 

Consider lines L1, L2, and L3.  $\Delta X$  is the distance the tool moves per time unit at the feedrate specified with address F in the Cartesian coordinate system. As the tool moves from L1 to L2 to L3, the angle at which the tool moves per time unit corresponding to  $\Delta X$  in the Cartesian coordinate system increases from $\theta$ 1 to $\theta$  2 to  $\theta$ 3.

In other words, the C-axis component of the feedrate becomes larger as the tool moves closer to the center of the workpiece. The C component of the feedrate may exceed the maximum cutting feedrate for the C-axis because the tool movement in the Cartesian coordinate system has been converted to the tool movement for the C-axis and the X-axis.

L : Distance (in mm) between the tool center and workpiece center when the tool center is the nearest to the workpiece center

R :Maximum cutting feedrate (deg/min) of the C axis

Then, a speed specifiable with address F in polar coordinate interpolation can be given by the formula below. Specify a speed allowed by the formula. The formula provides a theoretical value; in practice, a value slightly smaller than a theoretical value may need to be used due to a calculation error.

$$F < L \times R \times \frac{\pi}{180}$$
 (mm/min)

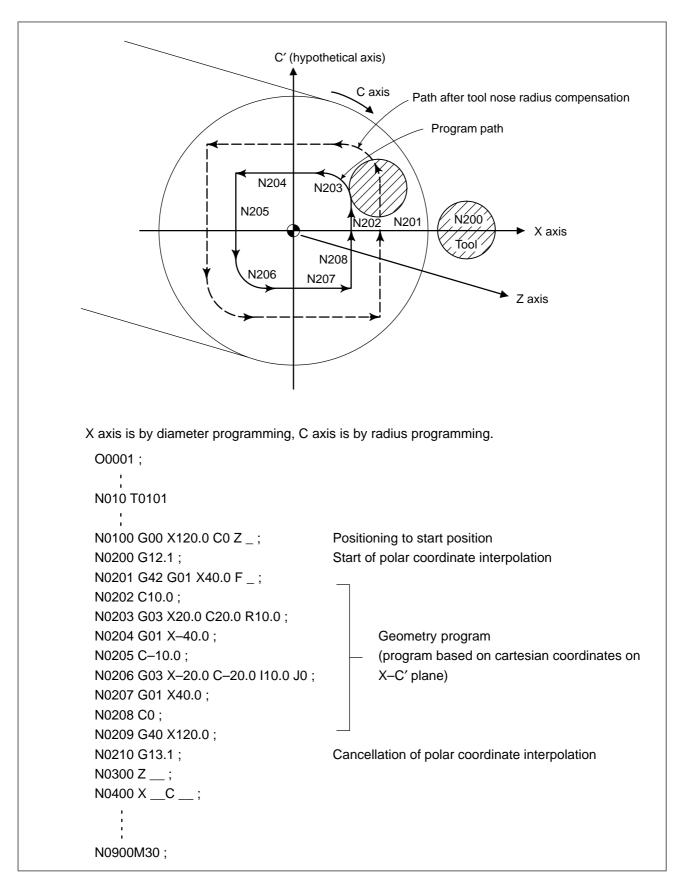
• Diameter and radius programming

Even when diameter programming is used for the linear axis (X-axis), radius programming is applied to the rotary axis (C-axis).

#### 4. INTERPOLATION FUNCTIONS

#### Examples

Example of Polar Coordinate Interpolation Program Based on X Axis (Linear Axis) and C Axis (Rotary Axis)



## 4.6 CYLINDRICAL INTERPOLATION (G07.1)

Format

#### **Explanations**

 Plane selection (G17, G18, G19) The amount of travel of a rotary axis specified by an angle is once internally converted to a distance of a linear axis along the outer surface so that linear interpolation or circular interpolation can be performed with another axis. After interpolation, such a distance is converted back to the amount of travel of the rotary axis.

The cylindrical interpolation function allows the side of a cylinder to be developed for programming. So programs such as a program for cylindrical cam grooving can be created very easily.

#### G07.1 IP r ; Starts the cylindrical interpolation mode (enables cylindrical interpolation).

G07.1 IP 0 ; The cylindrical interpolation mode is cancelled.

IP : An address for the rotation axis r : The radius of the cylinder

Specify G07.1 IP r ; and G07.1 IP 0; in separate blocks. G107 can be used instead of G07.1.

Use parameter No. 1002 to specify whether the rotation axis is the X–, Y–, or Z–axis, or an axis parallel to one of these axes. Specify the G code to select a plane for which the rotation axis is the specified linear axis. For example, when the rotation axis is an axis parallel to the X–axis, G17 must specify an Xp–Yp plane, which is a plane defined by the rotation axis and the Y–axis or an axis parallel to the Y–axis. Only one rotation axis can be set for cylindrical interpolation.

#### NOTE

The U–, V–, and W–axes (parallel with the basic axis) can be used with G–codes B and C.

#### • Feedrate

A feedrate specified in the cylindrical interpolation mode is a speed on the developed cylindrical surface.

• Circular interpolation

compensation

and tool nose radius

| • Circular interpolation<br>(G02,G03)  | In the cylindrical interpolation mode, circular interpolation is possible<br>with the rotation axis and another linear axis. Radius R is used in<br>commands in the same way as described in Section 4.4.<br>The unit for a radius is not degrees but millimeters (for metric input) or<br>inches (for inch input).<br>< Example Circular interpolation between the Z axis and C axis ><br>For the C axis of parameter No. 1022, 5 (axis parallel with the X axis)<br>is to be set. In this case, the command for circular interpolation is<br>G18 Z_C_;<br>G02 (G03) Z_C_R_;<br>For the C axis of parameter No. 1022, 6 (axis parallel with the Y axis)<br>may be specified instead. In this case, however, the command for<br>circular interpolation is<br>G19 C_Z_;<br>G02 (G03) Z_C_R_;  |  |
|--|--|--|
| • Cutter compensation  | To perform cutter compensation in the cylindrical interpolation mode, cancel any ongoing cutter compensation mode before entering the cylindrical interpolation mode. Then, start and terminate cutter compensation within the cylindrical interpolation mode.   |  |
| • Cylindrical interpolation accuracy   | In the cylindrical interpolation mode, the amount of travel of a rotary axis specified by an angle is once internally converted to a distance of a linear axis on the outer surface so that linear interpolation or circular interpolation can be performed with another axis. After interpolation, such a distance is converted back to an angle. For this conversion, the amount of travel is rounded to a least input increment. So when the radius of a cylinder is small, the actual amount of travel can differ from a specified amount of travel. Note, however, that such an error is not accumulative. If manual operation is performed in the cylindrical interpolation mode with manual absolute on, an error can occur for the reason described above. $The actual amount = \left[\frac{\text{MOTION REV}}{2\times 2\pi R} \left[\times \text{Specified value} \times \frac{2\times 2\pi R}{\text{MOTION REV}}\right]\right]$ MOTION REV : The amount of travel per rotation of the rotation axis (Setting value of parameter No. 1260) $R : Workpiece radius$ |  |
| Restrictions   |  |  |
| <ul> <li>Arc radius specification<br/>in the cylindrical<br/>interpolation mode</li> </ul> | In the cylindrical interpolation mode, an arc radius cannot be specified with word address I, J, or K.   |  |

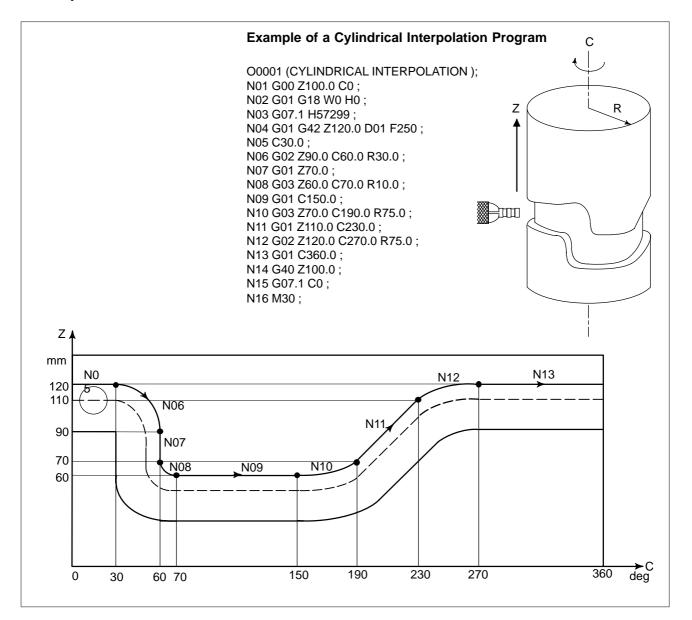
If the cylindrical interpolation mode is started when tool nose radius compensation is already applied, circular interpolation is not correctly performed in the cylindrical interpolation mode.

| <ul> <li>Positioning</li> </ul>   | In the cylindrical interpolation mode, positioning operations (including those that produce rapid traverse cycles such as G28, G80 through G89) cannot be specified. Before positioning can be specified, the cylindrical interpolation mode must be cancelled. Cylindrical interpolation (G07.1) cannot be performed in the positioning mode (G00). |
|---|--|
| <ul> <li>Coordinate system<br/>setting</li> </ul>   | In the cylindrical interpolation mode, a workpiece coordinate system G50 cannot be specified.  |
| <ul> <li>Cylindrical interpolation<br/>mode setting</li> </ul>                              | In the cylindrical interpolation mode, the cylindrical interpolation mode<br>cannot be reset. The cylindrical interpolation mode must be cancelled<br>before the cylindrical interpolation mode can be reset.  |
| <ul> <li>Canned cycle for drilling<br/>during cylindrical<br/>interpolation mode</li> </ul> | Canned cycles for drilling, G81 to G89, cannot be specified during cylindrical interpolation mode.   |
| <ul> <li>Mirror Image for Double<br/>Turret</li> </ul>                                      | Mirror image for double turret, G68 and G69, cannot be specified during cylindrical interpolation mode.  |

#### 4. INTERPOLATION FUNCTIONS

PROGRAMMING

#### Examples



## 4.7 HYPOTHETICAL AXIS INTERPOLATION (G07)

In helical interpolation, when pulses are distributed with one of the circular interpolation axes set to a hypothetical axis, sine interpolation is enable.

When one of the circular interpolation axes is set to a hypothetical axis, pulse distribution causes the speed of movement along the remaining axis to change sinusoidally. If the major axis for threading (the axis along which the machine travels the longest distance) is set to a hypothetical axis, threading with a fractional lead is enabled. The axis to be set as the hypothetical axis is specified with G07.

#### Format

G07  $\alpha$  0; Hypothetical axis setting

**G07**  $\alpha$  **1**; Hypothetical axis cancel

Where,  $\alpha$  is any one of the addresses of the controlled axes.

#### **Explanations**

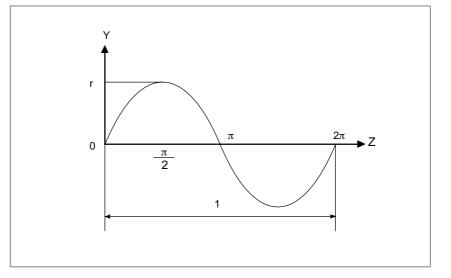
Sine interpolation

The  $\alpha$  axis is regarded as a hypothetical axis for the period of time from the G07  $\alpha$  0 command until the G07  $\alpha$  1 command appears. Suppose sine interpolation is performed for one cycle in the YZ plane. The hypothetical axis is them the X axis.

 $X^2 + Y^2 = r^2$  (r is the radius of an arc.)

$$Y = r SIN \left(\frac{2\pi}{1} Z\right)$$

1 is the distance traveled along the Z-axis in one cycle.)



- Interlock, stroke limit, and external deceleration
- Handle interrupt

Interlock, stroke limit, and external deceleration can also apply to the hypothetical axis.

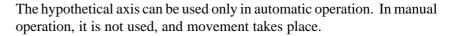
An interrupt caused by the handle also applies to the hypothetical axis. This means that movement for a handle interrupt is performed.

#### Limitations

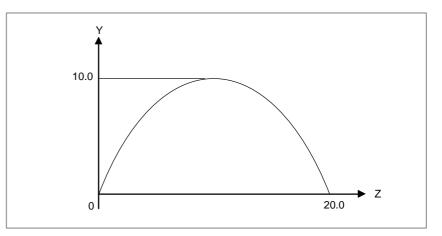
- Manual operation
- Move command
- Coordinate rotation

#### Examples

• Sine interpolation



- Specify hypothetical axis interpolation only in the incremental mode.
- Hypothetical axis interpolation does not support coordinate rotation.



N001 G07 X0 ;

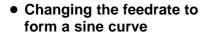
```
N002 G91 G17 G03 X-20.0 Y0.0 I-10.0 Z20.0 F100;
```

N003 G01 X10.0;

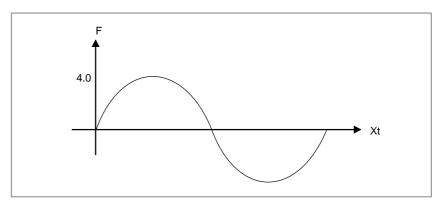
N004 G07 X1;

From the N002 to N003 blocks, the X-axis is set to a hypothetical axis. The N002 block specifies helical cutting in which the Z-axis is the linear axis. Since no movement takes place along the X axis, movement along the Y-axis is performed while performing sine interpolation along the Z-axis.

In the N003 block, there is no movement along the X-axis, and so the machine dwells until interpolation terminates.



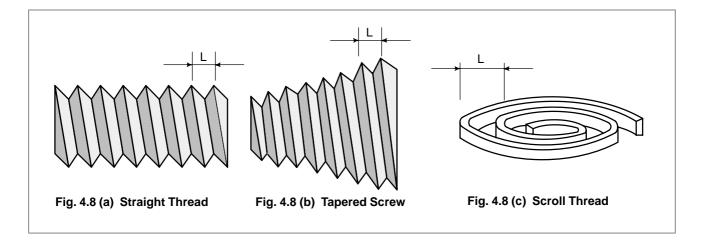
(Sample program)G07Z0 ;The Z-axis is set to a hypothetical axis.G02X0Z0I10.0F4. ;The feedrate on the X-axis changes sinusoidally.G07Z1 ;The use of the Z-axis as a hypothetical axis is canceled.



## 4.8 CONSTANT LEAD THREADING (G32)

Tapered screws and scroll threads in addition to equal lead straight threads can be cut by using a G32 command.

The spindle speed is read from the position coder on the spindle in real time and converted to a cutting feedrate for feed–per minute mode, which is used to move the tool.



#### Format

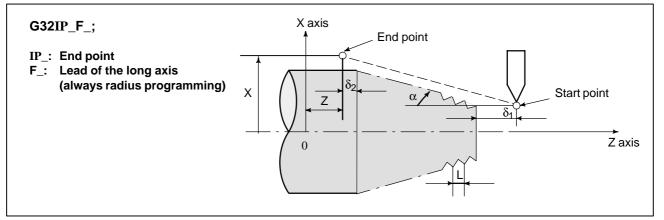


Fig. 4.8 (d) Example of Thread Cutting

#### **Explanations**

In general, thread cutting is repeated along the same tool path in rough cutting through finish cutting for a screw. Since thread cutting starts when the position coder mounted on the spindle outputs a 1–turn signal, threading is started at a fixed point and the tool path on the workpiece is unchanged for repeated thread cutting. Note that the spindle speed must remain constant from rough cutting through finish cutting. If not, incorrect thread lead will occur.

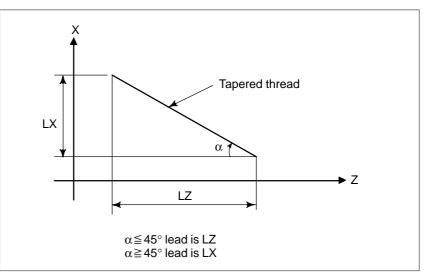


Fig. 4.8 (e) LZ and LX of a Tapered Thread

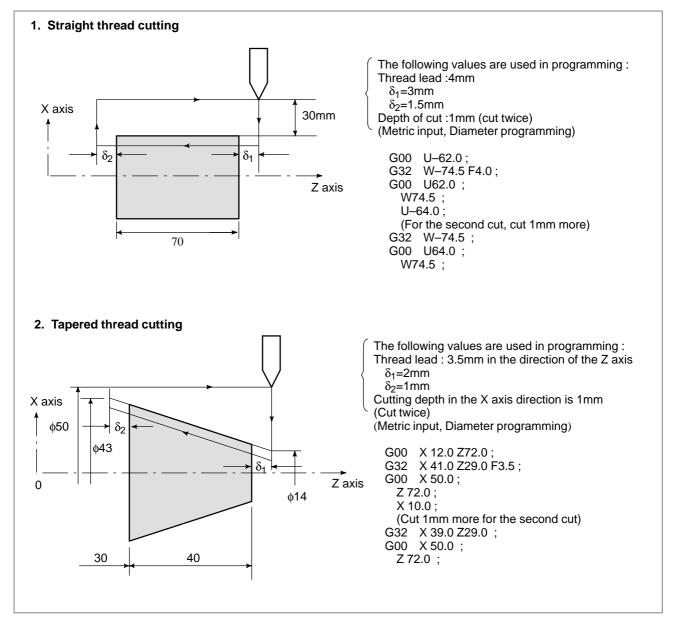
In general, the lag of the servo system, etc. will produce somewhat incorrect leads at the starting and ending points of a thread cut. To compensate for this, a threading length somewhat longer than required should be specified.

Table 4.8 lists the ranges for specifying the thread lead.

 Table. 4.8 Ranges of lead sizes that can be specified

|            | Least command increment       |
|------------|-------------------------------|
| mm input   | 0.0001 to 500.0000mm          |
| Inch input | 0.000001 inch to 9.999999inch |

#### **Explanations**



#### WARNING

- 1 Feedrate override is effective (fixed at 100%) during thread cutting.
- 2 It is very dangerous to stop feeding the thread cutter without stopping the spindle. This will suddenly increase the cutting depth. Thus, the feed hold function is ineffective while thread cutting. If the feed hold button is pressed during thread cutting, the tool will stop after a block not specifying thread cutting is executed as if the SINGLE BLOCK button were pushed. However, the feed hold lamp (SPL lamp) lights when the FEED HOLD button on the machine control panel is pushed. Then, when the tool stops, the lamp is turned off (Single Block stop status).
- 3 When the FEED HOLD button is held down, or is pressed again in the first block that does not specify thread cutting immediately after a thread cutting block, the tool stops at the block that does not specify thread cutting.
- 4 When thread cutting is executed in the single block status, the tool stops after execution of the first block not specifying thread cutting.
- 5 When the mode was changed from automatic operation to manual operation during thread cutting, the tool stops at the first block not specifying thread cutting as when the feed hold button is pushed as mentioned in Note 3.

However, when the mode is changed from one automatic operation mode to another, the tool stops after execution of the block not specifying thread cutting as for the single block mode in Note 4.

6 When the previous block was a thread cutting block, cutting will start immediately without waiting for detection of the 1-turn signal even if the present block is a thread cutting block.

G32Z \_ F\_ ;

Z\_; (A 1-turn signal is not detected before this block.)

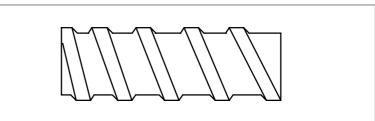
G32; (Regarded as threading block.)

- Z\_F\_;(One turn signal is also not detected.)
- 7 Because the constant surface speed control is effective during scroll thread or tapered screw cutting and the spindle speed changes, the correct thread lead may not be cut. Therefore, do not use the constant surface speed control during thread cutting. Instead, use G97.
- 8 A movement block preceding the thread cutting block must not specify chamfering or corner R.
- 9 A thread cutting block must not specifying chamfering or corner R.
- 10 The spindle speed override function is disabled during thread cutting. The spindle speed is fixed at 100%.
- 11 Thread cycle retract function is ineffective to G32.

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## 4.9 VARIABLE-LEAD THREAD CUTTING (G34)

Specifying an increment or a decrement value for a lead per screw revolution enables variable–lead thread cutting to be performed.





#### Format

G34 IP\_F\_K\_;

- IP : End point
  - F: Lead in longitudinal axis direction at the start point
  - K : Increment and decrement of lead per spindle revolution

#### **Explanations**

Address other than K are the same as in straight/taper thread cutting with G32.

Table 4.9 lists a range of values that can be specified as K.

 Table 4.9
 Range of valid K values

| Metric input | $\pm$ 0.0001 to $\pm$ 500.0000 mm/rev     |
|--------------|---|
| Inch input   | $\pm$ 0.000001 to $\pm$ 9.999999 inch/rev |

P/S alarm (No. 14) is produced, for example, when K such that the value in Table 4.9 is exceeded is directed, the maximum value of lead is exceeded as a result of increase or decrease by K or the lead has a negative value.

#### WARNING

The "Thread Cutting Cycle Retract" is not effective for G34.

#### **Examples**

Lead at the start point: 8.0 mm Lead increment: 0.3 mm/rev

G34 Z-72.0 F8.0 K0.3;

## 4.10 CONTINUOUS THREAD CUTTING

**Explanations** 

This function for continuous thread cutting is such that fractional pulses output to a joint between move blocks are overlapped with the next move for pulse processing and output (block overlap).

Therefore, discontinuous machining sections caused by the interruption of move during continuously block machining are eliminated, thus making it possible to continuously direct the block for thread cutting instructions.

Since the system is controlled in such a manner that the synchronism with the spindle does not deviate in the joint between blocks wherever possible, it is possible to performed special thread cutting operation in which the lead and shape change midway.

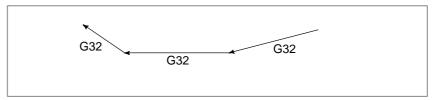


Fig. 4.10 Continuous Thread Cutting

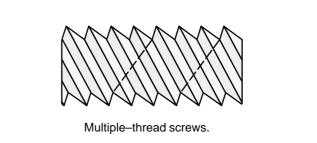
Even when the same section is repeated for thread cutting while changing the depth of cut, this system allows a correct machining without impairing the threads.

#### NOTE

- 1 Block overlap is effective even for G01 command, producing a more excellent finishing surface.
- 2 When extreme micro blocks continue, no block overlap may function.

## 4.11 MULTIPLE-THREAD CUTTING

Using the Q address to specify an angle between the one-spindle-rotation signal and the start of threading shifts the threading start angle, making it possible to produce multiple-thread screws with ease.



#### Format

(constant-lead threading) IP\_: End point G32 IP\_ F\_ Q\_; G32 IP\_ Q\_; F\_: Lead in longitudinal direction Q\_: Threading start angle

#### **Explanations**

| • | Available | thread | cutting |
|---|-----------|--------|---------|
|   | command   | ls     |         |

- G32: Constant-lead thread cutting
- G34: Variable–lead thread cutting
- G76: Multiple-thread cutting cycle
- G92: Thread cutting cycle

#### Limitations

• Start angle

(G76)

• Start angle increment

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- The start angle is not a continuous-state (modal) value. It must be specified each time it is used. If a value is not specified, 0 is assumed.
- The start angle (Q) increment is 0.001 degrees. Note that no decimal point can be specified. Example:

For a shift angle of 180 degrees, specify Q180000. Q180.000 cannot be specified, because it contains a decimal point.

• Specifiable start angle A start angle (Q) of between 0 and 360000 (in 0.001–degree units) can be specified. If a value greater than 360000 (360 degrees) is specified, it is range rounded down to 360000 (360 degrees).

 Multiple-thread cutting For the G76 multiple-thread cutting command, always use the FS15 tape format.

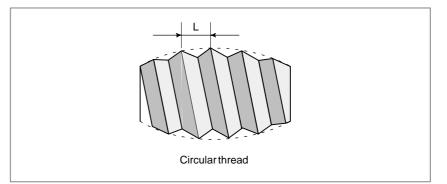
#### Examples

## Program for producing double-threaded screws (with start angles of 0 and 180 degrees)

G00 X40.0; G32 W-38.0 F4.0 Q0; G00 X72.0; W38.0; X40.0; G32 W-38.0 F4.0 Q180000; G00 X72.0; W38.0;

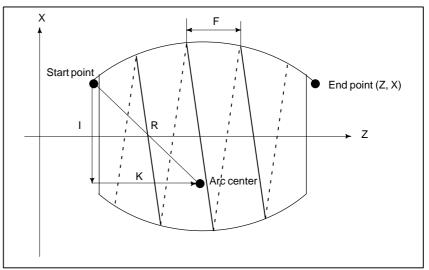
## 4.12 CIRCULAR THREADING (G35, G36)

Using the G35 and G36 commands, a circular thread, having the specified lead in the direction of the major axis, can be machined.



Format

| $ \begin{cases} G35\\G36 \end{cases} X (U) _ Z (W) _ \begin{cases} I _ K _ \\ R \end{cases} F _ Q _ $  |
|--|
| G35 : Clockwise circular threading command<br>G36 : Counterclockwise circular threading command  |
| X (U) : Specify the arc end point (in the same way as for G02, G03).<br>Z (W)  |
| <ul> <li>I, K : Specify the arc center relative to the start point, using relative coordinates (in the same way as for G02, G03).</li> <li>R : Specify the arc radius.</li> <li>F : Specify the lead in the direction of the major axis.</li> <li>Q : Specify the shift of the threading start angle (0 to 360° in units of 0.001°)</li> </ul> |



#### **Explanations**

- Specifying the arc radius
- Selecting a plane other than the ZX plane
- Automatic tool compensation

If R is specified with I and K, only R is effective.

If an additional axis other than the X– and Z–axes is provided, circular threading can be specified for a plane other than the ZX plane. The method of specification is the same as that for G02 and G03.

The G36 command is used to specify the following two functions: Automatic tool compensation X and counterclockwise circular threading. The function for which G36 is to be used depends on bit 3 (G36) of parameter No. 3405.

- When parameter G36 is set to 0, the G36 command is used for automatic tool compensation X.
- When parameter G36 is set to 1, the G36 command is used for counterclockwise circular threading.

Automatic tool compensation using G37.1/G37.2

G37.1 can be used to specify automatic tool compensation X and G37.2 can be used to specify automatic tool compensation Z. (Specification method) G37.1 X\_ G37.2 Z\_

G code when bit 3 of parameter No. 3405 is set to 1

| G code | G code group | Function                            |
|--------|--------------|-------------------------------------|
| G35    | 01           | Clockwise circular threading        |
| G36    | 01           | Counterclockwise circular threading |
| G37    |              | Automatic tool compensation Z       |
| G37.1  | 00           | Automatic tool compensation X       |
| G37.2  |              | Automatic tool compensation Z       |

#### Limitations

• Range of specifiable arc

An arc must be specified such that it falls within a range in which the major axis of the arc is always the Z-axis or always the X-axis, as shown in Fig. 4.12 (a) and (b). If the arc includes a point at which the major axis changes from the X-axis to Z-axis, or vice versa, as shown in Fig. 4.12 (c), P/S alarm 5058 is issued.

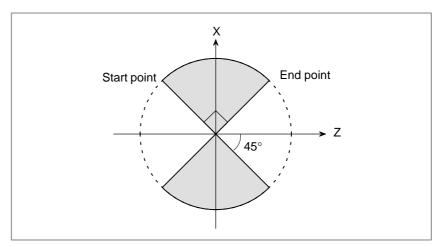
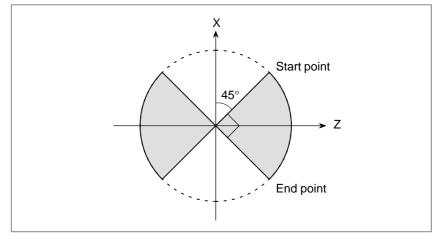
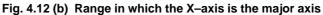


Fig. 4.12 (a) Range in which the Z-axis is the major axis





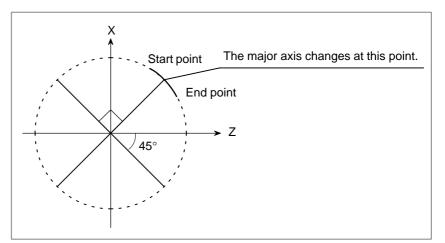


Fig. 4.12 (c) Example of arc specification which causes an alarm

#### 4. INTERPOLATION FUNCTIONS

## 4.13 SKIP FUNCTION (G31)

Linear interpolation can be commanded by specifying axial move following the G31 command, like G01. If an external skip signal is input during the execution of this command, execution of the command is interrupted and the next block is executed.

The skip function is used when the end of machining is not programmed but specified with a signal from the machine, for example, in grinding. It is used also for measuring the dimensions of a workpiece.

For details of how to use this function, refer to the manual supplied by the machine tool builder.

#### Format

G31 IP\_;

G31: One-shot G code (If is effective only in the block in which it is specified)

#### **Explanations**

The coordinate values when the skip signal is turned on can be used in a custom macro because they are stored in the custom macro system variable #5061 to #5068, as follows:

- #5061 X axis coordinate value
- #5062 Z axis coordinate value
- #5063 3rd axis coordinate value
- :
- :
- #5068 8th axis coordinate value

#### WARNING

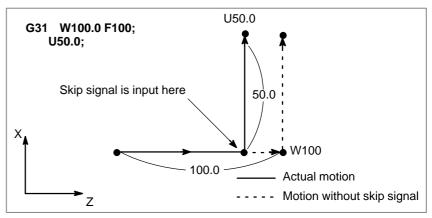
To increase the precision of the tool position when the skip signal is input, feedrate override, dry run, and automatic acceleration/deceleration is disabled for the skip function when the feedrate is specified as a feed per minute value. To enable these functions, set bit 7 (SKF) of parameter No. 6200 to 1. If the feedrate is specified as a feed per rotation value, feedrate override, dry run, and automatic acceleration/deceleration are enabled for the skip function, regardless of the setting of the SKF bit.

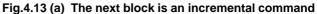
#### NOTE

- 1 If G31 command is issued while tool nose radius compensation is applied, an P/S alarm of No. 035 is displayed. Cancel the cutter compensation with the G40 command before the G31 command is specified.
- 2 For the high–speed skip option, executing G31 during feed–per– rotation mode causes P/S alarm (No. 211) to be generated.

#### Examples

• The next block to G31 is an incremental command





• The next block to G31 is an absolute command for 1 axis

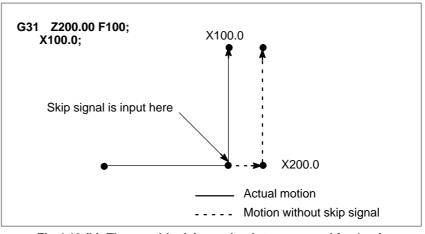
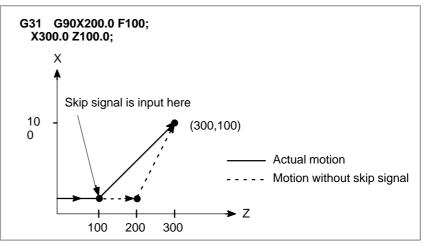
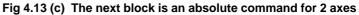


Fig.4.13 (b) The next block is an absolute command for 1 axis

 The next block to G31 is an absolute command for 2 axes





## 4.14 MULTISTAGE SKIP

In a block specifying P1 to P4 after G31, the multistage skip function stores coordinates in a custom macro variable when a skip signal (4–point or 8–point; 8–point when a high–speed skip signal is used) is turned on. Parameters No. 6202 to No. 6205 can be used to select a 4–point or 8–point (when a high–speed skip signal is used) skip signal. One skip signal can be set to match multiple Pn or Qn (n=1,2,3,4) as well as to match a Pn or Qn on a one–to–one basis. Parameters DS1 to DS8 (No. 6206 #0A#7) can be used for dwell.

A skip signal from equipment such as a fixed-dimension size measuring instrument can be used to skip programs being executed.

In plunge grinding, for example, a series of operations from rough machining to spark-out can be performed automatically by applying a skip signal each time rough machining, semi-fine machining, fine-machining, or spark-out operation is completed.

#### Format

|  | Move command<br>G31 IP F P ;<br>IP_: End point<br>F_: Feedrate<br>P_: P1-P4<br>Dwell<br>G04 X (U, P) (Q) ;<br>X(U, P)_: Dwell time<br>Q_: Q1 - Q4   |  |
|--|---|--|
| Explanations   | Multistage skip is caused by specifying P1, P2, P3, or P4 in a G31 block.<br>For an explanation of selecting (P1, P2, P3, or P4), refer to the manual<br>supplied by the machine tool builder.<br>Specifying Q1, Q2, Q3, or Q4 in G04 (dwell command) enables dwell<br>skip in a similar way to specifying G31. A skip may occur even if Q is<br>not specified. For an explanation of selecting (Q1, Q2, Q3, or Q4), refer<br>to the manual supplied by the machine tool builder. |  |
| <ul> <li>Correspondence to skip<br/>signals</li> </ul> | Parameter Nos. 6202 to 6205 can be used to specify whether the 4-point<br>or 8-point skip signal is used (when a high-speed skip signal is used).<br>Specification is not limited to one-to-one correspondence. It is possible<br>to specify that one skip signal correspond to two or more Pn's or Qn's<br>(n=1, 2, 3, 4). Also, bits 0 (DS1) to 7 (DS8) of parameter No. 6206 can<br>be used to specify dwell.  |  |
|  | <b>CAUTION</b><br>Dwell is not skipped when Qn is not specified and parameters DS1–DS8 (No. 6206#0–#7) are not set.   |  |

| 4.15<br>TORQUE LIMIT SKIP<br>(G31 P99)               | With the motor torque limited (for example, by a torque limit command, issued through the PMC window), a move command following G31 P99 (or G31 P98) can cause the same type of cutting feed as with G01 (linear interpolation).<br>With the issue of a signal indicating a torque limit has been reached (because of pressure being applied or for some other reason), a skip occurs.<br>For details of how to use this function, refer to the manuals supplied by the machine tool builder. |
|--|---|
| Format   |   |
|  | G31 P99 IP_ F_ ;  |
|  | G31 P98 IP_F_;  |
|  | G31: One–shot G code (G code effective only in the block in which it is issued)   |
|  |   |
| Explanations   |   |
| • G31 P99  | If the motor torque limit is reached, or a SKIP signal is received during execution of G31 P99, the current move command is aborted, and the next block is executed.  |
| • G31 P98  | If the motor torque limit is reached during execution of G31 P98, the current move command is aborted, and the next block is executed. The SKIP signal <x0004#7 2="" post="" tool="" x0013#7=""> does not affect G31 P98. Entering a SKIP signal during the execution of G31 P98 does not cause a skip.</x0004#7>   |
| <ul> <li>Torque limit command</li> </ul>             | If a torque limit is not specified before the execution of G31 P99/98, the move command continues; no skip occurs even if a torque limit is reached.  |
| <ul> <li>Custom macro system<br/>variable</li> </ul> | When G31 P99/98 is specified, the custom macro variables hold the coordinates at the end of a skip. (See Section 4.9.) If a SKIP signal causes a skip with G31 P99, the custom macro system variables hold the coordinates based on the machine coordinate system when it stops, rather than those when the SKIP signal is entered.   |
| Limitations  |   |
| • Axis command                                       | Only one axis can be controlled in each block with G31 P98/99.<br>If two or more axes are specified to be controlled in such blocks, or no axis command is issued, P/S alarm No. 015 is generated.  |
| <ul> <li>Degree of servo error</li> </ul>            | When a signal indicating that a torque limit has been reached is input during execution of G31 P99/98, and the degree of servo error exceeds 32767, P/S alarm No. 244 is generated.   |

## • High-speed skip With G31 P99, a SKIP signal can cause a skip, but not a high-speed skip.

- Simplified synchronization and slanted axis control
- Speed control
- Consecutive commands

G31 P99/98 cannot be used for axes subject to simplified synchronization or the X-axis or Z-axis when under slanted axis control.

Bit 7 (SKF) of parameter No. 6200 must be set to disable dry run, override, and auto acceleration or deceleration for G31 skip commands.

Do not use G31 P99/98 in consecutive blocks.

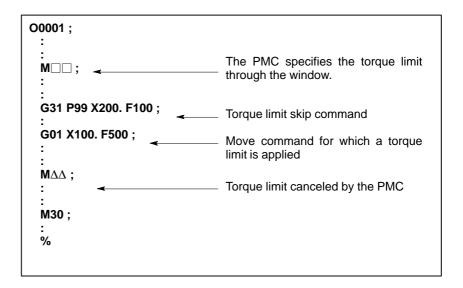
#### WARNING

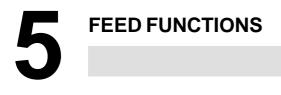
Always specify a torque limit before a G31 P99/98 command. Otherwise, G31 P99/98 allows move commands to be executed without causing a skip.

#### NOTE

If G31 is issued with tool nose radius compensation specified, P/S alarm No. 035 is generated. Therefore, before issuing G31, execute G40 to cancel tool nose radius compensation.

#### **Examples**





## 5.1 The feed functions control the feedrate of the tool. The following two feed functions are available: Feed functions

- 1. Rapid traverse When the positioning command (G00) is specified, the tool moves at!a rapid traverse feedrate set in the CNC (parameter No. 1420).
- 2. Cutting feed The tool moves at a programmed cutting feedrate.

Override can be applied to a rapid traverse rate or cutting feedrate using the switch on the machine operator's panel.

To prevent a mechanical shock, acceleration/deceleration is automatically applied when the tool starts and ends its movement (Fig. 5.1 (a)).

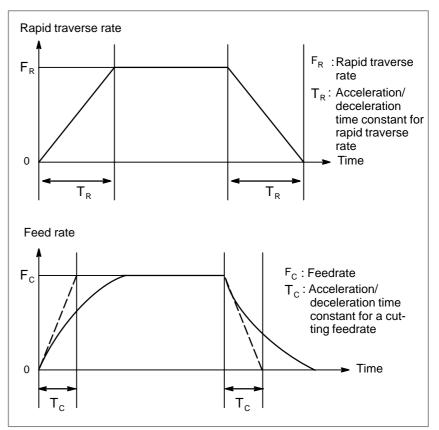


Fig. 5.1 (a) Automatic acceleration/deceleration (example)

#### • Override

 Automatic acceleration/ deceleration  Tool path in a cutting feed If the direction of movement changes between specified blocks during cutting feed, a rounded–corner path may result (Fig. 5.1 (b)).

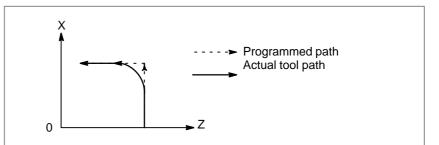


Fig. 5.1 (b) Example of Tool Path between Two Blocks

In circular interpolation, a radial error occurs (Fig. 5.1 (c)).

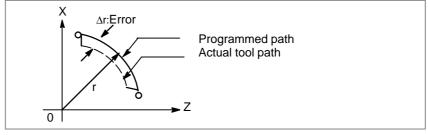


Fig. 5.1 (c) Example of Radial Error in Circular Interpolation

The rounded–corner path shown in Fig. 5.1 (b) and the error shown in Fig. 5.1 (c) depend on the feedrate. So, the feedrate needs to be controlled for the tool to move as programmed.

## 5.2 RAPID TRAVERSE

Format

#### G00 IP\_;

G00 : G code (group 01) for positioning (rapid traverse) IP\_ ; Dimension word for the end point

#### **Explanations**

The positioning command (G00) positions the tool by rapid traverse. In rapid traverse, the next block is executed after the specified feedrate becomes 0 and the servo motor reaches a certain range set by the machine tool builder (in–position check).

A rapid traverse rate is set for each axis by parameter No. 1420, so no rapid traverse feedrate need be programmed.

The following overrides can be applied to a rapid traverse rate with the switch on the machine operator's panel:F0, 25, 50, 100%

F0: Allows a fixed feedrate to be set for each axis by parameter No. 1421. For detailed information, refer to the appropriate manual of the machine tool builder.

5.3

#### Feedrate of linear interpolation (G01), circular interpolation (G02, G03), etc. are commanded with numbers after the F code. **CUTTING FEED** In cutting feed, the next block is executed so that the feedrate change from the previous block is minimized. Two modes of specification are available: 1. Feed per minute (G98) After F, specify the amount of feed of the tool per minute. 2. Feed per revolution (G99) After F, specify the amount of feed of the tool per spindle revolution. Format Feed per minute G code (group 05) for feed per minute G98; Feedrate command (mm/min or inch/min) **F\_**; Feed per revolution G99; G code (group 05) for feed per revolution **F\_**; Feedrate command (mm/rev or inch/rev)

#### **Explanations**

 Tangential speed constant control

• Feed per minute (G98)

Cutting feed is controlled so that the tangential feedrate is always set at a specified feedrate.

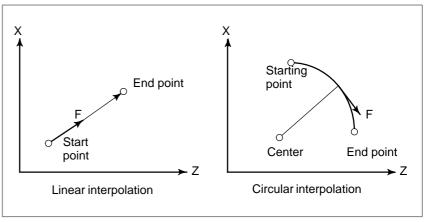


Fig. 5.3 (a) Tangential feedrate (F)

After specifying G98 (in the feed per minute mode), the amount of feed of the tool per minute is to be directly specified by setting a number after F. G98 is a modal code. Once a G98 is specified, it is valid until G99 (feed per revolution) is specified. At power-on, the feed per revolution mode is set.

An override from 0% to 254% (in 1% steps) can be applied to feed per minute with the switch on the machine operator's panel. For detailed information, see the appropriate manual of the machine tool builder.

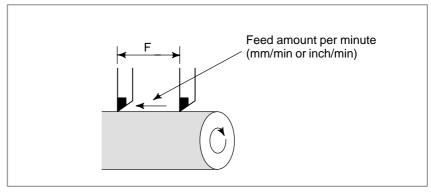


Fig. 5.3 (b) Feed per minute

#### WARNING

No override can be used for some commands such as for threading.

• Feed per revolution (G99)

After specifying G99 (in the feed per revolution mode), the amount of feed of the tool per spindle revolution is to be directly specified by setting a number after F. G99 is a modal code. Once a G99 is specified, it is valid until G98 (feed per minute) is specified.

An override from 0% to 254% (in 1% steps) can be applied to feed per revolution with the switch on the machine operator's panel. For detailed information, see the appropriate manual of the machine tool builder.

If bit 0 (NPC) of parameter No. 1402 has been set to 1, feed-per-rotation commands can be specified even when a position coder is not being used. (The CNC converts feed-per-rotation commands to feed-per-minute commands.)

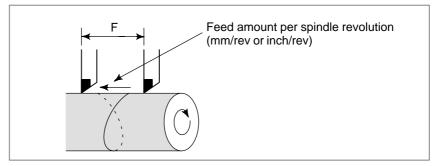


Fig. 5.3 (c) Feed per revolution

#### CAUTION

When the speed of the spindle is low, feedrate fluctuation may occur. The slower the spindle rotates, the more frequently feedrate fluctuation occurs.

• Cutting feedrate clamp

A common upper limit can be set on the cutting feedrate along each axis with parameter No. 1422. If an actual cutting feedrate (with an override applied) exceeds a specified upper limit, it is clamped to the upper limit.

#### NOTE

An upper limit is set in mm/min or inch/min. CNC calculation may involve a feedrate error of  $\pm 2\%$  with respect to a specified value. However, this is not true for acceleration/deceleration. To be more specific, this error is calculated with respect to a measurement on the time the tool takes to move 500 mm or more during the steady state:

• Reference

See Appendix C for a range of feedrates that can be specified.

## 5.4 DWELL (G04)

#### Format

#### Dwell $G04 X_{;}$ or $G04 U_{;}$ or $G04 P_{;}$

- X\_: Specify a time (decimal point permitted)
- U\_: Specify a time (decimal point permitted)
- P\_: Specify a time (decimal point not permitted)

#### **Explanations**

By specifying a dwell, the execution of the next block is delayed by the specified time.

Bit 1 (DWL) of parameter No. 3405 can specify dwell for each rotation in feed per rotation mode (G99).

 Table 5.4 (a)

 Command value range of the dwell time (Command by X)

| Increment system | Command value range | Dwell time unit |
|------------------|---------------------|-----------------|
| IS–B             | 0.001 to 99999.999  | s or rev        |
| IS-C             | 0.0001 to 9999.9999 | s or rev        |

 Table 5.4 (b)

 Command value range of the dwell time (Command by P)

| Increment system | Command value range | Dwell time unit |
|------------------|---------------------|-----------------|
| IS–B             | 1 to 99999999       | 0.001 s or rev  |
| IS-C             | 1 to 99999999       | 0.0001 s or rev |

6

## **REFERENCE POSITION**

A CNC machine tool has a special position where, generally, the tool is exchanged or the coordinate system is set, as described later. This position is referred to as a reference position.

# 6.1 REFERENCE POSITION RETURN

• Reference position

The reference position is a fixed position on a machine tool to which the tool can easily be moved by the reference position return function. For example, the reference position is used as a position at which tools are automatically changed. Up to four reference positions can be specified by setting coordinates in the machine coordinate system in parameters (No. 1240 to 1243).

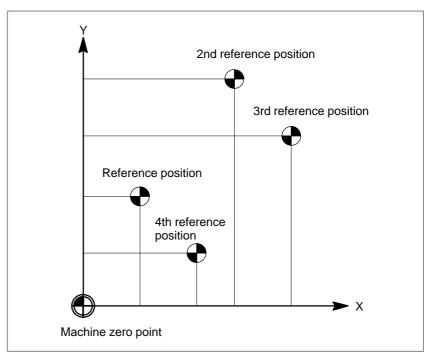


Fig. 6.1 (a) Machine zero point and reference positions

 Reference position return Tools are automatically moved to the reference position via an intermediate position along a specified axis. When reference position return is completed, the lamp for indicating the completion of return goes on.

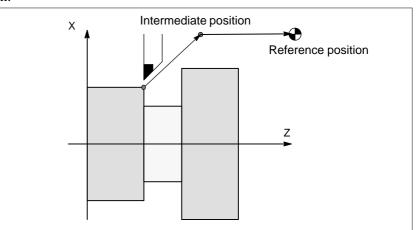


Fig. 6.2 (b) Reference position return

• Reference position return check

The reference position return check (G27) is the function which checks whether the tool has correctly returned to the reference position as specified in the program. If the tool has correctly returned to the reference position along a specified axis, the lamp for the axis goes on.

#### Format

• Reference position return

| G28 IP _; Reference position return<br>G30 P2 IP _; 2nd reference position return<br>G30 P3 IP _; 3rd reference position return<br>G30 P4 IP _; 4th reference position return | (P2 can<br>be omitted.) |
|---|-------------------------|
| IP : Command specifying the intermediate position (Absolute/incremental command)  |                         |

• Reference position return check

G27 IP\_;

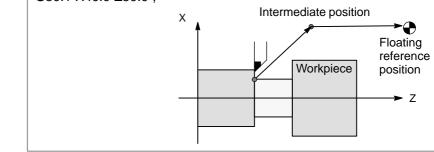
IP : Command specifying the reference position (Absolute/incremental command)

# Explanations

| <ul> <li>Reference position<br/>return (G28)</li> </ul>   | Positioning to the intermediate or reference positions are performed at the rapid traverse rate of each axis.<br>Therefore, for safety, the tool nose radius compensation, and tool offset should be cancelled before executing this command.  |
|---|--|
| <ul> <li>2nd, 3rd, and 4th<br/>reference position return<br/>(G30)</li> </ul>                                       | In a system without an absolute–position detector, the first, third, and fourth reference position return functions can be used only after the reference position return (G28) or manual reference position return (see III–3.1) is made. The G30 command is generally used when the automatic tool changer (ATC) position differs from the reference position.  |
| <ul> <li>Reference position<br/>return check (G27)</li> </ul>   | G27 command positions the tool at rapid traverse rate. If the tool reaches the reference position, the reference position return lamp lights up. However, if the position reached by the tool is not the reference position, an alarm (No. 092) is displayed.  |
| Restrictions  |  |
| <ul> <li>Status the machine lock<br/>being turned on</li> </ul>   | The lamp for indicating the completion of return does not go on when the machine lock is turned on, even when the tool has automatically returned to the reference position. In this case, it is not checked whether the tool has returned to the reference position even when a G27 command is specified.   |
| • First return to the reference position after the power has been turned on (without an absolute position detector) | When the G28 command is specified when manual return to the reference position has not been performed after the power has been turned on, the movement from the intermediate point is the same as in manual return to the reference position.<br>In this case, the tool moves in the direction for reference position return specified in parameter ZMIx (bit 5 of No. 1006). Therefore the specified intermediate position must be a position to which reference position return is possible. |
| <ul> <li>Reference position<br/>return check in an offset<br/>mode</li> </ul>                                       | In an offset mode, the position to be reached by the tool with the G27 command is the position obtained by adding the offset value. Therefore, if the position with the offset value added is not the reference position, the lamp does not light up, but an alarm is displayed instead. Usually, cancel offsets before G27 is commanded.  |
| • Lighting the lamp when<br>the programmed position<br>does not coincide with<br>the reference position             | When the machine tool is an inch system with metric input, the reference<br>position return lamp may also light up even if the programmed position<br>is shifted from the reference position by least input increment. This is<br>because the least input increment of the machine is smaller than its least<br>command increment.   |
| Reference   |  |

 Manual reference position return See III–3.1.

| 6.2<br>FLOATING<br>REFERENCE<br>POSITION RETURN<br>(G30.1)     | Tools ca be returned to the floating reference position.<br>A floating reference point is a position on a machine tool, and serves as<br>a reference point for machine tool operation.<br>A floating reference point need not always be fixed, but can be moved as<br>required.   |  |
|--|---|--|
| Format   |   |  |
|  | G30.1 IP ;  |  |
|  | IP: Command of the intermediate position of the floating reference position   |  |
|  | (Absolute command/incremental command)  |  |
| Explanations   | On some machine tools, the cutting tools can be replaced at any position<br>unless they interfere with the workpiece or tail stock.<br>With these machines, the cutting tools should be replaced at a position as<br>close to the workpiece as possible so as to minimize the machine cycle<br>time. For this purpose, the tool change position is to be changed,<br>depending on the figure of the workpiece. This operation can easily be<br>performed using this function. That is, a tool change position suitable for<br>the workpiece is memorized as a floating reference point. Then command<br>G30. 1 can easily cause return to the tool change position. |  |
| <ul> <li>Floating reference<br/>position</li> </ul>            | The G30.1 block first positions the tool at the intermediate point along the specified axes at rapid traverse rate, then further moves the tool from the intermediate point to the floating reference point at rapid traverse rate. Before using G30.1, cancel cutter compensation and tool offset.   |  |
| <ul> <li>Setting of floating<br/>reference position</li> </ul> | A floating reference point becomes a machine coordinate position<br>memorized by pressing the soft key <b>[SET FRP]</b> on the current positions<br>display screen.<br>A floating reference point is not lost even if power is turned off.  |  |
| Examples   |   |  |
|  | G30.1 X40.0 Z50.0 ;   |  |
|  | X Intermediate position   |  |



# COORDINATE SYSTEM

By teaching the CNC a desired tool position, the tool can be moved to the position. Such a tool position is represented by coordinates in a coordinate system. Coordinates are specified using program axes. When two program axes, the X-axis and Z-axis, are used, coordinates are specified as follows:



This command is referred to as a dimension word.

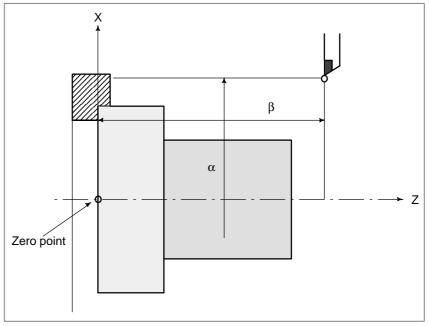


Fig. 7 Tool Position Specified by  $X\alpha Z\beta$ 

Coordinates are specified in one of following three coordinate systems:

- (1) Machine coordinate system
- (2) Workpiece coordinate system

(3) Local coordinate system

The number of the axes of a coordinate system varies from one machine to another. So, in this manual, a dimension word is represented as **IP**\_.

# 7.1 MACHINE COORDINATE SYSTEM

Format

The point that is specific to a machine and serves as the reference of the machine is referred to as the machine zero point. A machine tool builder sets a machine zero point for each machine.

A coordinate system with a machine zero point set as its origin is referred to as a machine coordinate system.

A machine coordinate system is set by performing manual reference position return after power–on (see III–3.1). A machine coordinate system, once set, remains unchanged until the power is turned off.

G53 IP \_ ; IP \_; Absolute dimension word

#### **Explanations**

 Selecting a machine coordinate system (G53) When a position has been specified as a set of machine coordinates, the tool moves to that position by means of rapid traverse. G53, used for selecting the machine coordinate system, is a one-shot G code. Any commands based on the selected machine coordinate system are thus effective only in the block containing G53. The G53 command must be specified using absolute values. If incremental values are specified, the G53 command is ignored. When the tool is to be moved to a machine-specific position such as a tool change position, program the movement in a machine coordinate system based on G53.

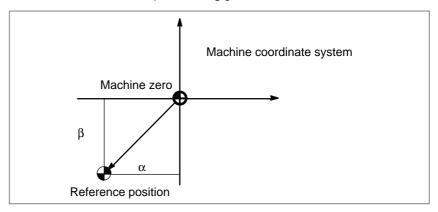
#### Restrictions

- Cancel of the compensation function
- G53 specification immediately after power–on

When the G53 command is specified, cancel the tool nose radius compensation and tool offset.

Since the machine coordinate system must be set before the G53 command is specified, at least one manual reference position return or automatic reference position return by the G28 command must be performed after the power is turned on. This is not necessary when an absolute–position detector is attached.

When manual reference position return is performed after power–on, a machine coordinate system is set so that the reference position is at the coordinate values of ( $\alpha$ ,  $\beta$ ) set using parameter No.1240.



#### Reference

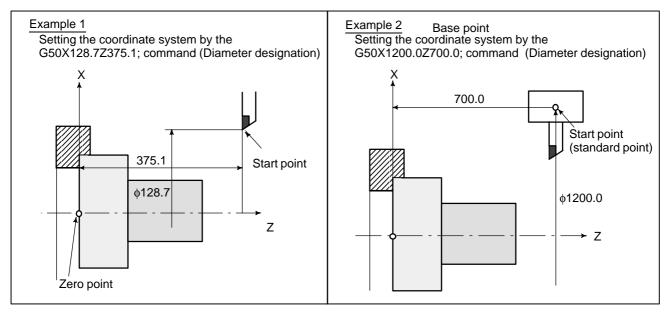
| WORKPIECE<br>COORDINATE<br>SYSTEM       | A coordinate system used for machining a workpiece is referred to as a<br>workpiece coordinate system. A workpiece coordinate system is to be set<br>with the NC beforehand ( <b>setting a workpiece coordinate system</b> ).<br>A machining program sets a workpiece coordinate system ( <b>selecting a</b><br><b>workpiece coordinate system</b> ).<br>A set workpiece coordinate system can be changed by shifting its origin<br>( <b>changing a workpiece coordinate system</b> ). |
|---|--|
| 7.2.1                                   | A workpiece coordinate system can be set using one of three methods:   |
| Setting a Workpiece                     | (1) Method using G50   |
| Coordinate System                       | A workpiece coordinate system is set by specifying a value after G50 in the program.   |
|   | (2) Automatic setting  |
|   | If bit 0 of parameter No. 1201 is set beforehand, a workpiece coordinate system is automatically set when manual reference position return is performed (see Part III–3.1.).   |
|   | This function is, however, disabled when the workpiece coordinate system option is being used.   |
|   | (3) Input using the MDI panel  |
|   | Six workpiece coordinate systems can be set beforehand using the MDI panel (see Part III–3.1.).  |
|   | When an absolute command is used, a workpiece coordinate system<br>must be established in any of the ways described above.   |
| Format                                  |  |
| <ul> <li>Setting a workpiece</li> </ul> | G50 IP   |

**Explanations** 

coordinate system by G50

A workpiece coordinate system is set so that a point on the tool, such as the tool tip, is at specified coordinates. If IP is an incremental command value, the work coordinate system is defined so that the current tool position coincides with the result of adding the specified incremental value to the coordinates of the previous tool position. If a coordinate system is set using G50 during offset, a coordinate system in which the position before offset matches the position specified in G50 is set.

#### Examples



| 7.2.2<br>Selecting a Workpiece<br>Coordinate System | <ul> <li>The user can choose from set workpiece coordinate systems as described below. (For information about the methods of setting, see Subsec. II-7.2.1.)</li> <li>(1) G50 or automatic workpiece coordinate system setting Once a workpiece coordinate system is selected, absolute commands work with the workpiece coordinate system.</li> </ul> |
|---|--|
|   | <ul><li>(2) Choosing from six workpiece coordinate systems set using the MDI</li><li>By specifying a G code from G54 to G59, one of the workpiece coordinate systems 1 to 6 can be selected.</li></ul>   |
|   | <ul> <li>G54 Workpiece coordinate system 1</li> <li>G55 Workpiece coordinate system 2</li> <li>G56 Workpiece coordinate system 3</li> <li>G57 Workpiece coordinate system 4</li> <li>G58 Workpiece coordinate system 5</li> <li>G59 Workpiece coordinate system 6</li> </ul>   |
|   | Workpiece coordinate system 1 to 6 are established after reference<br>position return after the power is turned on. When the power is turned<br>on, G54 coordinate system is selected.<br>When bit 2 (G50) of parameter No. 1202 is set to 1, executing the G50  |

When bit 2 (G50) of parameter No. 1202 is set to 1, executing the G50 command results in the issue of P/S alarm No. 10. This is designed to prevent the user from confusing coordinate systems.

#### Examples

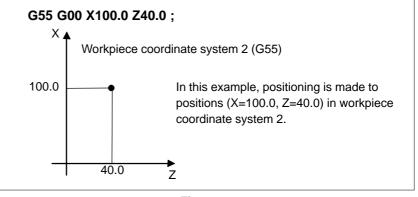


Fig. 7.2.2

# 7.2.3 Changing Workpiece Coordinate System

The six workpiece coordinate systems specified with G54 to G59 can be changed by changing an external workpiece zero point offset value or workpiece zero point offset value.

Three methods are available to change an external workpiece zero point offset value or workpiece zero point offset value.

(1) Inputting from the MDI panel (see III–11.4.10)

(2) Programming by G10 or G50

(3) Using the external data input function

An external workpiece origin offset can be changed by using a signal input to the CNC. For details, refer to the relevant manual supplied by the machine tool builder.

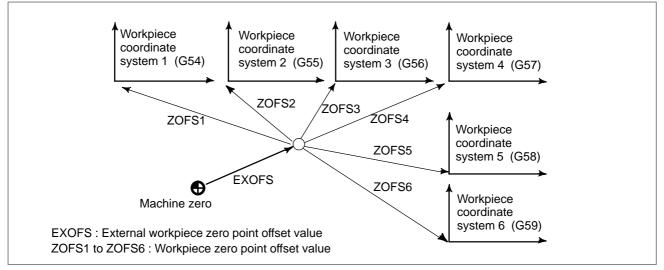


Fig. 7.2.3 Changing an external workpiece zero point offset value or workpiece zero point offset value

#### Format

Changing by G10

#### G10 L2 Pp IP \_;

p=0 : External workpiece zero point offset value

- p=1 to 6 : Workpiece zero point offset value correspond to workpiece coordinate system 1 to 6
- IP : For an absolute command (G90), workpiece zero point offset for each axis.
   For an incremental command (G91), value to be added to the set workpiece zero point offset for each axis (the sum
  - is set as the new offset).

#### • Changing by G50

G50 IP \_;

#### **Explanations**

- Changing by G10 With the G10 command, each workpiece coordinate system can be changed separately.
- Changing by G50

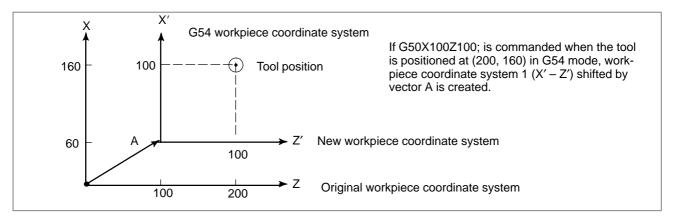
changed separately.

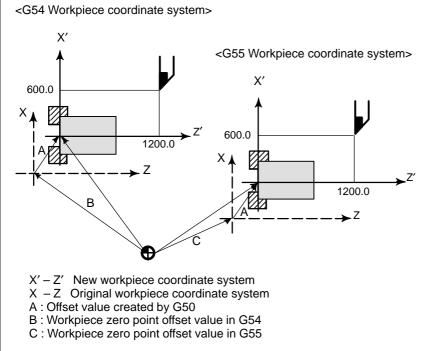
By specifying G50IP\_;, a workpiece coordinate system (selected with a code from G54 to G59) is shifted to set a new workpiece coordinate system so that the current tool position matches the specified coordinates (IP\_).

If IP is an incremental command value, the work coordinate system is defined so that the current tool position coincides with the result of adding the specified incremental value to the coordinates of the previous tool position. (Coordinate system shift)

Then, the amount of coordinate system shift is added to all the workpiece zero point offset values. This means that all the workpiece coordinate systems are shifted by the same amount.

#### Examples





Suppose that a G54 workpiece coordinate system is specified. Then, a G55 workpiece coordinate system where the black circle on the tool (figure at the left) is at (600.0,12000.0) can be set with the following command if the relative relationship between the G54 workpiece coordinate system and G55 workpiece coordinate system is set correctly:G50X600.0Z1200.0;Also, suppose that pallets are loaded at two different positions. If the relative relationship of the coordinate systems of the pallets at the two positions is correctly set by handling the coordinate systems as the G54 workpiece coordinate system and G55 workpiece coordinate system, a coordinate system shift with G50 in one pallet causes the same coordinate system shift in the other pallet. This means that workpieces on two pallets can be machined with the same program just by specifying G54 or G55.

# 7.2.4 Workpiece Coordinate System Preset (G92.1)

The workpiece coordinate system preset function presets a workpiece coordinate system shifted by manual intervention to the pre–shift workpiece coordinate system. The latter system is displaced from the machine zero point by a workpiece zero point offset value.

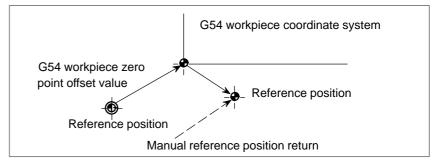
There are two methods for using the workpiece coordinate system preset function. One method uses a programmed command (G92.1). The other uses MDI operations on the absolute position display screen, relative position display screen, and overall position display screen (III – 11.1.4).

Format

#### Explanations

G92.1 IP 0; (G50.3 P0; for G code system A)
 IP 0; Specifies axis addresses subject to the workpiece coordinate system preset operation. Axes that are not specified are not subject to the preset operation.

When manual reference position return operation is performed in the reset state, a workpiece coordinate system is shifted by the workpiece zero point offset value from the machine coordinate system zero point. Suppose that the manual reference position return operation is performed when a workpiece coordinate system is selected with G54. In this case, a workpiece coordinate system is automatically set which has its zero point displaced from the machine zero point by the G54 workpiece zero point offset value; the distance from the zero point of the workpiece coordinate system to the reference position represents the current position in the workpiece coordinate system.



If an absolute position detector is provided, the workpiece coordinate system automatically set at power–up has its zero point displaced from the machine zero point by the G54 workpiece zero point offset value. The machine position at the time of power–up is read from the absolute position detector and the current position in the workpiece coordinate system is set by subtracting the G54 workpiece zero point offset value from this machine position. The workpiece coordinate system set by these operations is shifted from the machine coordinate system using the commands and operations listed next page.

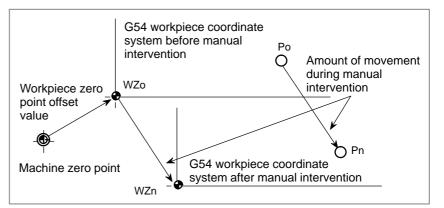
(a) Manual intervention performed when the manual absolute signal is off

(b) Move command executed in the machine lock state

(c) Movement by handle interrupt

- (d) Operation using the mirror image function
- (e) Setting the local coordinate system using G52, or shifting the workpiece coordinate system using G92

In the case of (a) above, the workpiece coordinate system is shifted by the amount of movement during manual intervention.



In the operation above, a workpiece coordinate system once shifted can be preset using G code specification or MDI operation to a workpiece coordinate system displaced by a workpiece zero point offset value from the machine zero point. This is the same as when manual reference position return operation is performed on a workpiece coordinate system that has been shifted. In this example, such G code specification or MDI operation has the effect of returning workpiece coordinate system zero point WZn to the original zero point WZo, and the distance from WZo to Pn is used to represent the current position in the workpiece coordinate system.

Bit 3 (PPD) of parameter No. 3104 specifies whether to preset relative coordinates (RELATIVE) as well as absolute coordinates.

When no workpiece coordinate system option (G54 to G59) is selected, the workpiece coordinate system is preset to the coordinate system set by automatic workpiece coordinate system setting. When automatic workpiece coordinate system setting is not selected, the workpiece coordinate system is preset with its zero point placed at the reference position.

#### Restrictions

- Cutter compensation, tool length compensation, tool offset When using the workpiece coordinate system preset function, cancel compensation modes: cutter compensation, tool length compensation, and tool offset. If the function is executed without cancelling these modes, compensation vectors are temporarily cancelled.
- Program restart

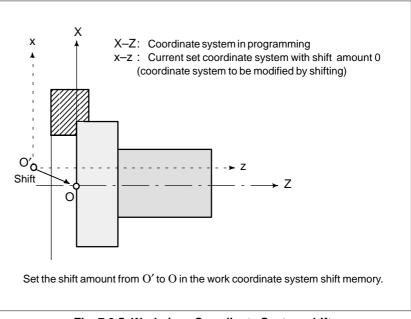
The workpiece coordinate system preset function is not executed during program restart.

• **Prohibited modes** Do not use the workpiece coordinate system preset function when the scaling, coordinate system rotation, programmable image, or drawing copy mode is set.

# 7.2.5 Workpiece Coordinate System Shift

When the coordinate system actually set by the G50 command or the automatic system setting deviates from the programmed work system, the set coordinate system can be shifted (see III–3.1). Set the desired shift amount in the work coordinate system shift memory.

#### **Explanations**



#### Fig. 7.2.5 Workpiece Coordinate System shift

See Section 11.4.5 of Part III for how to specify the distance the work coordinate system is shifted.

**Explanations** 

# 

By specifying G52IP\_;, a local coordinate system can be set in all the workpiece coordinate systems (G54 to G59). The origin of each local coordinate system is set at the position specified by IP\_ in the workpiece coordinate system.

Once a local coordinate system is established, the coordinates in the local coordinate system are used in an axis shift command. The local coordinate system can be changed by specifying the G52 command with the zero point of a new local coordinate system in the workpiece coordinate system.

To cancel the local coordinate system and specify the coordinate value in the workpiece coordinate system, match the zero point of the local coordinate system with that of the workpiece coordinate system.

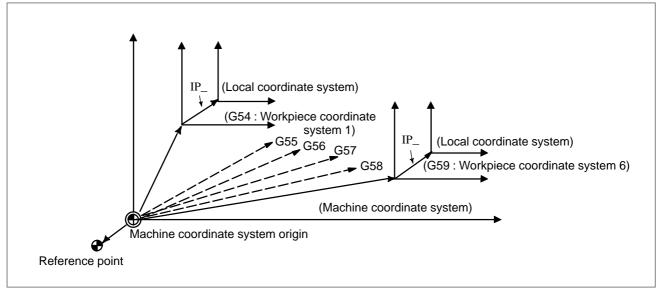


Fig. 7.3 Setting the local coordinate system

#### WARNING

- 1 The local coordinate system setting does not change the workpiece and machine coordinate systems.
- 2 When G50 is used to define a work coordinate system, if coordinates are not specified for all axes of a local coordinate system, the local coordinate system remains unchanged.

If coordinates are specified for any axis of a local coordinate system, the local coordinate system is canceled.

- 3 G52 cancels the offset temporarily in tool nose radius compensation.
- 4 Command a move command immediately after the G52 block in the absolute mode.
- 5 Whether the local coordinate system is canceled upon reset depends on the specified parameters. The local coordinate system is canceled upon reset when bit 6 (CLR) of parameter No. 3402 or bit 3 (RLC) of parameter No. 1202 is set to 1.

# 7.4 PLANE SELECTION

Select the planes for circular interpolation, tool nose radius compensation, coordinate system rotation, and drilling by G–code. The following table lists G–codes and the planes selected by them.

#### **Explanations**

| Table 7 | .4 | Plane  | selected | bv | G code |
|---------|----|--------|----------|----|--------|
|         |    | i iune | Scicolou | Ny | O COUC |

| G code | Selected plane | Хр            | Үр            | Zp            |
|--------|----------------|---------------|---------------|---------------|
| G17    | Xp Yp plane    | X–axis or an  | Y–axis or an  | Z–axis or an  |
| G18    | Zp Xp plane    | axis parallel | axis parallel | axis parallel |
| G19    | Yp Zp plane    | to it         | to it         | to it         |

Xp, Yp, Zp are determined by the axis address appeared in the block in which G17, G18 or G19 is commanded.

When an axis address is omitted in G17, G18 or G19 block, it is assumed that the addresses of basic three axes are omitted.

Parameter No. 1022 specifies whether each axis is a basic axis (X-axis, Y-axis, or Z-axis) or an axis parallel to a basic axis.

The plane is unchanged in the block in which G17, G18 or G19 is not commanded.

When the power is turned on, G18 (ZX plane) is selected .

The movement instruction is irrelevant to the plane selection.

#### NOTE

- 1 U–, V–, and W–axes (parallel to a basic axis) can be used with G–codes B and C.
- 2 Direct drawing dimension programming, chamfering, corner R, multiple repetitive canned cycle, and simple canned cycle are enabled only for the ZX plane. Specifying these functions for other planes causes P/S alarm No. 212 to be generated.

#### Examples

Plane selection when the X-axis is parallel with the U-axis.

- G17X\_Y\_; XY plane,
- G17U\_Y\_; UY plane
- G18X\_Z\_; ZX plane
  - X\_Y\_; Plane is unchanged (ZX plane)
- G17 ; XY plane
- G18; ZX plane
- G17 U\_; UY plane
- G18Y\_; ZX plane, Y axis moves regardless without any relation to the plane.

# COORDINATE VALUE AND DIMENSION

This chapter contains the following topics.

- 8.1 ABSOLUTE AND INCREMENTAL PROGRAMMING (G90, G91)
- 8.2 INCH/METRIC CONVERSION (G20, G21)
- 8.3 DECIMAL POINT PROGRAMMING
- 8.4 DIAMETER AND RADIUS PROGRAMMING

# 8.1 ABSOLUTE AND INCREMENTAL PROGRAMMING (G90, G91)

There are two ways to command travels of the tool; the absolute command, and the incremental command. In the absolute command, coordinate value of the end position is programmed; in the incremental command, move distance of the position itself is programmed. G90 and G91 are used to command absolute or incremental command, respectively.

Absolute programming or incremental programming is used depending on the command used. See following tables.

| G code system  | А            | B or C   |
|----------------|--------------|----------|
| Command method | Address word | G90, G91 |

#### Format

• G code system A

|                     | Absolute command | Incremental command |
|---------------------|------------------|---------------------|
| X axis move command | X                | U                   |
| Z axis move command | Z                | W                   |
| Y axis move command | Y                | V                   |
| C axis move command | C                | H                   |

G code system B or C

Absolute command G90 IP\_; Incremental command G91 IP\_;

#### Examples

• Tool movement from point P to point Q (diameter programming is used for the X-axis)

|                           | G code system A   | G code system B or C |
|---------------------------|---|----------------------|
| Absolute command          | X400.0 Z50.0 ;  | G90 X400.0 Z50.0 ;   |
| Incremental command       | U200.0 W–400.0 ;  | G91 X200.0 Z-400.0 ; |
| ¢400<br>¢400<br>50<br>450 | P<br>(200, 450)<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$<br>\$ |                      |

- 1 Absolute and incremental commands can be used together in a block.
  - In the above example, the following command can be specified :
  - X400.0 W-400.0 ;
- 2 When both X and U or W and Z are used together in a block, the one specified later is effective.
- 3 Incremental commands cannot be used when names of the axes are A and B during G code system A is selected.

# 8.2 INCH/METRIC CONVERSION (G20, G21) Format

Either inch or metric input can be selected by G code.

G20; Inch input G21; mm input

This G code must be specified in an independent block before setting the coordinate system at the beginning of the program. After the G code for inch/metric conversion is specified, the unit of input data is switched to the least inch or metric input increment of increment system IS–B or IS–C (Section II–2.3). The unit of data input for degrees remains unchanged. The unit systems for the following values are changed after inch/metric conversion:

- Feedrate commanded by F code
- Positional command
- Work zero point offset value
- Tool compensation value
- Unit of scale for manual pulse generator
- Movement distance in incremental feed
- Some parameters

When the power is turned on, the G code is the same as that held before the power was turned off.

#### WARNING

- 1 G20 and G21 must not be switched during a program.
- 2 When switching inch input (G20) to metric input (G21) and vice versa, the tool compensation value must be re-set according to the least input increment. However, when bit 0 (OIM) of parameter 5006 is 1, tool compensation values are automatically converted and need not be re-set.

#### CAUTION

Movement from the intermediate point is the same as that for manual reference position return. The direction in which the tool moves from the intermediate point is the same as the reference position return direction, as specified with bit 5 (ZMI) of parameter No. 1006.

- 1 When the least input increment and the least command increment systems are different, the maximum error is half of the least command increment. This error is not accumulated.
- 2 The inch and metric input can also be switched using setting of data setting (III–11.4.7).

| 8. COORDINATE VALUE<br>AND DIMENSION | PROGRAMMING   | B-63004EN/02  |
|--------------------------------------|---|---|
| 8.3<br>DECIMAL POINT<br>PROGRAMMING  | Numerical values can be entered with a decimal<br>can be used when entering a distance, time, or spe<br>be specified with the following addresses:<br>X, Y, Z, U, V, W, A, B, C, I, J, K, R, and F.   | · ·   |
| Explanations                         | There are two types of decimal point notation: c<br>and standard notation.<br>When calculator-type decimal notation is used, a<br>point is considered to be specified in millimeters.<br>notation is used, such a value is considered to be<br>increments. Select either calculator-type or stand<br>using the DPI bit (bit 0 of parameter 3401). Value<br>with and without decimal point in a single progr | a value without decimal<br>When standard decimal<br>specified in least input<br>ard decimal notation by<br>es can be specified both |

# Examples

| Program command                                   | Pocket calculator<br>type decimal point<br>programming | Standard type decimal<br>point programming        |
|---|--|---|
| X1000<br>Command value with-<br>out decimal point | 1000mm<br>Unit : mm                                    | 1mm<br>Unit : Least input increment<br>(0.001 mm) |
| X1000.0<br>Command value with<br>decimal point    | 1000mm<br>Unit : mm                                    | 1000mm<br>Unit : mm                               |

#### WARNING

In a single block, specify a G code before entering a value. The position of decimal point may depend on the command.

# Examples:

**G20;** Input in inches **X1.0 G04;** X1.0 is considered to be a distance and processed as X10000. This command

| ×1.0 G04, | A 1.0 is considered to be a distance and processed as A 10000. This command |
|-----------|---|
|           | is equivalent to G04 X10000. The tool dwells for 10 seconds.                |
| G04 X1.0; | Equivalent to G04 X1000. The tool dwells for one second.                    |

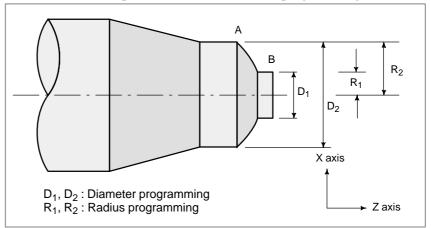
| 1 | Fractions less than the least input increment are truncated. |   |  |
|---|--|---|--|
|   | Examples:  |   |  |
|   | X1.23456;  | Truncated to X1.234 when the least input increment is 0.001 mm.   |  |
|   |  | Processed as X1.2345 when the least input increment is 0.0001 inch.   |  |
| 2 | point, the nur   | nan eight digits are specified, an alarm occurs. If a value is entered with a decimal<br>nber of digits is also checked after the value is converted to an integer according<br>oput increment. |  |
|   | Examples:  |   |  |
|   | -  | ; P/S alarm 003 occurs because more than eight digits are specified.  |  |
|   | X123456.7;   | If the least input increment is 0.001 mm, the value is converted to integer 123456700. Because the integer has more than eight digits, an P/S alarm 003 occurs.                                 |  |

# 8.4 DIAMETER AND RADIUS PROGRAMMING

Since the work cross section is usually circular in CNC lathe control programming, its dimensions can be specified in two ways :

#### **Diameter and Radius**

When the diameter is specified, it is called diameter programming and when the radius is specified, it is called radius programming.



#### **Explanations**

 Notes on diameter programming/radius programming for each command Radius programming or diameter programming can be specified by parameter DIA (No.1006#3). When using diameter programming, note the conditions listed in the table 8.4.

Table 8.4 Notes on specifying diameter value

| ltem  | Notes  |
|---|--|
| X axis command  | Specified with a diameter value  |
| Incremental command   | Specified with a diameter value<br>In the above figure, specifies D2 minus<br>D1 for tool path B to A. |
| Coordinate system setting (G50)   | Specifies a coordinate value with a diam-<br>eter value  |
| Component of tool offset value  | Parameter (No.5004#1) determines either diameter or radius value                                       |
| Parameters in canned cycle,<br>such as cutting depth along X<br>axis. (R) | Specifies a radius value   |
| Radius designation in circular in-<br>terpolation (R, I, K, and etc.)     | Specifies a radius value   |
| Feedrate along axis   | Specifies change of radius/rev. or change of radius/min.   |
| Display of axis position  | Displayed as diameter value  |



# SPINDLE SPEED FUNCTION

The spindle speed can be controlled by specifying a value following address S.

In addition, the spindle can be rotated by a specified angle. This chapter contains the following topics.

- 9.1 SPECIFYING THE SPINDLE SPEED WITH A CODE
- 9.2 SPECIFYING THE SPINDLE SPEED VALUE DIRECTLY (S5–DIGIT COMMAND)
- 9.3 CONSTANT SURFACE SPEED CONTROL (G96, G97)
- 9.4 SPINDLE SPEED FLUCTUATION DETECTION FUNCTION (G25, G26)
- 9.5 SPINDLE POSITIONING FUNCTION

# 9.1 SPECIFYING THE SPINDLE SPEED WITH A CODE

Specifying a value following address S sends code and strobe signals to the machine. On the machine, the signals are used to control the spindle speed. A block can contain only one S code. Refer to the appropriate manual provided by the machine tool builder for details such as the number of digits in an S code or the execution order when a move command and an S code command are in the same block.

9.2 SPECIFYING THE SPINDLE SPEED VALUE DIRECTLY (S5–DIGIT COMMAND) The spindle speed can be specified directly by address S followed by a five-digit value (rpm). The unit for specifying the spindle speed may vary depending on the machine tool builder. Refer to the appropriate manual provided by the machine tool builder for details.

9.3 CONSTANT SURFACE SPEED CONTROL (G96, G97) Specify the surface speed (relative speed between the tool and workpiece) following S. The spindle is rotated so that the surface speed is constant regardless of the position of the tool.

Format

• Constant surface speed control command

G96 S00000;

↑Surface speed (m/min or feet/min)

Note : This surface speed unit may change according to machine tool builder's specification.

 Constant surface speed control cancel command

G97 S<u>00000</u>;

↑Spindle speed (rpm)

Note : This surface speed unit may change according to machine tool builder's specification.

 Clamp of maximum spindle speed

G50 S : The maximum spindle speed (rpm) follows S.

#### Explanations

• Constant surface speed control command (G96)

G96 (constant surface speed control command) is a modal G code. After a G96 command is specified, the program enters the constant surface speed control mode (G96 mode) and specified S values are assumed as a surface speed. A G96 command must specify the axis along which constant surface speed control is applied. A G97 command cancels the G96 mode.When constant surface speed control is applied, a spindle speed higher than the value specified in G50S\_; (maximum spindle speed) is clamped at the maximum spindle speed. When the power is turned on, the maximum spindle speed is not yet set and the speed is not clamped.S (surface speed) commands in the G96 mode are assumed as S = 0 (the surface speed is 0) until M03 (rotating the spindle in the positive direction) or M04 (rotating the spindle in the negative direction) appears in the program.

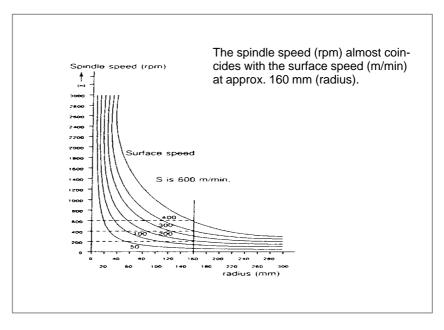


Fig. 9.3 (a) Relation between workpiece radius, spindle speed and surface speed

 Setting the workpiece coordinate system for constant surface speed control

To execute the constant surface speed control, it is necessary to set the work coordinate system, Z axis, (axis to which the constant surface speed control applies) becomes zero.

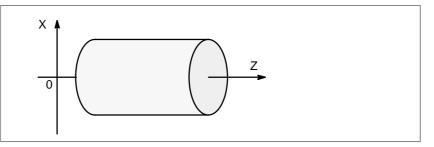
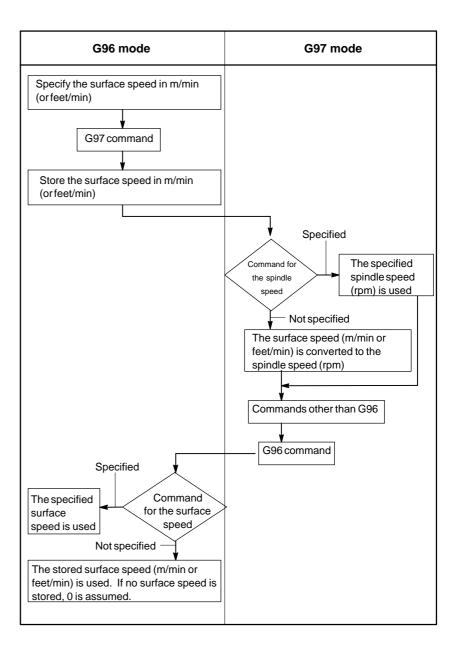


Fig. 9.3 (b) Example of the Workpiece Coordinate System for Constant Surface Speed Control

# • Surface speed specified in the G96 mode



#### Restrictions

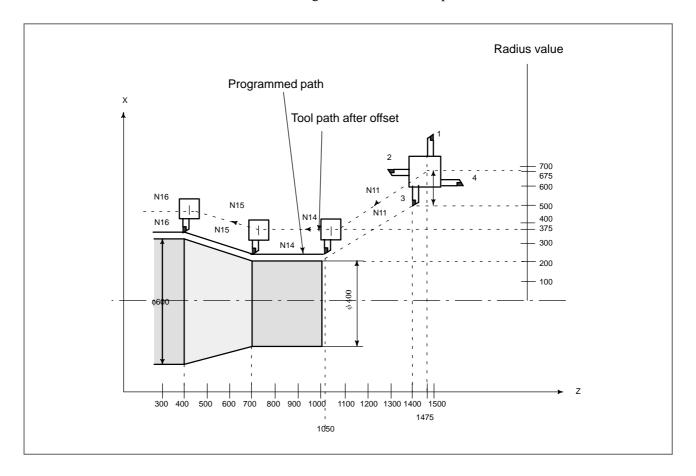
• Constant surface speed control for threading

The constant surface speed control is also effective during threading. Accordingly, it is recommended that the constant surface speed control be invalidated with G97 command before starting the scroll threading and taper threading, because the response problem in the servo system may not be considered when the spindle speed changes.

#### 9. SPINDLE SPEED FUNCTION

#### Constant surface speed control for rapid traverse (G00) In a rapid traverse block specified control is not made by calculating th of the tool position, but is made by calculating th

In a rapid traverse block specified by G00, the constant surface speed control is not made by calculating the surface speed to a transient change of the tool position, but is made by calculating the surface speed based on the position at the end point of the rapid traverse block, on the condition that cutting is not executed at rapid traverse.



#### Example

N8 G00 X1000.0Z1400.0 ; N9 T33; N11 X400.0Z1050.0; N12 G50S3000 ; (Designation of max. spindle speed) N13 G96S200 ; (Surface speed 200 m/min) N14 G01 Z 700.0F1000 ; N15 X600.0Z 400.0; N16 Z ... ; The CNC calculates the spindle speed which is proportional to the specified surface speed at the position of the programmed coordinate value on the X axis. This is not the value calculated according to the X axis accordinate after offset when offset is valid. At the end point N15 in

axis coordinate after offset when offset is valid. At the end point N15 in the example above, the speed at 600 dia. (Which is not the turret center but the tool nose) is 200 m/min. If X axis coordinate value is negative, the CNC uses the absolute value.

# 9.4 SPINDLE SPEED FLUCTUATION DETECTION FUNCTION (G25, G26)

Format

PROGRAMMING

With this function, an overheat alarm (No. 704) is raised when the spindle speed deviates from the specified speed due to machine conditions. This function is useful, for example, for preventing the seizure of the guide bushing.

G26 enables spindle speed fluctuation detection. G25 disables spindle speed fluctuation detection.

| G26 Pp Qq Rr ; | Spindle fluctuation detection on  |
|----------------|-----------------------------------|
| G25 ;          | Spindle fluctuation detection off |

- p : Time (in ms) from the issue of a new spindle rotation command (S command) to the start of checking whether the actual spindle speed is so fast that an overheat can occur.When a specified speed is reached within the time period of P, spindle speed is checked at that time.
- **q** : Tolerance (%) of a specified spindle speed
  - $q = \frac{1-actual spindle speed}{specified spindle speed} \times 100$

If a specified spindle speed lies within this range, it is regarded as having reached the specified value. Then, an actual spindle speed is checked.

**r** : Spindle speed fluctuation (%) at which the actual spindle speed is so fast that an overheat can occur

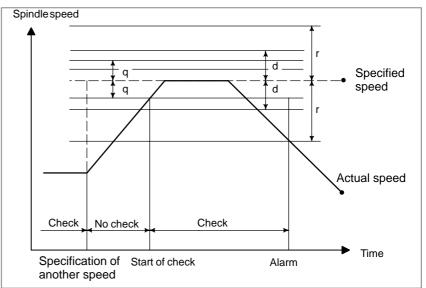
 $r = \frac{1-speed \ that \ can \ cause \ overheat}{specified \ spindle \ speed} \times 100$ 

G26 enables the spindle speed fluctuation detection function, and G25 disables the spindle speed fluctuation detection. Even if G25 is specified  $p_{c}q_{c}$  and r are not alcored

Even if G25 is specified, p, q, and r are not cleared.

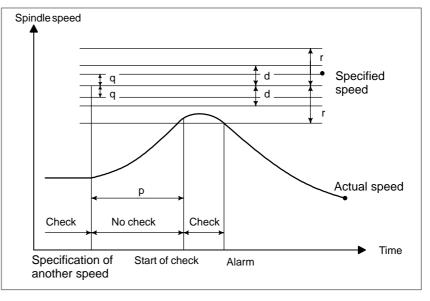
#### **Explanations**

The fluctuation of the spindle speed is detected as follows:



#### 1. When an alarm is issued after a specified spindle speed is reached

#### 2. When an alarm is issued before a specified spindle speed is reached



#### Specified speed :

(Speed specified by address S and five-digit value)  $\times$  (spindle override)

Actual speed : Speed detected with a position coder

- **p**: Time elapses since the specified speed changes until a check starts.
- **q**: (Percentage tolerance for a check to start) × (specified speed)
- r: (Percentage fluctuation detected as an alarm condition) × (specified speed)
- d: Fluctuation detected as an alarm (specified in parameter 4913)

An alarm is issued when the difference between the specified speed and the actual speed exceeds both r and d.

- 1 When an alarm is issued in automatic operation, a single block stop occurs. The spindle overheat alarm is indicated on the CRT screen, and the alarm signal "SPAL" is output (set to 1 for the presence of an alarm). This signal is cleared by resetting.
- 2 Even when reset operation is performed after an alarm occurs, the alarm is issued again unless the cause of the alarm is corrected.
- 3 No check is made during spindle stop state (\*SSTP = 0).
- 4 By setting the parameter (No. 4913), an allowable range of speed fluctuations can be set which suppresses the occurrence of an alarm. However, an alarm is issued one second later if the actual speed is found to be 0 rpm.

| 9.5<br>SPINDLE<br>POSITIONING<br>FUNCTION  | <ul> <li>In turning, the spindle connected to the spindle motor is rotated at a certain speed to rotate the workpiece mounted on the spindle. The spindle positioning function turns the spindle connected to the spindle motor by a certain angle to position the workpiece mounted on the spindle at a certain angle. The spindle is positioned about the C-axis.</li> <li>The spindle positioning function involves the following three operations:</li> <li>1. Canceling the spindle rotation mode and entering the spindle positioning mode (spindle orientation)</li> <li>2. Positioning the spindle in the spindle positioning mode</li> <li>3. Canceling the spindle positioning mode, and entering the spindle rotation mode</li> </ul> |
|--|--|
| 9.5.1<br>Spindle Orientation   | When spindle positioning is first performed after the spindle motor is used<br>for normal spindle operation, or when spindle positioning is interrupted,<br>the spindle orientation is required.<br>Orientation permits the spindle to stop at a predetermined position.<br>Orientation is directed by the M code set in parameter No. 4960. The<br>direction of orientation can be set with a parameter. For the analog<br>spindle, the direction is set in ZMIx (bit 5 of parameter 1006).<br>For the serial spindle, it is set in RETRN (bit 5 of parameter 4005).  |
| 9.5.2<br>Spindle Positioning   | The spindle can be positioned with an arbitrary angle or semi–fixed angle.   |
| <ul> <li>Positioning with a<br/>semi–fixed angle<br/>specified by an M code</li> </ul> | Address M is followed by a 2–digit numeric. The specifiable value may<br>be one of the six values from M $\alpha$ to M ( $\alpha$ +5). Value $\alpha$ must be set in<br>parameter No. 4962 beforehand. The positioning angles corresponding<br>to M $\alpha$ to M ( $\alpha$ +5) are listed below. Value $\beta$ must be set in parameter No.<br>4963 beforehand.  |

| M-code | Positioning angle | (Ex.)β=30, |
|--------|-------------------|------------|
| Μα     | β                 | 30,        |
| Μ(α+1) | 2β                | 60,        |
| Μ(α+2) | 3β                | 90,        |
| Μ(α+3) | 4β                | 120,       |
| Μ(α+4) | 5β                | 150,       |
| Μ(α+5) | 6β                | 180,       |

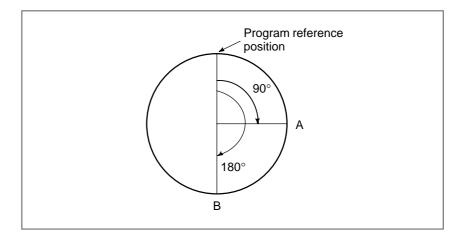
Specify the command with incremental values. The direction of rotation can be specified in parameter IDM (bit 1 of parameter 4950).

| <ul> <li>Positioning with a given<br/>angle specified by</li> </ul> | Specify the position using address C or H followed by a signed numeric value or numeric values. Addresses C and H must be specified in the G00 |
|---|--|
| address C or H  | mode.  |
|   | (Example) C-1000   |
|   | H4500  |
|   | The end point must be specified with a distance from the program   |
|   | reference position (in absolute mode) using address C. Alternatively, the  |
|   | end point must also be specified with a distance from the start point to the   |
|   | end point (in incremental mode) using address H.   |
|   | A numeric with the decimal point can be entered.   |
|   | The value must be specified in degrees.  |
|   | (Example) C35.0=C35 degrees  |

• Program reference position

The position to which the spindle is oriented is assumed as the program reference position. The program reference position can be changed by setting of a coordinate system (G50) or automatic setting of a coordinate system (#OZPR of parameter 1202).

#### • Feedrate for positioning



| Command format      |  | G code A         |  | G code B and C                    |  |
|---------------------|--|------------------|--|-----------------------------------|--|
|                     |  | Addres<br>s used | Command<br>A–B in the<br>above<br>figure | Addres<br>s used<br>and G<br>code | Command<br>A–B in the<br>above<br>figure |
| Absolute<br>command | Specify the<br>end point<br>with a dis-<br>tance from<br>the program<br>reference<br>position. | С                | C180.0 ;                                 | G90,C                             | G90C180.0;                               |
| Incremental command | Specify a dis-<br>tance from<br>the start<br>point to the<br>end point.                        | н                | H90.0 ;                                  | G91,C                             | G90C90.0 ;                               |

| <ul> <li>Feedrate during<br/>positioning</li> </ul> | The feedrate during positioning equals the rapid traverse speed specified<br>in parameter No. 1420. Linear acceleration/deceleration is performed.<br>For the specified speed, an override of 100%, 50%, 25%, and F0<br>(parameter No. 1421) can be applied. |  |  |
|---|--|--|--|
| <ul> <li>Speed during orientation</li> </ul>        | The tool moves at the rapid traverse speed set in parameter No.1420 until<br>a sufficient speed for orientation is attained. After the speed for<br>orientation has been attained, orientation is performed at the speed set in<br>parameter No. 1425.       |  |  |

## 9.5.3 Canceling Spindle Positioning

When modes are to be switched from spindle positioning to normal spindle rotation, the M code set in parameter No. 4961 is specified.

#### WARNING

- 1 Feed hold, dry run, machine lock, and auxiliary function lock cannot be performed during spindle positioning.
- 2 Parameter No. 4962 must always be set even when positioning with a semi-fixed angle specified in an M-code is not performed. If the parameter is not set, M-codes from the M00 to M05 do not function properly.

- 1 Specify spindle positioning alone in a block. A move command for the X or Z axis cannot be specified within the same block.
- 2 When emergency stop is applied during spindle positioning, spindle positioning stops. To resume it, restart with the orientation step.
- 3 The serial spindle Cs–axis contour control function and the spindle positioning function cannot be used at a time. If both options are specified, the spindle positioning function has priority.
- 4 The spindle positioning axis is indicated in pulses in the machine coordinate system.

# 10 TOOL FUNCTION (T FUNCTION)

Two tool functions are available. One is the tool selection function, and the other is the tool life management function.

# 10.1 TOOL SELECTION

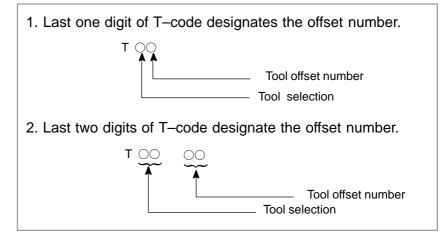
By specifying a 2–digit/4–digit numerical value following address T, a code signal and a strobe signal are transmitted to the machine tool. This is mainly used to select tools on the machine.

One T code can be commanded in a block. Refer to the machine tool builder's manual for the number of digits commandable with address T and the correspondence between the T codes and machine operations.

When a move command and a T code are specified in the same block, the commands are executed in one of the following two ways:

- 1. Simultaneous execution of the move command and T function commands.
- 2. Executing T function commands upon completion of move command execution.

The selection of either sequence depends on the machine tool builder's specifications. Refer to the machine tool builder's manual for details.



**Explanations** 

The value after the T code indicates the desired tool. Part of the values is also used as the offset number indicating the compensation amount for tool offset.

Refer to the machine tool builder's manual for correspondence between the T–code and the tool and the number of digit to specify tool selection. Example (T2+2) N1G00X1000Z1400

N2T0313; (Select Tool No. 3 and Offset value No. 13) N3X400Z1050;

Some machines use a 1-digit value to specify tool selection.

# 10.2 TOOL LIFE MANAGEMENT

Tools are classified into some groups. For each group, a tool life (time or frequency of use) is specified. Each time a tool is used, the time for which the tool is used is accumulated. When the tool life has been reached, the next tool previously determined in the same group is used. This function is called the tool life management function. With 2–path control, tool life management is performed for each tool post separately. So tool life management data is also set for each tool post.

# 10.2.1 Program of Tool Life Data

#### Format

Tools used sequentially in each group and their tool life are registered in the CNC as following program format of table 10.2.1 (a).

|  | Table 10.2.1 (a) | Program | format of | life | management |
|--|------------------|---------|-----------|------|------------|
|--|------------------|---------|-----------|------|------------|

| Tape format   | Meaning   |
|---|---|
| O;<br>G10L3;<br>PL;<br>T;<br>T;<br>PL;<br>T;<br>T;<br>G11;<br>M02(M30); | Program number<br>Start of setting tool life data<br>P:Group number (1 to 128)<br>L:Tool life (1 to 9999)<br>(1)<br>(2)<br>Tools are selected from<br>(n)<br>(1)to (2) to to (n).<br>Data for the next group<br>End of setting tool life data<br>End of program |

For the method of registering tool life data in CNC, refer to Subsec. III–11.4.14.

# **Explanations**

| • Maximum number of                           |  |
|---|--|
|   | for a tool life.   |
|   | Up to 4300 minutes in time or 9999 times in frequency can be specified |
| tool has been used                            | 6800#2 (LTM).  |
| or number of times the                        | frequency of use, which depends on the parameter setting parameter No. |
| <ul> <li>Specification by duration</li> </ul> | A tool life is specified either as the time of use (in minutes) or the |

Maximum number of groups and tools
 The number of groups to be registered and the number of tools registered per group can be combined in three ways. One of the three combinations is set by a parameter No. 6800#0, #1 (Each GS1 and GS2).

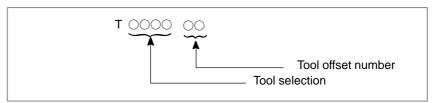
| GS2 GS1<br>(No.6800#1) (No.6800#0) |              |                                | of groups and tools<br>ction of 128 tool pairs | The Max. number of groups and tools with optional function of 128 tool pairs |                |
|------------------------------------|--------------|--------------------------------|--|--|----------------|
| (110.0000#1)                       | (110.0000#0) | Number of group Number of tool |  | Number of group  | Number of tool |
| 0                                  | 0            | 16                             | 16   | 16   | 32             |
| 0                                  | 1            | 32                             | 8  | 32   | 16             |
| 1                                  | 0            | 64                             | 4  | 64   | 8              |
| 1                                  | 1            | 16                             | 16   | 128  | 4              |

Table 10.2.1 (b) The max. number of groups and tools that can be registered

In each of the cases listed above, the maximum number of tools which can be registered is 512 or 256 depending, respectively, on whether the option for 128 tool life control groups is used or not. When the option is not used, set the parameters as follows: For up to 16 groups, with up to 16 tools in each group, set GS1 = 0 and GS2 = 0. For up to 32 groups, with up to 8 tools in each group, set GS1 = 0 and GS2 = 1. To change the combination, change the parameter, then set program is executed with the old tool group combination set in the NC. Whenever the parameter is changed, be sure to reexecute the group setting program.

The same tool number may appear anywhere any times in the program of tool life data.

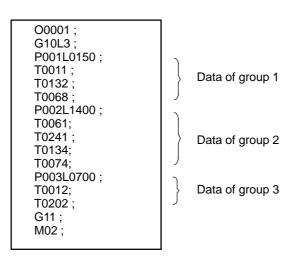
A T code for registering tools can usually consist of up to four digits. When the option for 128 tool life control groups is used, however, it can consist of up to six digits.



When using the tool life control function, do not use tool position offset parameters LD1 and LGN (bits 0 and 1 of parameter No. 5002).

• A T code for registering tools

## Example



# **Explanations**

The group numbers specified in P need not be serial. They need not be assigned to all groups, either. When using two or more offset numbers for the same tool in the same process, set as follows;

| Tape format  | Meaning   |
|--|---|
| P004L0500;<br>T0101;<br>T0105;<br>T0108;<br>T0206;<br>T0203;<br>T0202;<br>T0209;<br>T0304;<br>T0309;<br>P005L1200;<br>T0405; | The tools in group 4 are used from (1)<br>to (2) to (3).<br>(1) Each tool is used 500 times (or for<br>500 minutes).<br>When this group is specified three<br>times in one process, the offset num-<br>(2) bers are selected in the following or-<br>ders:<br>Tools (1): $01 \rightarrow 05 \rightarrow 08$<br>(3) Tools (2): $06 \rightarrow 03 \rightarrow 02 \rightarrow 09$<br>Tools (3): $04 \rightarrow 09$ |

# 10.2.2 Counting a Tool Life

## Explanation

 When a tool life is specified as the time of use (in minutes) Between  $T\Delta\Delta99(\Delta\Delta=Tool \text{ group number})$  and  $T\Delta\Delta88$  in a machining program, the time for which the tool is used in the cutting mode is counted at intervals of 4 seconds. The time taken for single–block stoppage, feed hold, rapid traverse, dwelling, and FIN wait is ignored. Up to 4300 minutes can be specified for a life.

When a tool life is specified as the frequency of use
 Counting is performed for each process that is initiated by the cycle start of a machining program and ended when the NC is reset by the M02 or M03 command. The counters for tool groups used in a process are incremented by one. Even when the same group is specified more than once in one process, the counter is incremented only by one. Up to 9999 can be set for a tool life. Counting of a tool life is performed for each group. The life counter contents are not erased even when the power of CNC is cut off.

When a life is specified as the frequency of use, apply an external reset (ERS) signal to the CNC when M02 or M30 is executed.

# 10.2.3 Specifying a Tool Group in a Machining Program

In machining programs, T codes are used to specify tool groups as follows:

| Tape format                    | Meaning   |
|--------------------------------|---|
| T∆∆99;<br>T∆∆88;<br>M02(M300); | Ends the tool used by now, and starts to use the tool of<br>the ∆∆group. "99" distinguishes this specification<br>from ordinary specification.<br>Cancels the offset of the tool of the group. "88" distin–<br>guishes this specification from ordinary specification.<br>Ends the machining program. |

# Explanations

| Tape format | Meaning   |
|-------------|---|
| T0199;      | Ends the previous tool, and starts to use the tool of the 01 group.   |
| T0188;      | Cancels the offset of the tool of the 01 group.   |
| T0508;      | Ends the tool of the 01 group. Selects tool number 05 and offset number 08.   |
| T0500;      | Cancels the offset of tool number 05.   |
| T0299;      | Ends tool number 05, and starts to use the tool of the 02 group.  |
| T0199;      | Ends the tool of the 02 group, and starts to use the tool of the 01 group. If more than one offset number is specified for the tool, the second offset number is selected. Otherwise, the previous offset number is used. |

# AUXILIARY FUNCTION

There are two types of auxiliary functions; miscellaneous function (M code) for specifying spindle start, spindle stop program end, and so on, and secondary auxiliary function (B code).

When a move command and miscellaneous function are specified in the same block, the commands are executed in one of the following two ways:

- i) Simultaneous execution of the move command and miscellaneous function commands.
- ii) Executing miscellaneous function commands upon completion of move command execution.

The selection of either sequence depends on the machine tool builder's specification. Refer to the manual issued by the machine tool builder for details.

| 11.1<br>AUXILIARY<br>FUNCTION<br>(M FUNCTION)       | <ul> <li>When address M followed by a number is specified, a code signal and strobe signal are transmitted. These signals are used for turning on/off the power to the machine.</li> <li>In general, only one M code is valid in a block but up to three M codes can be specified in a block (although some machines may not allow that). The correspondence between M codes and functions is up to the machine tool builder.</li> <li>All M codes are processed in the machine except for M98, M99,M198, M codes for calling a subprogram (parameters Nos. 6071 to 6079), and M codes for calling a custom macro (parameters Nos. 6080 to 6089). Refer to the appropriate manual issued by the machine tool builder.</li> </ul> |
|---|--|
| Explanations  | The following M codes have special meanings.   |
| • M02,M03<br>(End of program)                       | This indicates the end of the main program<br>Automatic operation is stopped and the CNC unit is reset. This differs<br>with the machine tool builder. After a block specifying the end of the<br>program is executed,control returns to the start of the program. Bit 5 of<br>parameter No. 3404 (M02) or bit 4 of parameter No. 3404 (M03) can be<br>used to disable M02 or M03 from returning control to the start of the<br>program.   |
| <ul> <li>M00<br/>(Program stop)</li> </ul>          | Automatic operation is stopped after a block containing M00 is executed.<br>When the program is stopped, all existing modal information remains<br>unchanged. The automatic operation can be restarted by actuating the<br>cycle operation. This differs with the machine tool builder.  |
| <ul> <li>M01<br/>(Optional stop)</li> </ul>         | Similarly to M00, automatic operation is stopped after a block containing M01 is executed. This code is only effective when the Optional Stop switch on the machine operator's panel has been pressed.   |
| <ul> <li>M98<br/>(Calling of subprogram)</li> </ul> | This code is used to call a subprogram. The code and strobe signals are not sent. See the subprogram section II $-13.3$ for details .  |
| <ul> <li>M99<br/>(End of subprogram)</li> </ul>     | This code indicates the end of a subprogram.<br>M99 execution returns control to the main program. No code or strobe<br>signal is sent. See the subprogram section II–13.3 for details.  |
| <ul> <li>M198<br/>(Calling a subprogram)</li> </ul> | This code is used to call a subprogram of a file in the external input/output function. See the description of the subprogram call function (III–4.5) for details.   |
|   | <b>NOTE</b><br>A block immediately after an M00, M01, M02, or M03 block<br>is not buffered. Similarly, ten M codes which do not buffer<br>can be set by parameters (Nos. 3411 to 3421). Refer to the<br>machine tool builder's instruction manual for these M codes.   |

# 11.2 MULTIPLE M COMMANDS IN A SINGLE BLOCK

## **Explanations**

So far, one block has been able to contain only one M code. Up to three M codes can be specified in a single block when bit 7 (M3B) of parameter No. 3404 is set to 1.

Up to three M codes specified in a block are simultaneously output to the machine. This means that compared with the conventional method of a single M command in a single block, a shorter cycle time can be realized in machining.

CNC allows up to three M codes to be specified in one block. However, some M codes cannot be specified at the same time due to mechanical operation restrictions. For detailed information about the mechanical operation restrictions on simultaneous specification of multiple M codes in one block, refer to the manual of each machine tool builder.

M00, M01, M02, M30, M98, M99, or M198 must not be specified together with another M code.

Some M codes other than M00, M01, M02, M30, M98, M99, and M198 cannot be specified together with other M codes; each of those M

codes must be specified in a single block. Such M codes include these which direct the CNC to perform internal operations in addition to sending the M codes themselves to the machine. To be specified, such M codes are M codes for calling program numbers 9001 to 9009 and M codes for disabling advance reading (buffering) of subsequent blocks. Meanwhile, multiple of M codes that direct the CNC only to send the M codes themselves (without performing internal operations) can be specified in a single block.

# Examples

| One M command in a single block | Multiple M commands in a single block |
|---------------------------------|---------------------------------------|
| M40 ;                           | M40M50M60 ;                           |
| M50 ;                           | G28G91X0Z0 ;                          |
| M60 ;                           | :                                     |
| G28G91X0Z0 ;                    | :                                     |
| :                               | :                                     |
| :                               | :                                     |
| :                               | :                                     |

# 11.3 M CODE GROUP CHECK FUNCTION

The M code group check function checks if a combination of multiple M codes (up to three M codes) contained in a block is correct. This function has two purposes. One is to detect if any of the multiple M codes specified in a block include an M code that must be specified alone. The other purpose is to detect if any of the multiple M codes specified in a block include M codes that belong to the same group. In either of these cases, P/S alarm No. 5016 is issued.

For details on group data setting, refer to the manual available from the machine tool builder.

## **Explanations**

M code setting
 Up to 500 M codes can be specified. In general, M0 to M99 are always specified. M codes from M100 and up are optional.
 Group numbers
 Group numbers can be set from 0 to 127. Note, however, that 0 and 1 have special meanings. Group number 0 represents M codes that need not be checked. Group number 1 represents M codes that must be specified alone.

# 11.4 THE SECOND AUXILIARY FUNCTIONS (B CODES)

## Explanations

- Command range
- Command method

Indexing of the table is performed by address B and a following 8–digit number. The relationship between B codes and the corresponding indexing differs between machine tool builders.

Refer to the manual issued by the machine tool builder for details.

0 to 99999999

- The decimal point can be used for input. Command Output value B10. 10000
  - B10 10
- 2. It is possible to change over the scale factor of B output, 1000 or 1 when the decimal point input is omitted, using the parameter DPI (No. 3401#0).

Command Output value When DPI is 1: B1 1000 When DPI is 0: B1 1

3. It is possible to change over the scale factor of B output 1000 or 10000 when the decimal point input is omitted in the inch input system, using the parameter AUX (No. 3405#0) When DPI=1.
Command Output value When AUX is 1: B1 10000 When AUX is 0: B1 1000

Restrictions

When this functions is used, the B address specifying an axis movement disabled.

# PROGRAM CONFIGURATION

## General

• Main program and subprogram

There are two program types, main program and subprogram. Normally, the CNC operates according to the main program. However, when a command calling a subprogram is encountered in the main program, control is passed to the subprogram. When a command specifying a return to the main program is encountered in a subprogram, control is returned to the main program.

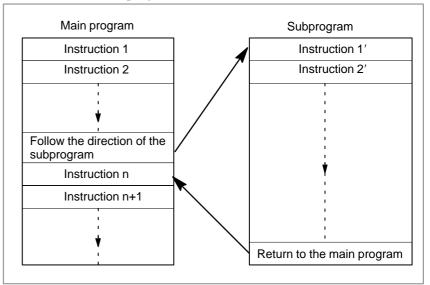


Fig. 12 (a) Main program and Subprogram

The CNC memory can hold up to 400 main programs and subprograms (63 as standard). A main program can be selected from the stored main programs to operate the machine. See Chapter III–10 for the methods of registering and selecting programs.

#### • Program components

A program consists of the following components:

#### Table 12 Program components

| Components      | Descriptions                                  |
|-----------------|---|
| Tape start      | Symbol indicating the start of a program file |
| Leader section  | Used for the title of a program file, etc.    |
| Program start   | Symbol indicating the start of a program      |
| Program section | Commands for machining                        |
| Comment section | Comments or directions for the operator       |
| Tape end        | Symbol indicating the end of a program file   |

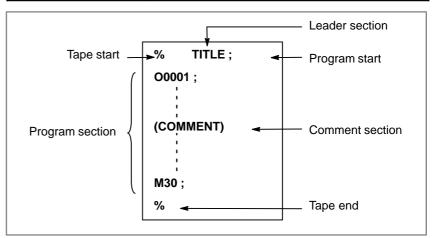


Fig. 12 (b) Program configuration

• Program section configuration

A program section consists of several blocks. A program section starts with a program number and ends with a program end code.

| Program section | Program section          |  |  |
|-----------------|--------------------------|--|--|
| configuration   |                          |  |  |
| Program number  | O0001 ;                  |  |  |
| Block 1         | N1 G91 G00 X120.0 Y80.0; |  |  |
| Block 2         | N2 G43 Z–32.0 H01 ;      |  |  |
| :               | :                        |  |  |
| Block n         | Nn Z0 ;                  |  |  |
| Program end     | M30 ;                    |  |  |

A block contains information necessary for machining, such as a move command or coolant on/off command.Specifying a value following a slash (/) at the start of a block disables the execution of some blocks (see "optional block skip" in Section II–12.2).

# 12.1 PROGRAM COMPONENTS OTHER THAN PROGRAM SECTIONS

This section describes program components other than program sections. See Section II–12.2 for a program section.

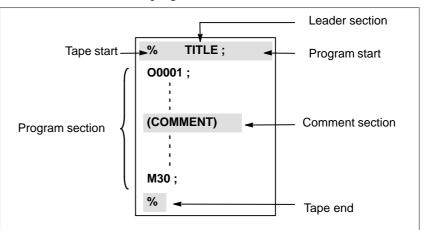


Fig. 12.1 Program configuration

## **Explanations**

Tape start

The tape start indicates the start of a file that contains CNC programs. The mark is not required when programs are entered using SYSTEM P or ordinary personal computers. The mark is not displayed on the display screen. However, if the file is output, the mark is automatically output at the start of the file.

Table 12.1 (a) Code of a tape start

| Name       | ISO<br>code | EIA<br>code | Notation in this manual |
|------------|-------------|-------------|-------------------------|
| Tape start | %           | ER          | %                       |

• Leader section

Program start

Data entered before the programs in a file constitutes a leader section. When machining is started, the label skip state is usually set by turning on the power or resetting the system. In the label skip state, all information is ignored until the first end–of–block code is read. When a file is read into the CNC unit from an I/O device, leader sections are skipped by the label skip function.

A leader section generally contains information such as a file header. When a leader section is skipped, even a TV parity check is not made. So a leader section can contain any codes except the EOB code.

The program start code is to be entered immediately after a leader section, that is, immediately before a program section. This code indicates the start of a program, and is always required to disable the label skip function.

With SYSTEM P or ordinary personal computers, this code can be entered by pressing the return key.

Table 12.1 (b) Code of a program start

| Name          | ISO<br>code | EIA<br>code | Notation in this manual |
|---------------|-------------|-------------|-------------------------|
| Program start | LF          | CR          | - ,                     |

#### 12. PROGRAM CONFIGURATION

#### NOTE

If one file contains multiple programs, the EOB code for label skip operation must not appear before a second or subsequent program number. However, an program start is required at the start of a program if the preceding program ends with %.

Comment section

Any information enclosed by the control-out and control-in codes is regarded as a comment and skipped by the CNC. The user can enter a header, comments, directions to the operator, etc. There is no limit on the length of a comment section.

Table 12.1 (c) Codes of a control-in and a control-out

| Name        | ISO<br>code | EIA<br>code | Notation in this manual | Meaning                  |
|-------------|-------------|-------------|-------------------------|--------------------------|
| Control-out | (           | 2–4–5       | (                       | Start of comment section |
| Control-in  | )           | 2–4–7       | )                       | End of comment section   |

When a program is read into memory for memory operation, comment sections, if any, are not ignored but are also read into memory. Note, however, that codes other than those listed in the code table in Appendix F are ignored, and thus are not read into memory. When the program in this memory is output to an external input/output device (see Section III-8), any comments are also output.

When a program is displayed on the screen, its comment sections are also displayed. However, those codes that were ignored when read into memory are not outputted or displayed.

During memory operation or DNC operation, all comment sections are ignored.

The TV check function can be used for a comment section by setting parameter CTV (bit 1 of No. 0100).

#### CAUTION

If a long comment section appears in the middle of a program section, a move along an axis may be suspended for a long time because of such a comment section. So a comment section should be placed where movement suspension may occur or no movement is involved.

## NOTE

- 1 If only a control-in code is read with no matching control-out code, the read control-in code is ignored. 2 The EOB code cannot be used in a comment.

### • Tape end

A tape end is to be placed at the end of a file containing NC programs. If programs are entered using the automatic programming system, the mark need not be entered. The mark is not displayed on the CRT display screen. However, when a file is output, the mark is automatically output at the end of the file.

If an attempt is made to execute % when M02 or M03 is not placed at the end of the program, the P/S alarm (No. 5010) is occurred.

| Name     | ISO<br>code | EIA<br>code | Notation in this manual |
|----------|-------------|-------------|-------------------------|
| Tape end | %           | ER          | %                       |

#### Table 12.1 (d) Code of a tape end

# 12.2 PROGRAM SECTION CONFIGURATION

This section describes elements of a program section. See Section II–12.1 for program components other than program sections.

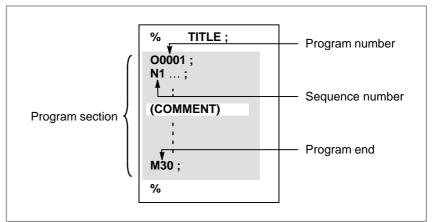


Fig. 12.2 (a) Program configuration

• Program number

A program number consisting of address O followed by a four-digit number is assigned to each program at the beginning registered in memory to identify the program.

When the 8-digit program number option is used, however, specify eight digits for the program number (see Section II.12.4).

In ISO code, the colon (:) can be used instead of O.

When no program number is specified at the start of a program, the sequence number (N....) at the start of the program is regarded as its program number. If a five-digit sequence number is used, the lower four digits are registered as a program number. If the lower four digits are all 0, the program number registered immediately before added to 1 is registered as a program number. Note, however, that N0 cannot be used for a program number.

If there is no program number or sequence number at the start of a program, a program number must be specified using the MDI panel when the program is stored in memory (See Section 8.4 or 10.1 in Part III.).

# NOTE

Program numbers 8000 to 9999 may be used by machine tool builders, and the user may not be able to use these numbers.

 Sequence number and block A program consists of several commands. One command unit is called a block. One block is separated from another with an EOB of end of block code.

| Table 12.2 (a) | EOB code |
|----------------|----------|
|----------------|----------|

| Name               | ISO<br>code | EIA<br>code | Notation in this manual |
|--------------------|-------------|-------------|-------------------------|
| End of block (EOB) | LF          | CR          | -<br>,                  |

At the head of a block, a sequence number consisting of address N followed by a number not longer than five digits (1 to 99999) can be placed. Sequence numbers can be specified in a random order, and any numbers can be skipped. Sequence numbers may be specified for all blocks or only for desired blocks of the program. In general, however, it is convenient to assign sequence numbers in ascending order in phase with the machining steps (for example, when a new tool is used by tool replacement, and machining proceeds to a new surface with table indexing.)

N300 X200.0 Z300.0; A sequence number is underlined.

Fig. 12.2 (b) Sequence number and block (example)

#### NOTE

N0 must not be used for the reason of file compatibility with other CNC systems.

Program number 0 cannot be used. So 0 must not be used for a sequence number regarded as a program number.

TV check (Vertical parity check along tape)

A parity check is made for a block on input tape vertically. If the number of characters in one block (starting with the code immediately after an EOB and ending with the next EOB) is odd, an P/S alarm (No.002) is output. No TV check is made only for those parts that are skipped by the label skip function. Bit 1 (CTV) of parameter No. 0100 can be used to specify whether the characters constituting comments, enclosed in "(" and ")", are counted when obtaining the number of characters for TV check. The TV check function can be enabled or disabled by setting on the MDI unit (See subsec. 11.4.7 in Part III.).

#### Block configuration (word and address)

A block consists of one or more words. A word consists of an address followed by a number some digits long. (The plus sign (+) or minus sign (-) may be prefixed to a number.)

#### Word = Address + number (Example : X–1000)

For an address, one of the letters (A to Z) is used ; an address defines the meaning of a number that follows the address. Table 12.2 (b) indicates the usable addresses and their meanings.

The same address may have different meanings, depending on the preparatory function specification.

| Function                   | Address                      | Meaning   |
|----------------------------|------------------------------|---|
| Program number             | O <sup>(1)</sup>             | Program number  |
| Sequence number            | Ν                            | Sequence number   |
| Preparatory function       | G                            | Specifies a motion mode (linear, arc, etc.)             |
| Dimension word             | X, Y, Z, U, V,<br>W, A, B, C | Coordinate axis move command                            |
|                            | I, J, K                      | Coordinate of the arc center                            |
|                            | R                            | Arc radius  |
| Feed function              | F                            | Rate of feed per minute,<br>Rate of feed per revolution |
| Spindle speed function     | S                            | Spindle speed   |
| Tool function              | Т                            | Tool number   |
| Auxiliary function         | М                            | On/off control on the machine tool                      |
|                            | В                            | Table indexing, etc.                                    |
| Dwell                      | P, X, U                      | Dwell time  |
| Program number designation | Р                            | Subprogram number                                       |
| Number of repetitions      | Р                            | Number of subprogram repetitions                        |
| Parameter                  | P, Q                         | Canned cycle parameter                                  |

Table 12.2 (b) Major functions and addresses

#### NOTE

In ISO code, the colon (:) can also be used as the address of a program number.

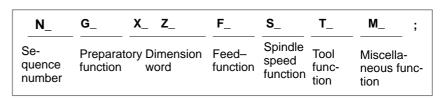


Fig. 12.2 (c) 1 block (example)

### Major addresses and ranges of command values

Major addresses and the ranges of values specified for the addresses are shown below. Note that these figures represent limits on the CNC side, which are totally different from limits on the machine tool side. For example, the CNC allows a tool to traverse up to about 100 m (in millimeter input) along the X axis.

However, an actual stroke along the X axis may be limited to 2 m for a specific machine tool.

Similarly, the CNC may be able to control a cutting federate of up to 240 m/min, but the machine tool may not allow more than 3 m/min. When developing a program, the user should carefully read the manuals of the machine tool as well as this manual to be familiar with the restrictions on programming.

| F                   | unction                  | Address                 | Input in mm                  | Input in inch                |
|---------------------|--------------------------|-------------------------|------------------------------|------------------------------|
| Program             | number                   | O <sup>(1)</sup>        | 1–9999                       | 1–9999                       |
| Sequenc             | e number                 | N                       | 1–99999                      | 1–99999                      |
| Preparat            | ory function             | G                       | 0–99                         | 0–99                         |
| Dimen-<br>sion      | Increment<br>system IS–B | X, Y, Z,<br>U, V, W,    | -999999.999 to<br>+99999.999 | -9999.9999 to<br>+9999.9999  |
| word                | Increment<br>system IS–C | A, B, C, I,<br>J, K, R, | -9999.9999 to<br>+9999.9999  | -999.99999 to<br>+999.99999  |
| Feed<br>per         | Increment<br>system IS–B | F                       | 1 to 240000<br>mm/min        | 0.01 to 9600.00<br>inch/min  |
| minute              | Increment<br>system IS–C | -                       | 1 to 100000<br>mm/min        | 0.01 to 4000.00<br>inch/min  |
| Feed per            | revolution               | F                       | 0.01 to 500.00<br>mm/rev     | 0.0001 to 9.9999<br>inch/rev |
| Spindle s           | speed function           | S                       | 0 to 20000                   | 0 to 20000                   |
| Tool func           | tion                     | Т                       | 0 to 99999999                | 0 to 99999999                |
| Auxiliary           | function                 | М                       | 0 to 99999999                | 0 to 99999999                |
|                     |                          | В                       | 0 to 99999999                | 0 to 99999999                |
| Dwell               | Increment<br>system IS–B | P, X, U                 | 0 to 99999.999s              | 0 to 99999.999s              |
|                     | Increment<br>system IS–C |                         | 0 to 9999.9999s              | 0 to 9999.9999s              |
| Designat<br>program |                          | Р                       | 1 to 9999                    | 1 to 9999                    |
| Number              | of repetitions           | Р                       | 1 to 9999                    | 1 to 9999                    |

#### Table 12.2 (c) Major addresses and ranges of command values

#### NOTE

In ISO code, the colon (:) can also be used as the address of a program number.

Optional block skip

When a slash followed by a number (/n (n=1 to 9)) is specified at the head of a block, and optional block skip switch n on the machine operator panel is set to on, the information contained in the block for which /n corresponding to switch number n is specified is ignored in tape operation or memory operation.

When optional block skip switch n is set to off, the information contained in the block for which /n is specified is valid. This means that the operator can determine whether to skip the block containing /n.

Number 1 for /1 can be omitted. However, when two or more optional block skip switches are used for one block, number 1 for /1 cannot be omitted.

#### Example)

(Incorrect)(Correct)

//3 G00X10.0; /1/3 G00X10.0;

This function is ignored when programs are loaded into memory. Blocks containing /n are also stored in memory, regardless of how the optional block skip switch is set.

Programs held in memory can be output, regardless of how the optional block skip switches are set.

Optional block skip is effective even during sequence number search operation.

Depending on the machine tool, all optional block skip switches (1 to 9) may not be usable. Refer to manuals of the machine tool builder to find which switches are usable.

## WARNING

## 1 Position of a slash

A slash (/) must be specified at the head of a block. If a slash is placed elsewhere, the information from the slash to immediately before the EOB code is ignored.

2 Disabling an optional block skip switch

Optional block skip operation is processed when blocks are read from memory or tape into a buffer. Even if a switch is set to on after blocks are read into a buffer, the blocks already read are not ignored.

## NOTE

## TV and TH check

When an optional block skip switch is on. TH and TV checks are made for the skipped portions in the same way as when the optional block skip switch is off.

#### • Program end

The end of a program is indicated by punching one of the following codes at the end of the program:

Table 12.2 (d) Code of a program end

| Code | Meaning usage    |
|------|------------------|
| M02  | For main program |
| M30  |                  |
| M99  | For subprogram   |

If one of the program end codes is executed in program execution, the CNC terminates the execution of the program, and the reset state is set. When the subprogram end code is executed, control returns to the program that called the subprogram.

## WARNING

A block containing an optional block skip code such as /M02 ; , /M30 ; , or /M99 ; is not regarded as the end of a program, if the optional block skip switch on the machine operator's panel is set to on. (See item "Optional block skip".)

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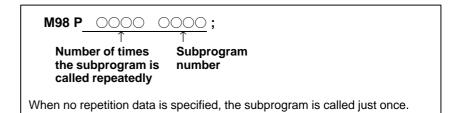
| SUBPROGRAM<br>(M98, M99) | If a program contains a fixed sequence or frequently repeated pattern, such<br>a sequence or pattern can be stored as a subprogram in memory to simplify<br>the program.<br>A subprogram can be called from the main program.<br>A called subprogram can also call another subprogram. |
|--------------------------|--|
|--------------------------|--|

# Format

• Subprogram configuration

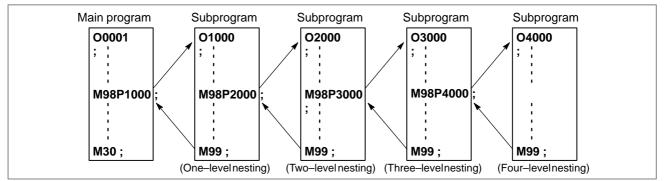
| One subprogram | n<br>; Subprogram number<br>(or the colon (:) optionally in the case of ISO)                        |  |  |  |
|----------------|---|--|--|--|
| M99;           | Program end   |  |  |  |
|                | M99 need not constitute a separate block as indicated below.<br>Example) <b>X100.0 Y100.0 M99</b> ; |  |  |  |

• Subprogram call (M98)



## **Explanations**

When the main program calls a subprogram, it is regarded as a one-level subprogram call. Thus, subprogram calls can be nested up to four levels as shown below.



A single call command can repeatedly call a subprogram up to 9999 times. For compatibility with automatic programming systems, in the first block, Nxxxx can be used instead of a subprogram number that follows O(or:). A sequence number after N is registered as a subprogram number.

**Reference item** 

See Chapter 10 in Part III for the method of registering a subprogram.

#### NOTE

- 1 The M98 and M99 signals are not output to the machine tool.
- 2 If the subprogram number specified by address P cannot be found, an alarm (No. 078) is output.

**Examples** 

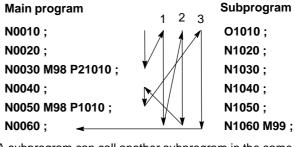
#### ☆ M98 P51002 ;

This command specifies "Call the subprogram (number 1002) five times in succession." A subprogram call command (M98P\_) can be specified in the same block as a move command.

#### ☆ X1000.0 M98 P1200 ;

This example calls the subprogram (number 1200) after an X movement.

 $\Rightarrow$  Execution sequence of subprograms called from a main program



A subprogram can call another subprogram in the same way as a main program calls a subprogram.

#### **Special Usage**

 Specifying the sequence number for the return destination in the main program If P is used to specify a sequence number when a subprogram is terminated, control does not return to the block after the calling block, but returns to the block with the sequence number specified by P. Note, however, that P is ignored if the main program is operating in a mode other than memory operation mode.

This method consumes a much longer time than the normal return method to return to the main program.

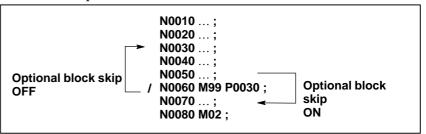
| Main program      | 1 | Subprogram        |  |
|-------------------|---|-------------------|--|
| N0010 ;           |   | O0010 ;           |  |
| N0020 ;           |   | N1020 ;           |  |
| N0030 M98 P1010 ; |   | N1030 ;           |  |
| N0040 ;           |   | N1040 :           |  |
| N0050 ;           |   | N1050 ;           |  |
| N0060 ; <         |   | N1060 M99 P0060 : |  |

# • Using M99 in the main program

If M99 is executed in a main program, control returns to the start of the main program. For example, M99 can be executed by placing /M99; at an appropriate location of the main program and setting the optional block skip function to off when executing the main program. When M99 is executed, control returns to the start of the main program, then execution is repeated starting at the head of the main program.

Execution is repeated while the optional block skip function is set to off. If the optional block skip function is set to on, the /M99; block is skipped; control is passed to the next block for continued execution.

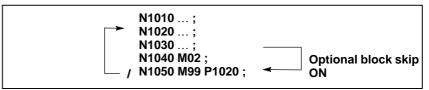
If/M99Pn ; is specified, control returns not to the start of the main program, but to sequence number n. In this case, a longer time is required to return to sequence number n.



• Using a subprogram only

A subprogram can be executed just like a main program by searching for the start of the subprogram with the MDI.

(See Section 9.4 in Part III for information about search operation.) In this case, if a block containing M99 is executed, control returns to the start of the subprogram for repeated execution. If a block containing M99Pn is executed, control returns to the block with sequence number n in the subprogram for repeated execution. To terminate this program, a block containing /M02 ; or /M30 ; must be placed at an appropriate location, and the optional block switch must be set to off ; this switch is to be set to on first.



# 12.4 8–DIGIT PROGRAM NUMBER

## **Explanations**

 Inhibiting editing of programs The 8-digit program number function enables specification of program numbers with eight digits following address O (O00000001 to O99999999).

**12. PROGRAM CONFIGURATION** 

Editing of subprograms O00008000 to O00008999, O00009000 to O00009999, O80000000 to O89999999, and O90000000 to O99999999 can be inhibited.

| Parameter        | Program numbers for which editing is disabled |  |
|------------------|---|--|
| NE8(No.3202#0)   | O00008000 to O00008999                        |  |
| NE9(No.3202#4)   | O00009000 to O00009999                        |  |
| PRG8E(No.3204#3) | O80000000 to O89999999                        |  |
| PRG9E(No.3204#4) | O90000000 to O99999999                        |  |

#### NOTE

When a wrong password has been specified for the password function (see III–9.9), the settings of NE9 (bit 3 of parameter No. 3202) and PQE (bit 4 of parameter No. 3204) cannot be changed.

• File name

For program punch by specifying a range, files are named as follows: When punching by specifying O00000001 and O00123456: "O00000001–G"

When punching by specifying O12345678 and O45678900: "O12345678-G"

When 2-path control is being applied, the file name for the first path is suffixed with "-1" and that for the second path is suffixed with "-2."

Special subprogram numbers can be changed by using bit 5 (SPR) of parameter No. 3204.

1) Macro call using G code

| Parameter used to | Program      | number       |  |
|-------------------|--------------|--------------|--|
| specify G code    | When SPR = 0 | When SPR = 1 |  |
| No.6050           | O00009010    | O90009010    |  |
| No.6051           | O00009011    | O90009011    |  |
| No.6052           | O00009012    | O90009012    |  |
| No.6053           | O00009013    | O90009013    |  |
| No.6054           | O00009014    | O90009014    |  |
| No.6055           | O00009015    | O90009015    |  |
| No.6056           | O00009016    | O90009016    |  |
| No.6057           | O00009017    | O90009017    |  |
| No.6058           | O00009018    | O90009018    |  |
| No.6059           | O00009019    | O90009019    |  |

# Special programs

| Parameter used to | Program number |              |  |
|-------------------|----------------|--------------|--|
| specify M code    | When SPR = 0   | When SPR = 1 |  |
| No.6080           | O00009020      | O90009020    |  |
| No.6081           | O00009021      | O90009021    |  |
| No.6082           | O00009022      | O90009022    |  |
| No.6083           | O00009023      | O90009023    |  |
| No.6084           | O00009024      | O90009024    |  |
| No.6085           | O00009025      | O90009025    |  |
| No.6086           | O00009026      | O90009026    |  |
| No.6087           | O00009027      | O90009027    |  |
| No.6088           | O00009028      | O90009028    |  |
| No.6089           | O00009029      | O90009029    |  |

# 2) Macro call using M code

3) Subprogram call using M code

| Parameter used to | Program number |              |
|-------------------|----------------|--------------|
| specify M code    | When SPR = 0   | When SPR = 1 |
| No.6071           | O00009001      | O90009001    |
| No.6072           | O00009002      | O90009002    |
| No.6073           | O00009003      | O90009003    |
| No.6074           | O00009004      | O90009004    |
| No.6075           | O00009005      | O90009005    |
| No.6076           | O00009006      | O90009006    |
| No.6077           | O00009007      | O90009007    |
| No.6078           | O00009008      | O90009008    |
| No.6079           | O00009009      | O90009009    |

# 4) Macro call using T code

| Parameter used to specify T code | Program number |              |
|----------------------------------|----------------|--------------|
|                                  | When SPR = 0   | When SPR = 1 |
| TCS(No.6001#5)                   | O00009000      | O90009000    |

## 5) Macro call using ASCII code

| Parameter used to  | Program number |              |
|--------------------|----------------|--------------|
| specify ASCII code | When SPR = 0   | When SPR = 1 |
| No.6090            | O00009004      | O90009004    |
| No.6091            | O00009005      | O90009005    |

| Program numaber |              |  |
|-----------------|--------------|--|
| When SPR = 0    | When SPR = 1 |  |
| O00009500       | O90009500    |  |
| O00009501       | O90009501    |  |
| O00009502       | O90009502    |  |
| O00009503       | O90009503    |  |
| O00009504       | O90009504    |  |
| O00009505       | O90009505    |  |
| O00009506       | O90009506    |  |
| O00009507       | O90009507    |  |
| O00009508       | O90009508    |  |
| O00009509       | O90009509    |  |
| O00009510       | O90009510    |  |

6) Pattern data function

• External program number search External input signals can be used to search for a program number. A program stored in CNC memory can be selected by externally inputting a program number, between 1 and 99999999, to the CNC. For details,

Limitations

• Subprogram call

This function disables subprogram call unless FS15 tape format (see II–19) is used. This restriction also applies to calling a program in external I/O devices (M198).

refer to the appropriate manual supplied from the machine tool builder.

(Example)

M98 P12345678 ; Subprogram number only The repetition count is not included.

• DNC

O8–digit program number can not be used in DNC1, DNC2, ethernet, data server, OPEN CNC, CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION.



# FUNCTIONS TO SIMPLIFY PROGRAMMING

General

This chapter explains the following items:

- 13.1 CANNED CYCLE (G90, G92, G94)
- 13.2 MULTIPLE REPETITIVE CYCLE (G70-G76)
- 13.3 CANNED CYCLE FOR DRILLING (G80-G89)
- 13.4 CANNED GRINDING CYCLE (FOR GRINDING MACHINE)
- 13.5 CHAMFERING AND CORNER R
- 13.6 MIRROR IMAGE FOR DOUBLE TURRET (G68, G69)
- **13.7 DIRECT DRAWING DIMENSIONS PROGRAMMING**
- **13.8 RIGID TAPPING**

#### NOTE

Explanatory diagrams in this chapter uses diameter programming in X axis. In radius programming, changes U/2 with U and X/2 with X. 13.1 CANNED CYCLE (G90, G92, G94) There are three canned cycles : the outer diameter/internal diameter cutting canned cycle (G90), the thread cutting canned cycle (G92), and the end face turning canned cycle (G94).

# 13.1.1 Outer Diameter / Internal Diameter Cutting Cycle (G90)

• Straight cutting cycle

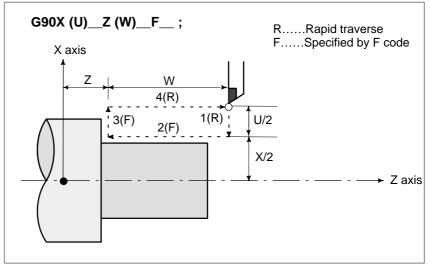


Fig. 13.1.1 (a) Straight Cutting Cycle

In incremental programming, the sign of the numbers following address U and W depends on the direction of paths 1 and 2. In the cycle of 14. 1 1 (a), the signs of U and W are negative.

In single block mode, operations 1, 2, 3 and 4 are performed by pressing the cycle start button once.

• Taper cutting cycle

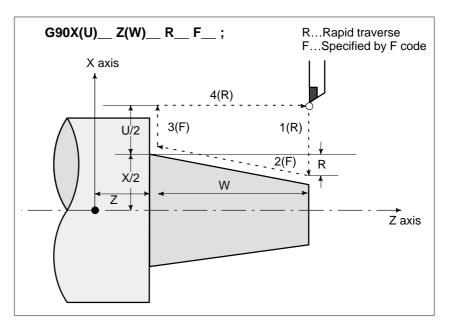
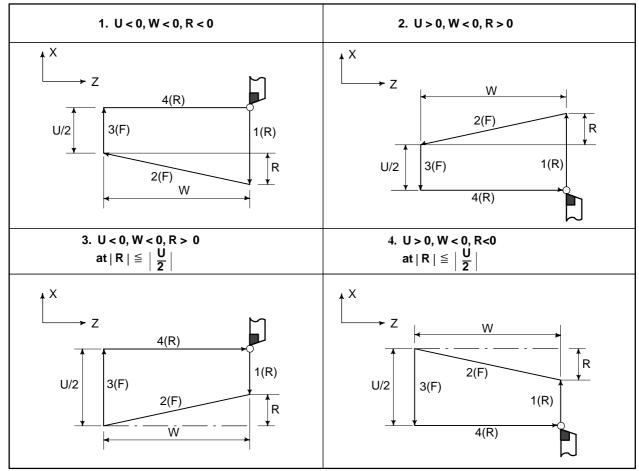


Fig. 13.1.1 (b) Taper Cutting Cycle

• Signs of numbers specified in the taper cutting cycle

In incremental programming, the relationship between the signs of the numbers following address U, W, and R, and the tool paths are as follows:



(G92)

# 13.1.2 **Thread Cutting Cycle** G92X(U) Z(W) F\_ ; Lead (L) is specified. X axis Ζ W 4(R) 3(R) 1(R) 2(F) X/2 Z axis R..... Rapid traverse F..... Specified by F code (The chamfered angle in the left figure is 45 degrees or less because of the delay in the servo system. Approx. 45 Detailed chamfered thread

#### Fig. 13.1.2 (a) Straight Thread Cutting

In incremental programming, the sign of numbers following addresses U and W depends on the direction of paths 1 and 2. That is, if the direction of path 1 is the negative along the X axis, the value of U is negative.

The range of thread leads, limitation of spindle speed, etc. are the same as in G32 (thread cutting). Thread chamfering can be performed in this thread cutting cycle. A signal from the machine tool, initiates thread chamfering. The chamfering distance is specified in a range from 0.1L to 12.7L in 0.1L increments by parameter (No. 5130). (In the above expression, L is the thread lead.)

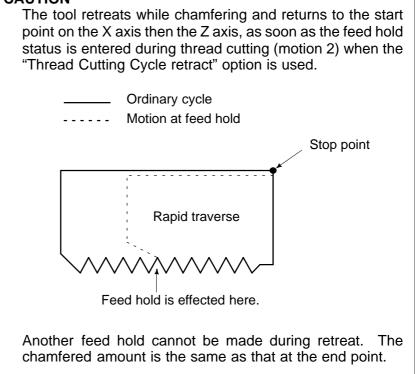
In the single block mode, operations 1, 2, 3, and 4 are performed by pressing cycle start button once.

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#### WARNING

Notes on this thread cutting are the same as in thread cutting in G32. However, a stop by feed hold is as follows; Stop after completion of path 3 of thread cutting cycle.





• Taper thread cutting cycle

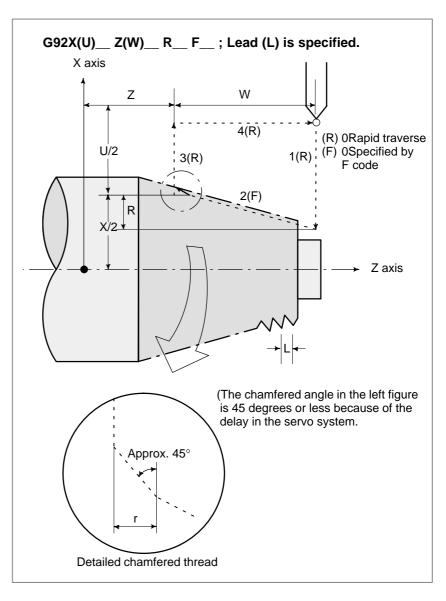


Fig. 13.1.2 (b) Taper thread cutting cycle

# 13.1.3 End Face Turning Cycle (G94)

• Face cutting cycle

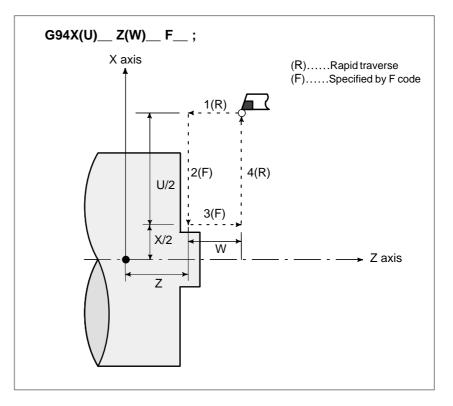


Fig. 13.1.3 (a) Face Cutting Cycle

In incremental programming, the sign of numbers following addresses U and W depends on the direction of paths 1 and 2. That is, if the direction of the path is in the negative direction of the Z axis, the value of W is negative.

In single block mode, operations 1, 2, 3, and 4 are performed by pressing the cycle start button once.

## • Taper face cutting cycle

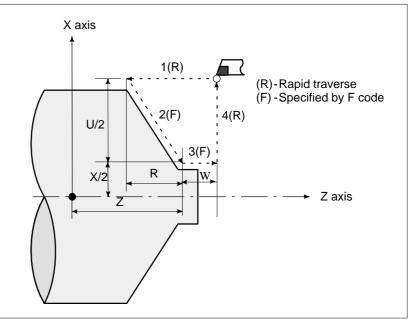
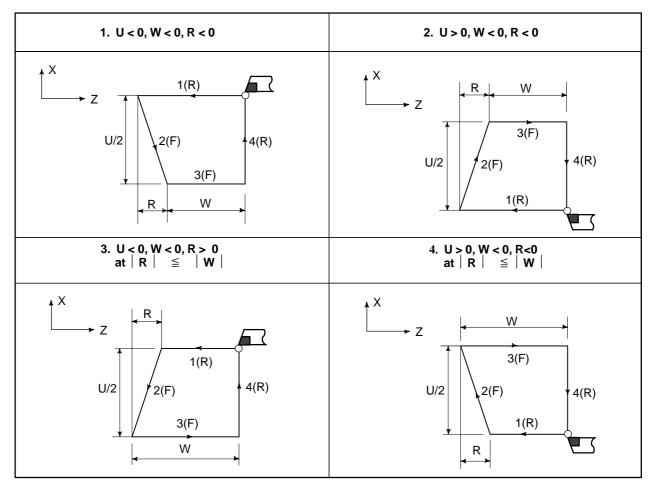


Fig. 13.1.3 (b)

• Signs of numbers specified in the taper cutting cycle

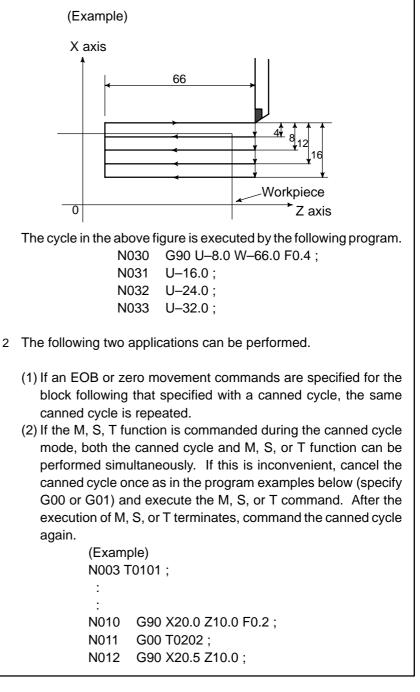
In incremental programming, the relationship between the signs of the numbers following address U, W, and R, and the tool paths are as follows:



#### NOTE

Since data values of X (U), Z (W) and R during canned cycle are modal, if X (U), Z (W), or R is not newly commanded, the previously specified data is effective. Thus, when the Z axis movement amount does not vary as in the example below, a canned cycle can be repeated only by specifying the movement commands for the X-axis.

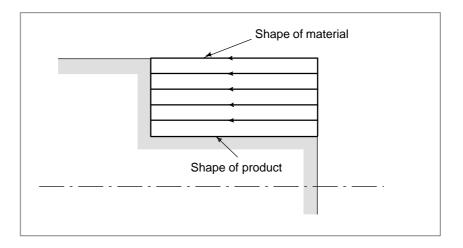
However, these data are cleared, if a one-shot G code expect for G04 (dwell) or a G code in the group 01 except for G90, G92, G94 is commanded.



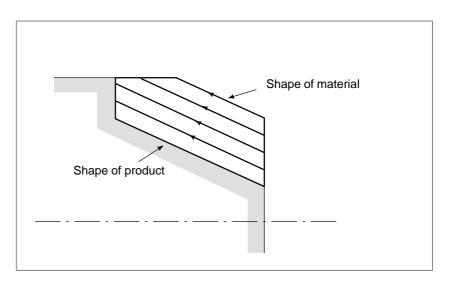
# 13.1.4 How to Use Canned Cycles (G90, G92, G94)

An appropriate canned cycle is selected according to the shape of the material and the shape of the product.

• Straight cutting cycle (G90)

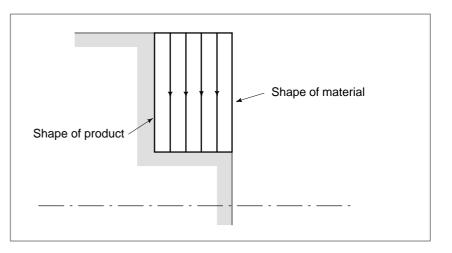


• Taper cutting cycle (G90)

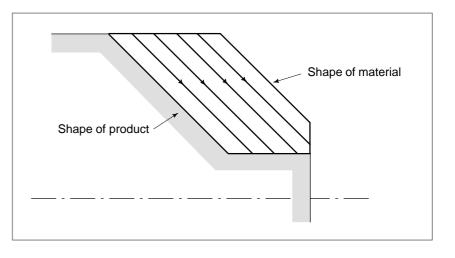


13. FUNCTIONS TO SIMPLIFY PROGRAMMING

• Face cutting cycle (G94)



• Face taper cutting cycle (G94)



### 13.2 MULTIPLE REPETITIVE CYCLE (G70–G76)

Stock Removal in Turning (G71) This option canned cycles to make CNC programming easy. For instance, the data of the finish work shape describes the tool path for rough machining. And also, a canned cycles for the thread cutting is available.

There are two types of stock removals in turning : Type I and II.

• Type I

13.2.1

If a finished shape of A to A' to B is given by a program as in the figure below, the specified area is removed by  $\Delta d$  (depth of cut), with finishing allowance  $\Delta u/2$  and  $\Delta w$  left.

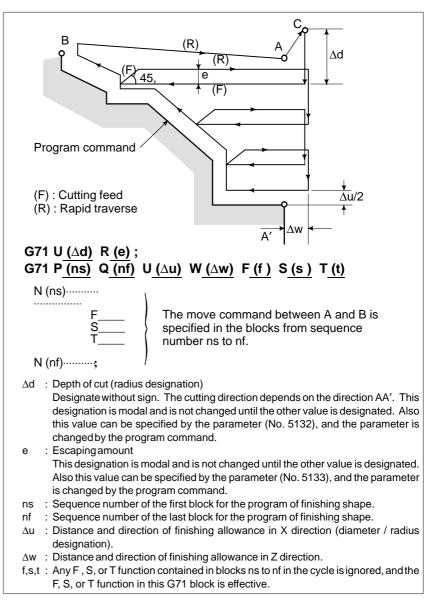


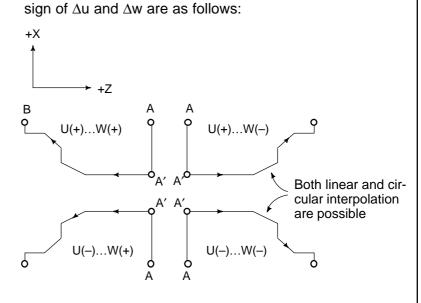
Fig. 13.2.1 (a) Cutting Path in Stock Removal in Turning (Type I)

#### NOTE

- 1 While both  $\Delta d$  and  $\Delta u$ , are specified by address U, the meanings of them are determined by the presence of addresses P and Q.
- 2 The cycle machining is performed by G71 command with P and Q specification.

F, S, and T functions which are specified in the move command between points A and B are ineffective and those specified in G71 block or the previous block are effective.

When an option of constant surface speed control is selected, G96 or G97 command specified in the move command between points A and B are ineffective, and that specified in G71 block or the previous block is effective. The following four cutting patterns are considered. All of these cutting cycles are made paralleled to Z axis and the



The tool path between A and A' is specified in the block with sequence number "ns" including G00 or G01, and in this block, a move command in the Z axis cannot be specified. The tool path between A' and B must be steadily increasing or decreasing pattern in both X and Z axis. When the tool path between A and A' is programmed by G00/G01, cutting along AA' is performed in G00/G01 mode respectively.

3 The subprogram cannot be called from the block between sequence number "ns" and "nf".

• Type II

Type II differs from type I in the following : The profile need not show monotone increase or monotone decrease along the X axis, and it may have up to 10 concaves (pockets).

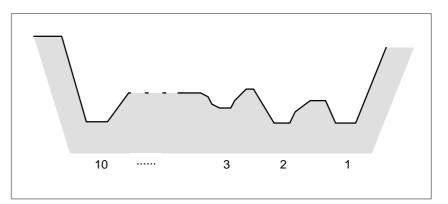


Fig. 13.2.1 (b) Number of Pockets in Stock Removal in Turning (Type II)

Note that, however, the profile must have monotone decrease or increase along the Z axis. The following profile cannot be machined:

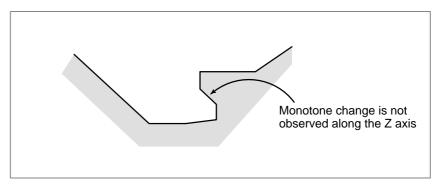


Fig. 13.2.1 (c) Figure Which Cannot Be Machined in Stock Removal in Turning (Type II)

The first cut portion need not be vertical ; any profile is permitted if monotone change is shown along the Z axis.

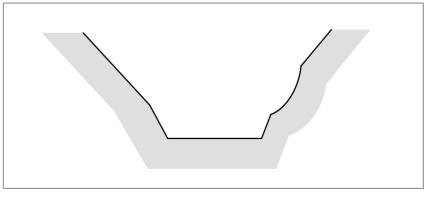


Fig. 13.2.1 (d) Figure Which Can Be Machined (Monotonic change) in Stock Removal in Turning (Type II)

After turning, a clearance is provided by cutting along the workpiece profile.

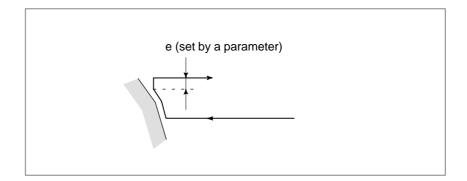


Fig. 13.2.1 (e) Chamfering in Stock Removal in Turning (Type II)

The clearance e (specified in R) to be provided after cutting can also be set in parameter No. 5133.

A sample cutting path is given below:

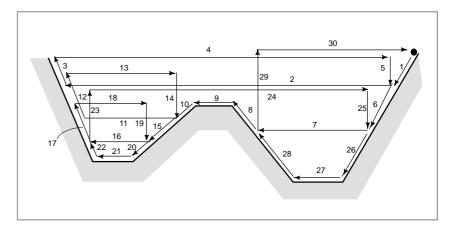


Fig. 13.2.1 (f) Cutting Path in Stock Removal in Facing

The offset of the tool tip radius is not added to finishing allowances  $\Delta u$  and  $\Delta w$ . In turning, the offset of the tool tip radius is assumed to be zero.

W=0 must be specified; otherwise, the tool tip may cut into one wall side. For the first block of a repetitive portion, two axes X (U) and Z (W) must be specified. When Z motion is not performed, W0 is also specified.

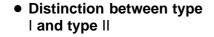
When only one axis is specified in the first block of a repetitive portion -- Type I

When two axes are specified in the first block of a repetitive portion -- Type II

When the first block does not include Z motion and type IIis to be used, W0 must be specified.

(Example)

| (ampro)         |                 |
|-----------------|-----------------|
| ТҮРЕ І          | TYPE II         |
| G71 V10.0 R5.0; | G71 V10.0 R5.0; |
| G71 P100 Q200;  | G71 P100 Q200;  |
| N100X (U);      | N100X (U)Z(W);  |
| :               | :               |
| :               | :               |
| N200;           | N200;           |
|                 |                 |



13.2.2

**Stock Removal in** 

Facing (G72)

# As shown in the figure below, this cycle is the same as G71 except that cutting is made by a operation parallel to X axis.

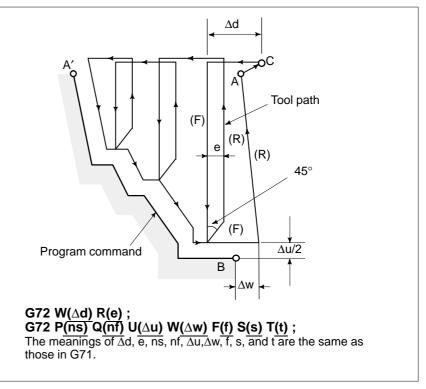


Fig. 13.2.2 (a) Cutting Path in Stock Removal in Facing

• Signs of specified numbers

The following four cutting patterns are considered. All of these cutting cycles are made parallel to X axis and the sign of  $\Delta u$  and  $\Delta w$  are as follows:

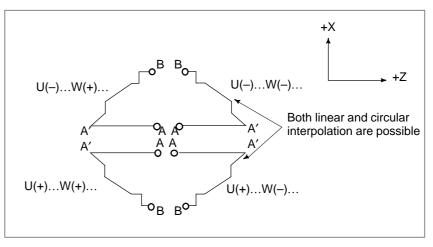


Fig. 13.2.2 (b) Signs of Numbers Specified with U and W in Stock Removal in Facing

The tool path between A and A' is specified in the block with sequence number "ns" including G00 or G01, and in this block, a move command in the X axis cannot be specified. The tool path between A' and B must be steadily increasing and decreasing pattern in both X and Z axes. Whether the cutting along AA' is G00 or G01 mode is determined by the command between A and A', as described in item 13.2.1.

### 13.2.3 Pattern Repeating (G73)

This function permits cutting a fixed pattern repeatedly, with a pattern being displaced bit by bit. By this cutting cycle, it is possible to efficiently cut work whose rough shape has already been made by a rough machining, forging or casting method, etc.

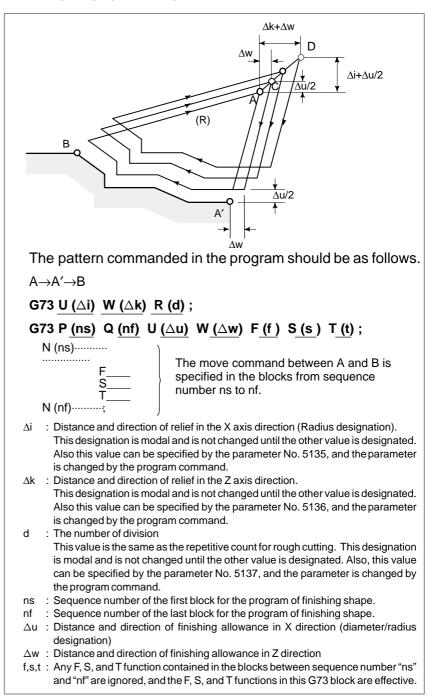


Fig. 13.2.3 Cutting path in Pattern Repeating

#### NOTE

- 1 While the values Δi and Δk, or Δu and Δw are specified by address U and W respectively, the meanings of them are determined by the presence of addresses P and Q in G73 block. When P and Q are not specified in a same block, addresses U and W indicates Δi and Δk respectively. When P and Q are specified in a same block, addresses U and W indicates Δu and Δw respectively.
- 2 The cycle machining is performed by G73 command with P and Q specification.
  The four cutting patterns are considered. Take care of the sign of Δu, Δw, Δk, and Δi.
  When the machining cycle is terminated, the tool returns to point A.

After rough cutting by G71, G72 or G73, the following command permits

### 13.2.4 Finishing Cycle (G70)

Format

#### G70P (ns) Q (nf) ;

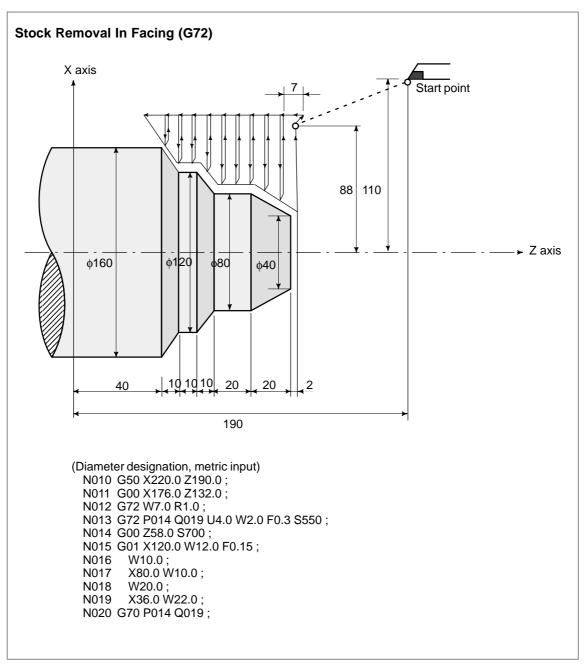
- (ns) : Sequence number of the first block for the program of finishing shape.
- (nf) : Sequence number of the last block for the program of finishing shape.

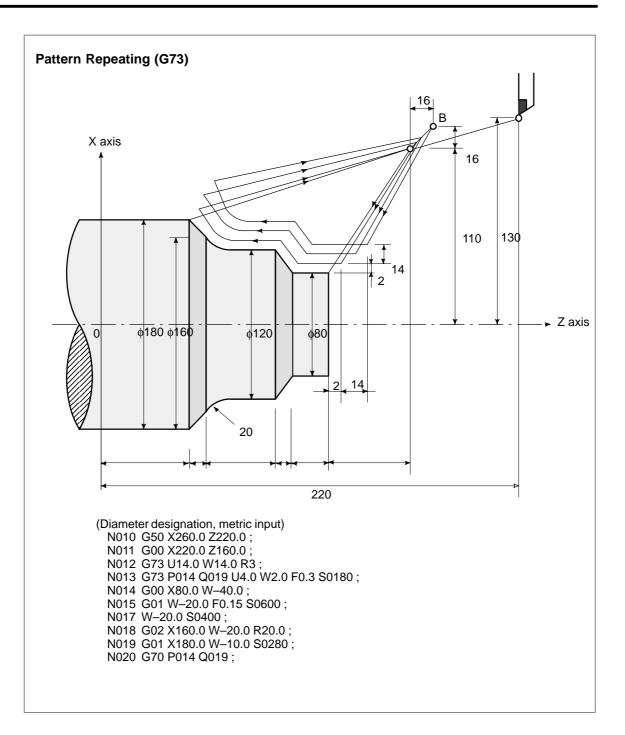
#### NOTE

finishing.

- 1 F, S, and T functions specified in the block G71, G72, G73 are not effective but those specified between sequence numbers "ns" and "nf" are effective in G70.
- 2 When the cycle machining by G70 is terminated, the tool is returned to the start point and the next block is read.
- 3 In blocks between "ns" and "nf" referred in G70 through G73, the subprogram cannot be called.

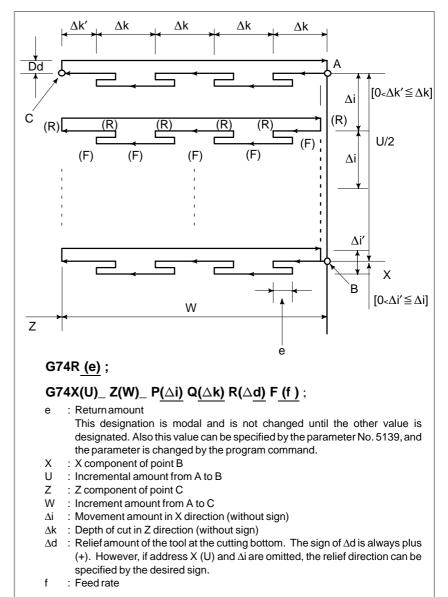
### Examples





### 13.2.5 End Face Peck Drilling Cycle (G74)

The following program generates the cutting path shown in Fig. 13.2.5. Chip breaking is possible in this cycle as shown below. If X(U) and Pare omitted, operation only in the Z axis results, to be used for drilling.





#### NOTE

- While both e and ∆d are specified by address R, the meanings of them are determined by the present of address X (U). When X(U) is specified, ∆d is used.
- 2 The cycle machining is performed by G74 command with X (U) specification.

### 13.2.6 Outer Diameter / Internal Diameter Drilling Cycle (G75)

The following program generates the cutting path shown in Fig. 13.2.6. This is equivalent to G74 except that X is replaced by Z. Chip breaking is possible in this cycle, and grooving in X axis and peck drilling in X axis (in this case, Z, W, and Q are omitted) are possible.

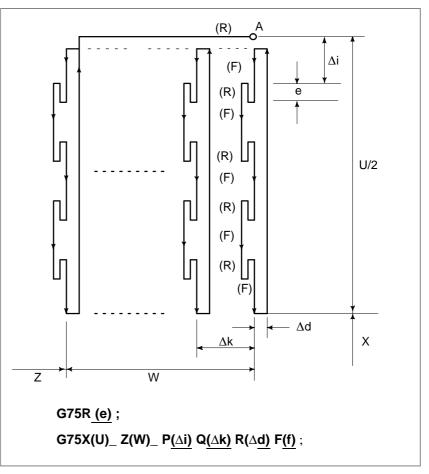
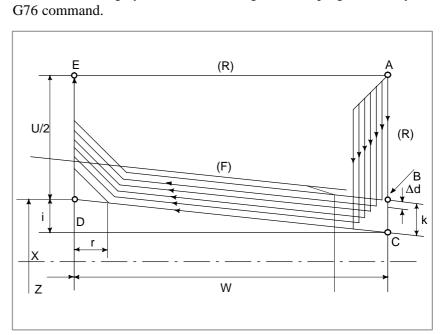


Fig. 13.2.6 Cutting Path in Outer Diameter / Internal Diameter Drilling Cycle

Both G74 and G75 are used for grooving and drilling, and permit the tool to relief automatically. Four symmetrical patterns are considered, respectively.

### 13.2.7 Multiple Thread Cutting Cycle (G76)



The thread cutting cycle as shown in Fig.13.2.7 is programmed by the

Fig. 13.2.7 Cutting Path in Multiple thread cutting cycle

| ∕ Tool tip  |  |  |
|---|--|--|
|   |  |  |
| $ \begin{array}{c} & & & \\ & & \\ & & \\ & & \\ & \\ & \\ & \\ $   |  |  |
| G76P (m) (r) (a) Q <u>(</u> ∆d min) R(d);<br>G76X (u) _ Z(W) _ R(i) P(k) Q(∆d) F(L) ;   |  |  |
| m ; Repetitive count in finishing (1 to 99)<br>This designation is modal and is not changed until the other value is<br>designated. Also this value can be specified by the parameter No.   |  |  |
| <ul> <li>5142, and the parameter is changed by the program command.</li> <li>r Chamfering amount<br/>When the thread lead is expressed by L, the value of L can be set from<br/>0.0L to 9.9L in 0.1L increment (2–digit number from 00 to 90).</li> </ul>   |  |  |
| This designation is modal and is not changed until the other value is designated. Also this value can be specified by the parameter No. 5130, and the parameter is changed by the program command.  |  |  |
| <ul> <li>a : Angle of tool tip</li> <li>One of six kinds of angle, 805, 605, 555, 305, 295, and 05, can be selected, and specified by 2–digit number.</li> <li>This designation is modal and is not changed until the other value is designated. Also this value can be specified by the parameter No. 5143, and the parameter is changed by the program command.</li> </ul>  |  |  |
| m, r, and a are specified by address P at the same time.<br>(Example)   |  |  |
| When m=2, r=1.2L, a=60°, specify as shown below (L is lead of thread).<br>P $\frac{02}{m} \frac{12}{r} \frac{60}{a}$  |  |  |
| <ul> <li>Δdmin : Minimum cutting depth (specified by the radius value)<br/>When the cutting depth of one cycle operation (Δd – Δd –1) becomes<br/>smaller than this limit, the cutting depth is clamped at this value. This<br/>designation is modal and is not changed until the other value is<br/>designated. Also this value can be specified by parameter No.<br/>5140, and the parameter is changed by the program command.</li> <li>d : Finishing allowance</li> </ul> |  |  |
| This designation is modal and is not changed until the other value is designated. Also this value can be specified by parameter No.   |  |  |
| <ul> <li>i Substrated. Also this value can be specified by parameter No.</li> <li>5141, and the parameter is changed by the program command.</li> <li>i Difference of thread radius If i = 0, ordinary straight thread cutting can be made.</li> </ul>  |  |  |
| k : Height of thread<br>This value is specified by the radius value.  |  |  |
| $\Delta d$ : Depth of cut in 1st cut (radius value)<br>L : Lead of thread (same as G32).  |  |  |

### Fig. 13.2.7 (b) Detail of cutting

• Thread cutting cycle retract

When feed hold is applied during threading in the multiple thread cutting cycle (G76), the tool quickly retracts in the same way as in chamfering performed at the end of the thread cutting cycle. The tool goes back to the start point of the cycle. When cycle start is triggered, the multiple thread cutting cycle resumes.

Without this retraction function, when feed hold is applied during threading, the tool goes back to the start point of the cycle after threading is completed.

See notes in 13.1.2.

PROGRAMMING

#### NOTE

- 1 The meanings of the data specified by address P, Q, and R determined by the presence of X (U) and X (W).
- 2 The cycle machining is performed by G76 command with X (U) and Z (W) specification.

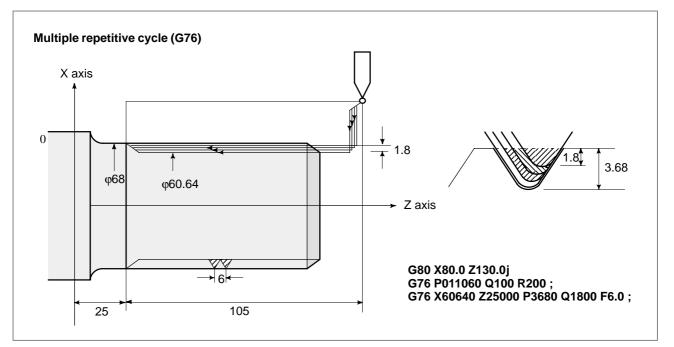
By using this cycle, one edge cutting is performed and the load on the tool tip is reduced.

Making the cutting depth  $\Delta d$  for the first path, and  $\Delta dn$  for the nth path, cutting amount per one cycle is held constant. Four symmetrical patterns are considered corresponding to the sign of each address.

The internal thread cutting is available. In the above figure, the feed rate between C and D is specified by address F, and in the other path, at rapid traverse. The sign of incremental dimensions for the above figure is as follows:

- U, W : minus (determined by the direction of the tool path AC and CD.)
- R: minus (determined by the direction of the tool path AC.)
- P: plus (always)
- Q: plus (always)
- 3 Notes on thread cutting are the same as those on G32 thread cutting and G92 thread cutting cycle.
- 4 The designation of chamfering is also effective for G92 thread cutting cycle.
- 5 The tool returns to the cycle start point at that time (cutting depth △dn) as soon as the feed hold status is entered during thread cutting when the "Thread Cutting Cycle retract" option is used.

#### **Examples**



Staggered thread cutting

Specifying P2 can perform staggered thread cutting with a constant depth of cut.

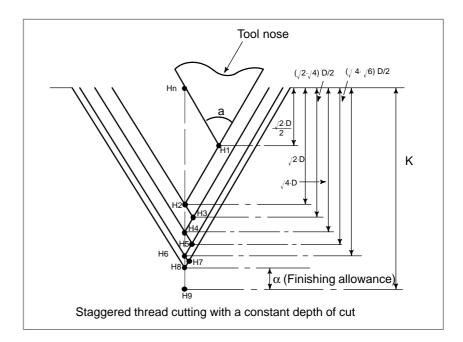
Example: G76 X60640 Z25000 K3680 D1800 F6.0 A60 P2;

For staggered thread cutting, always use the FS15 tape format (see Section 18.5).

If the depth of cut in one cycle is less than dmin (specified in parameter No. 5140), the depth of cut is clamped at  $\Delta$ dmin.

#### NOTE

Multiple repetitive cycle II is required.



| 13.2.8<br>Notes on Multiple   | 1. In the blocks where the multiple repetitive cycle are commanded, the addresses P, Q, X, Z, U, W, and R should be specified correctly for each block.  |
|-------------------------------|--|
| Repetitive Cycle<br>(G70–G76) | <ol> <li>In the block which is specified by address P of G71, G72 or G73, G00<br/>or G01 group should be commanded. If it is not commanded, P/S<br/>alarm No. 65 is generated.</li> </ol>  |
|                               | 3. In MDI mode, G70, G71, G72, or G73 cannot be commanded. If it is commanded, P/S alarm No. 67 is generated. G74, G75, and G76 can be commanded in MDI mode.  |
|                               | 4. In the blocks in which G70, G71, G72, or G73 are commanded and between the sequence number specified by P and Q, M98 (subprogram call) and M99 (subprogram end) cannot be commanded.  |
|                               | <ul> <li>5. In the blocks between the sequence number specified by P and Q, the following commands cannot be specified.</li> <li>One shot G code except for G04 (dwell)</li> <li>O1 group G code except for G00, G01, G02, and G03</li> <li>O6 group G code</li> <li>M98 / M99</li> </ul>  |
|                               | <ul> <li>6. While a multiple repetitive cycle (G70AG76) is being executed, it is possible to stop the cycle and to perform manual operation. But, when the cycle operation is restarted, the tool should be returned to the position where the cycle operation is stopped.</li> <li>If the cycle operation is restarted without returning to the stop position, the movement in manual operation is added to the absolute value, and the tool path is shifted by the movement amount in manual operation.</li> </ul> |
|                               | <ol> <li>When G70, G71, G72, or G73 is executed, the sequence number<br/>specified by address P and Q should not be specified twice or more in<br/>the same program.</li> </ol>  |
|                               | <ol> <li>The blocks between the sequence number specified by P and Q on the<br/>multiple repetitive cycle must not be programmed by using "Direct<br/>Drawing Dimensions Programming" or "Chamfering and Corner R".</li> </ol>   |
|                               | 9. G74, G75, and G76 also do not support the input of a decimal point for P or Q. The least input increments are used as the units in which the amount of travel and depth of cut are specified.   |
|                               | 10.When $\#1 = 2500$ is executed using a custom macro, 2500.000 is assigned to $\#1$ . In such a case, P#1 is equivalent to P2500.   |
|                               | 11. Tool nose radius compensation cannot be applied to G71, G72, G73, G74, G75, G76, or G78.   |
|                               | 12. The multiple repetitive cycle cannot be executing during DNC operation.  |
|                               | 13.Interruption type custom macro cannot be executed during executing the multiple repetitive cycle.   |
|                               | 14. The multiple repetitive cycle cannot be executing during Advanced Preview Control mode.  |
|                               | 15.Tool compensation is disabled during execution of G74 or G75.   |

## 13.3 CANNED CYCLE FOR DRILLING (G80–G89)

The canned cycle for drilling simplifies the program normally by directing the machining operation commanded with a few blocks, using one block including G code.

This canned cycle conforms to JIS B 6314. Following is the canned cycle table.

| Table 13 | .3 (a) | Canned | Cycles |
|----------|--------|--------|--------|
|----------|--------|--------|--------|

| G code | Drilling<br>axis | Hole machining<br>operation (– direction) | Operation in the bottom hole position | Retraction operation<br>(+ direction) | Applications         |
|--------|------------------|---|---------------------------------------|---------------------------------------|----------------------|
| G80    |                  |   |                                       |                                       | Cancel               |
| G83    | Z axis           | Cutting feed / intermittent               | Dwell                                 | Rapid traverse                        | Front drilling cycle |
| G84    | Z axis           | Cuttingfeed                               | Dwell→spindle CCW                     | Cuttingfeed                           | Front tapping cycle  |
| G85    | Z axis           | Cuttingfeed                               |                                       | Cuttingfeed                           | Front boring cycle   |
| G87    | X axis           | Cutting feed / intermittent               | Dwell                                 | Rapid traverse                        | Side drilling cycle  |
| G88    | X axis           | Cuttingfeed                               | Dwell→Spindle CCW                     | Cuttingfeed                           | Side tapping cycle   |
| G89    | X axis           | Cuttingfeed                               | Dwell                                 | Cutting feed                          | Side boring cycle    |

In general, the drilling cycle consists of the following six operation sequences.

- Operation 1 Positioning of X (Z) and C axis
- Operation 2 Rapid traverse up to point R level
- Operation 3 Hole machining
- Operation 4 Operation at the bottom of a hole
- Operation 5 Retraction to point R level
- Operation 6 Rapid traverse up to the initial point

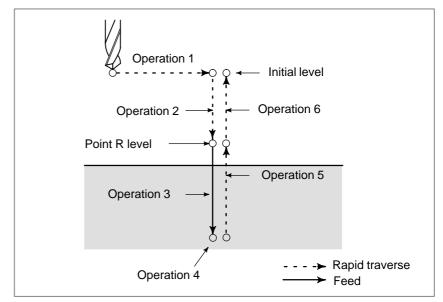


Fig. 13.3 Drilling Cycle Operation Sequence

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#### **Explanations**

 Positioning axis and drilling axis

Return point level

G98/G99

A drilling G code specifies positioning axes and a drilling axis as shown below. The C-axis and X- or Z-axis are used as positioning axes. The X- or Z-axis, which is not used as a positioning axis, is used as a drilling axis.

Although canned cycles include tapping and boring cycles as well as drilling cycles, in this chapter, only the term drilling will be used to refer to operations implemented with canned cycles.

| Table13.3 (b) | Positioning | axis and | drilling axis |
|---------------|-------------|----------|---------------|
|---------------|-------------|----------|---------------|

| G code Positioning pl |                | Drilling axis |
|-----------------------|----------------|---------------|
| G83, G84, G85         | X axis, C axis | Z axis        |
| G87, G88, G89         | Z axis, C axis | X axis        |

G83 and G87, G84 and G88, and G85 and G89 have the same function respectively except for axes specified as positioning axes and a drilling axis.

• Drilling mode G83AG85 / G87A89 are modal G codes and remain in effect until canceled. When in effect, the current state is the drilling mode.

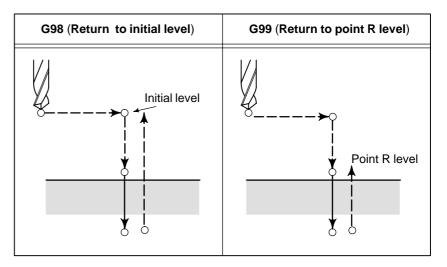
Once drilling data is specified in the drilling mode, the data is retained until modified or canceled.

Specify all necessary drilling data at the beginning of canned cycles; when canned cycles are being performed, specify data modifications only.

In G code system A, the tool returns to the initial level from the bottom of a hole. In G code system B or C, specifying G98 returns the tool to the initial level from the bottom of a hole and specifying G99 returns the tool to the point–R level from the bottom of a hole.

The following illustrates how the tool moves when G98 or G99 is specified. Generally, G99 is used for the first drilling operation and G98 is used for the last drilling operation.

The initial level does not change even when drilling is performed in the G99 mode.



| <ul> <li>Number of repeats</li> </ul>                        | To repeat drilling for equally–spaced holes, specify the number of repeat<br>in K<br>K is effective only within the block where it is specified.<br>Specify the first hole position in incremental mode.<br>If it is specified in absolute mode, drilling is repeated at the same position   |  |  |  |
|--|--|--|--|--|
|  | Number of repeats K The maximum command value = 9999   |  |  |  |
|  | When K0 is specified with parameter K0E (parameter No. 5102 #4) set<br>to 0, drilling is performed once.<br>When K0 is specified with parameter K0E (parameter No. 5102 #4) set<br>to 1, drilling data is just stored without drilling being performed.  |  |  |  |
| <ul> <li>M code used for C-axis<br/>clamp/unclamp</li> </ul> | When an M code specified in parameter No. 5110 for C-axis clamp / unclamp is coded in a program, the CNC issues the M code for C-axis clamp after the tool is positioned and before the tool is fed in rapid traverse to the point-R level. The CNC also issues the M code for C-axis unclamp (the M code for C-axis clamp +1) after the tool retracts to the point-R level. The tool dwells for the time specified in parameter No. 5111. |  |  |  |
| Cancel   | To cancel a canned cycle, use G80 or a group 01 G code.  |  |  |  |
| <ul> <li>Symbols in figures</li> </ul>                       | <ul> <li>Group 01 G codes</li> <li>G00 : Positioning (rapid traverse)</li> <li>G01 : Linear interpolation</li> <li>G02 : Circular interpolation (CW)</li> <li>G03 : Circular interpolation (CCW)</li> <li>Subsequent sections explain the individual canned cycles. Figures in these explanations use the following symbols:</li> </ul>  |  |  |  |
|  |  |  |  |  |
|  | → Positioning (rapid traverse G00)   |  |  |  |
|  | Cutting feed (linear interpolation G01)  |  |  |  |
|  | Manual feed  |  |  |  |
|  | P1Dwell specified in the programP1Dwell specified in parameter No.5111   |  |  |  |
|  | $M_{\alpha}$ Issuing the M code for C–axis clamp   |  |  |  |

(The value of  $\alpha$  is specified with parameter No. 5110.)

 $M\left(\alpha{+}1\right)\,$  Issuing the M code for C–axis unclamp

#### CAUTION

- In each canned cycle,
  - R\_ (distance between the initial level and point R) is always handled as a radius.
  - Z\_ or X\_ (distance between point R and the bottom of the hole) is, however, handled either as a diameter or radius, depending on the specification.
- For the B or C G–code system, G90 or G91 can be used to select an incremental or absolute command for hole position data (X, C or Z, C), the distance from point R to the bottom of the hole (Z or X), and the distance from the initial level to the point R level (R).

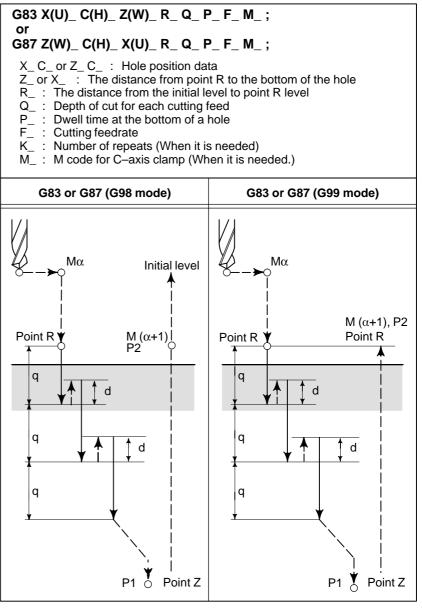
### 13.3.1 Front Drilling Cycle (G83) / Side Drilling Cycle (G87)

 High-speed peck drilling cycle (G83, G87) (parameter RTR (No. 5101#2) =0)

Format

The peck drilling cycle or high–speed peck drilling cycle is used depending on the setting in RTR, bit 2 of parameter No. 5101. If depth of cut for each drilling is not specified, the normal drilling cycle is used.

This cycle performs high–speed peck drilling. The drill repeats the cycle of drilling at the cutting feedrate and retracting the specified retraction distance intermittently to the bottom of a hole. The drill draws cutting chips out of the hole when it retracts.



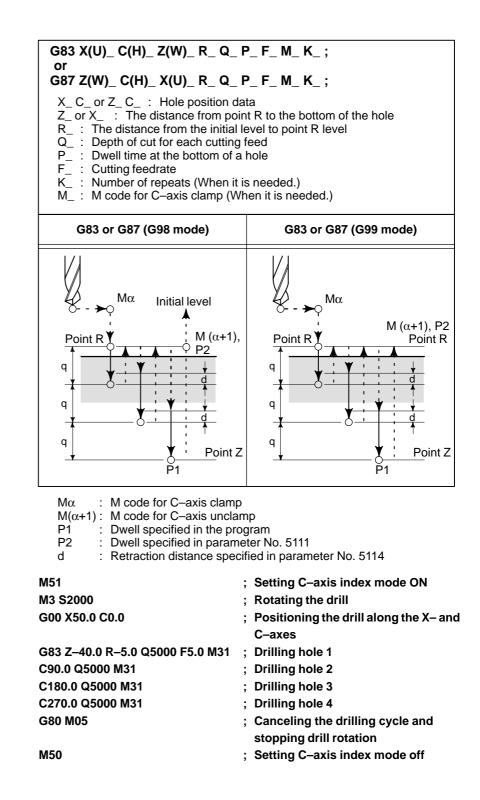
 $M\alpha$  : M code for C-axis clamp

- $M(\alpha+1)$ : M code for C-axis unclamp
- P1 : Dwell specified in the program
- P2 : Dwell specified in parameter No. 5111

d : Retraction distance specified in parameter No. 5114

#### Peck drilling cycle (G83, G87) (parameter No. 5101#2 =1)

Format

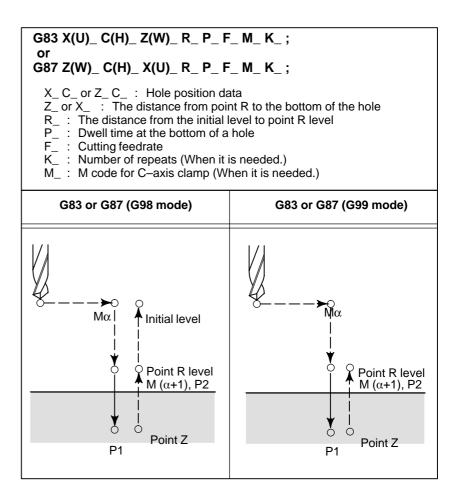


Examples

#### NOTE

If the depth of cut for each cutting feed (Q) is not commanded, normal drilling is performed. (See the description of the drilling cycle.)

If depth of cut is not specified for each drilling, the normal drilling cycle is used. The tool is then retracted from the bottom of the hole in rapid traverse.



- $\begin{array}{lll} M\alpha & : & M \mbox{ code for } C\mbox{-axis clamp} \\ M(\alpha\mbox{+1}) : & M \mbox{ code for } C\mbox{-axis unclamp} \end{array}$
- P1 : Dwell specified in the program
- P2 : Dwell specified in parameter No. 5111

Format

• Drilling cycle

(G83 or G87)

| Examples | M51                            | : | Setting C-axis index mode ON                                |
|----------|--------------------------------|---|---|
| •        | M3 S2000                       | ; | Rotating the drill  |
|          | G00 X50.0 C0.0                 |   | Positioning the drill along the X– and C–axes               |
|          | G83 Z-40.0 R-5.0 P500 F5.0 M31 | ; | Drilling hole 1   |
|          | C90.0 M31                      | ; | Drilling hole 2   |
|          | C180.0 M31                     | ; | Drilling hole 3   |
|          | C270.0 M31                     | ; | Drilling hole 4   |
|          | G80 M05                        |   | Canceling the drilling cycle and<br>stopping drill rotation |
|          | M50                            | ; | Setting C-axis index mode off                               |

### 13.3.2

Front Tapping Cycle (G84) / Side Tapping Cycle (G88) This cycle performs tapping.

In this tapping cycle, when the bottom of the hole has been reached, the spindle is rotated in the reverse direction.

#### Format

| G84 X(U)_ C(H)_ Z(W)_ R_ P_ F_ M_ K_ ;         or         G88 Z(W)_ C(H)_ X(U)_ R_ P_ F_ M_ K_ ;         X_ C_ or Z_ C_ : Hole position data         Z_ or X_ : The distance from point R to the bottom of the hole         R_ : The distance from the initial level to point R level         P_ : Dwell time at the bottom of a hole         F_ : Cutting feedrate         K_ : Number of repeats (When it is needed.)         M_ : M code for C-axis clamp (when it is needed.) |  |  |
|---|--|--|
| G84 or G88 (G98 mode)   | G84 or G88 (G99 mode)                                    |  |
| $M\alpha$ Initial level<br>Spindle CW<br>Point R<br>Point Z<br>P1<br>Spindle CCW  | Mα<br>Spindle CW<br>M (α+1), P2<br>Point R Point R level |  |

#### **Explanations**

Tapping is performed by rotating the spindle clockwise. When the bottom of the hole has been reached, the spindle is rotated in the reverse direction for retraction. This operation creates threads.

Feedrate overrides are ignored during tapping. A feed hold does not stop the machine until the return operation is completed.

#### NOTE

Bit 6 (M5T) of parameter No. 5101 specifies whether the spindle stop command (M05) is issued before the direction in which the spindle rotates is specified with M03 or M04. For details, refer to the operator's manual created by the machine tool builder.

#### Examples

| ; Setting C-axis index mode ON           |
|--|
| ; Rotating the drill                     |
| ; Positioning the drill along the X- and |
| C– axes                                  |
| ; Drilling hole 1                        |
| ; Drilling hole 2                        |
| ; Drilling hole 3                        |
| ; Drilling hole 4                        |
| ; Canceling the drilling cycle and       |
| stopping drill rotation                  |
| ; Setting C-axis index mode off          |
|  |

This cycle is used to bore a hole.

### 13.3.3

Front Boring Cycle (G85) / Side Boring Cycle (G89)

Format

G85 X(U)\_ C(H)\_ Z(W)\_ R\_ P\_ F\_ K\_ M\_ ; or G89 Z(W)\_ C(H)\_ X(U)\_ R\_ P\_ F\_ K\_ M\_ ;  $X\_C\_$  or  $Z\_C\_$  : Hole position data  $Z\_$  or  $X\_$  : The distance from point R to the bottom of the hole R\_: The distance from the initial level to point R level Р : Dwell time at the bottom of a hole F : Cutting feedrate K\_: Number of repeats (When it is needed.) M\_: M code for C-axis clamp (When it is needed.) G85 or G89 (G98 mode) G85 or G89 (G99 mode)  $\text{M}\alpha$ Initial level Mα Y Point R level Mβ, P2 Point R ¢ Point R C Μβ, Ρ2 Point Z Point Z

#### **Explanations**

After positioning, rapid traverse is performed to point R. Drilling is performed from point R to point Z. After the tool reaches point Z, it returns to point R at a feedrate twice the cutting feedrate.

#### Examples

| M5 1                           | ; | Setting C-axis index mode ON           |
|--------------------------------|---|--|
| M3 S2000                       | ; | Rotating the drill                     |
| G00 X50.0 C0.0                 | ; | Positioning the drill along the X- and |
|                                |   | C–axes                                 |
| G83 Z-40.0 R-5.0 P500 F5.0 M31 | ; | Drilling hole 1                        |
| C90.0 M31                      | ; | Drilling hole 2                        |
| C180.0 M31                     | ; | Drilling hole 3                        |
| C270.0 M31                     | ; | Drilling hole 4                        |
| G80 M05                        | ; | Canceling the drilling cycle and       |
|                                |   | stopping drill rotation                |
| M50                            | ; | Setting C-axis index mode off          |

#### 

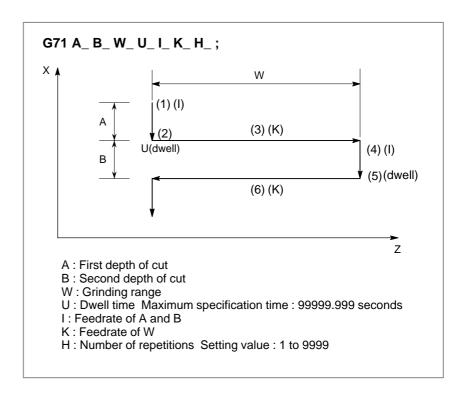
| 13.3.4<br>Canned Cycle for<br>Drilling Cancel (G80) | G80 cancels canned cycle.                   |  |
|---|---|--|
| Format  |   |  |
|   | G80 ;                                       |  |
| Explanations  | •   | celed to perform normal operation.<br>ed. Other drilling data is also canceled   |
| Examples  | M51<br>M3 S2000<br>G00 X50.0 C0.0           | <ul> <li>Setting C-axis index mode ON</li> <li>Rotating the drill</li> <li>Positioning the drill along the X- and C-axes.</li> </ul> |
|   | G83 Z–40.0 R–5.0 P500 F5.0 M31<br>C90.0 M31 | ,  |
|   | C180.0 M31                                  | ; Drilling hole 2<br>; Drilling hole 3   |
|   | C270.0 M31                                  | ; Drilling hole 4  |
|   | G80 M05                                     | ; Canceling the drilling cycle and<br>stopping drill rotation  |
|   | M50   | ; Setting C-axis index mode off  |

### 13.3.5 Precautions to be Taken by Operator

| <ul> <li>Reset and emergency<br/>stop</li> </ul> | Even when the controller is stopped by resetting or emergency stop in the course of drilling cycle, the drilling mode and drilling data are saved ; with this mind, therefore, restart operation.  |
|--|--|
| • Single block                                   | When drilling cycle is performed with a single block, the operation stops at the end points of operations 1, 2, 6 in Fig. 13.3 (a). Consequently, it follows that operation is started up 3 times to drill one hole. The operation stops at the end points of operations 1, 2 with the feed hold lamp ON. The operation stops in the feed hold conditions at the end point of operation 6 if the repeat remains, and it stops in stop conditions in other cases. |
| <ul> <li>Feed hold</li> </ul>                    | When "Feed Hold" is applied between operations 3 and 5 by G84/G88, the feed hold lamp lights up immediately if the feed hold is applied again to operation 6.  |
| Override   | During operation with G84 and G88, the feedrate override is 100%.  |

### 13.4 CANNED GRINDING CYCLE (FOR GRINDING MACHINE)

13.4.1 Traverse Grinding Cycle (G71) Format There are four grinding canned cycles : the traverse grinding cycle (G71), traverse direct fixed–dimension grinding cycle, oscillation grinding cycle, and oscillation direct fixed–dimension grinding cycle. With a machine tool that allows canned cycles for grinding to be used, the multiple repetitive canned cycle for turning cannot be used.



### Explanations

The specification ranges and units of the canned cycle for grinding are described below.

Move command Range :  $\pm 8$  digits Units : 1  $\mu$ /0.0001 inch 0.1  $\mu$ /0.00001 inch Feedrate Range Feed per minute : 0.001 to 240000 mm/min 0.0001 to 9600 inch/min (for 1  $\mu$ /0.0001 inch) Feed per revolution : 0.00001 to 500 mm/rev 0.00001 to 9 inch/rev

A, B, and W are to be specified in an incremental mode. In the case of a single block, the operations 1, 2, 3, 4, 5, and 6 are performed with one cycle start operation. A=B=0 results in a spark–out.

### 13.4.2

### Traverse Direct Fixed–dimension Grinding Cycle (G72)

Format

#### Explanations

 Operation at the time of skip signal input

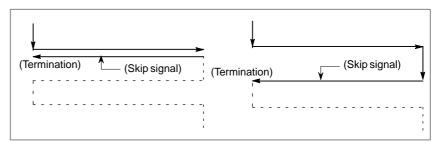
#### G72 P\_ A\_ B\_ W\_ U\_ I\_ K\_ H\_ ;

- P: Gauge number (1 to 4)
- A : First depth of cut
- B : Second depth of cut
- W : Grinding range U : Dwell time Maximum specification time : 99999.999seconds
- I : Feedrate of A and B
- K : Feedrate of W
- H: Number of repetitions Setting value : 1 to 9999

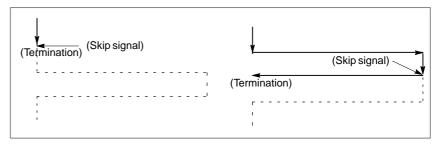
When the multistage skip operation is used, a gauge number can be specified. The method of gauge number specification is the same as the method of multistage skip function. When the multistage skip operation is not used, the conventional skip signal is valid.

The same specifications as G71 apply except for gauge number specification.

1. When the tool moves along the Z-axis to grind a workpiece, if a skip signal is input, the tool returns to the Z coordinate where the cycle started after the tool reaches the end of the specified grinding area.



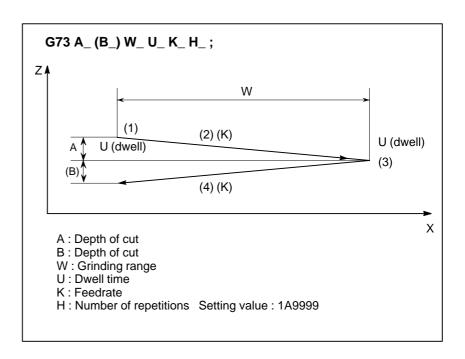
2. When the tool cuts a workpiece along the X-axis, if a skip signal is input, the tool stops cutting immediately and returns to the Z coordinate where the cycle started.



3. The skip signal is valid during dwell, without being affected by parameters DS1 to DS8 (No. 6206#0 to #7). Dwell is immediately stopped for return to the Z axis coordinate where the cycle started.

### 13.4.3 Oscillation Grinding Cycle (G73)

Format



### **Explanations**

A, B, and W are to be specified in an incremental mode.

In the case of a single block, the operations 1, 2, 3, and 4 are performed with one cycle start operation.

The specification of B is valid only for a specified block. This is not associated with B of the G71 or G72 cycle.

### 13.4.4

Oscillation Direct Fixed–Dimension Grinding Cycle

Format

#### G74 P\_ A\_ (B\_) W\_ U\_ K\_ H\_ ;

- P: Gauge number (1 to 4)
- A : Depth of cut
- B : Depth of cut W : Grinding range
- U : Dwell time
- K : Feedrate of W
- H: Number of repetitions Setting value : 1 to 9999

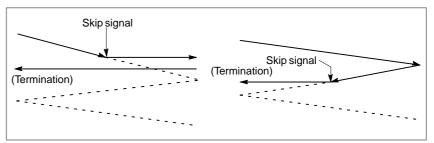
### Explanations

• Operation at the time of skip signal input

is not used, the conventional skip signal is valid.The same specifications as G73 apply to the other items.1. When the tool moves along the Z-axis to grind a workpiece, if a skip

When the multistage skip operation is used, a gauge number can be specified. The method of gauge number specification is the same as the method of multistage skip function. When the multistage skip operation

signal is input, the tool returns to the Z coordinate where the cycle started after the tool reaches the end of the specified grinding area.



2. The skip signal is valid during dwell, without being affected by parameters DS1 to DS8 (No. 6206#0 to #7). Dwell is immediately stopped for return to the Z axis coordinate where the cycle started.

#### NOTE

- 1 The data items A, B, W, I, and K in a canned cycle are modal values common to G71 through G74. The data items A, B, W, U, I and K are cleared when a one-shot G code other than G04 or a 01 group G code other than G71 to G74 is specified.
- 2 No B code can be specified in the canned cycle mode.

### 13.5 CHAMFERING AND CORNER R

• Chamfering  $Z \to X$ 

A chamfer or corner can be inserted between two blocks which intersect at a right angle as follows :

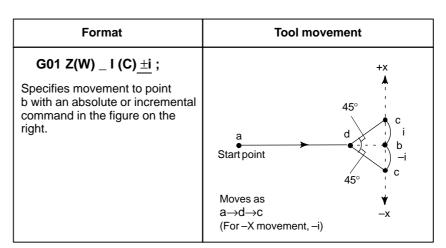
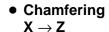


Fig. 13.5 (a) Chamfering ( $Z \rightarrow X$ )



| Format  | Tool movement                   |
|---|---------------------------------|
| <b>G01 X(U)</b> _ <b>K</b> ( <b>C</b> ) <u>±</u> <b>k</b> ; | Start point                     |
| Specifies movement to point                                 | a Moves as                      |
| b with an absolute or incremental                           | $a \rightarrow d \rightarrow c$ |
| command in the figure on the                                | $45^{\circ}$                    |
| right.  | $-z \leftarrow$                 |

Fig. 13.5 (b) Chamfering (X $\rightarrow$ Z)

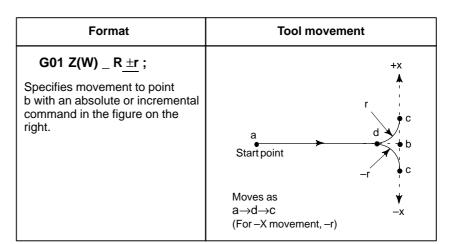


Fig. 13.5 (c) Corner R ( $Z \rightarrow X$ )

# • Corner R $Z \rightarrow X$



#### • Corner R

 $\textbf{X} \rightarrow \textbf{Z}$ 

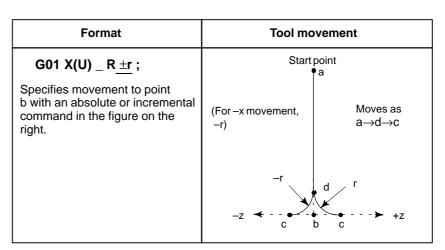


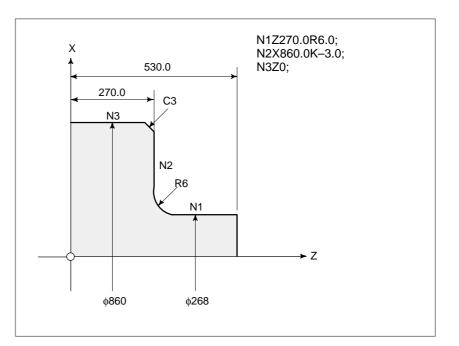
Fig. 13.5 (d) Corner R ( $X \rightarrow Z$ )

Explanations

The movement for chamfering or corner R must be a single movement along the X or Z axis in G01 mode. The next block must be a single movement along the X or Z axis perpendicular to the former block. I or K, and R always specify a radius value.

Note that the start point for a command specified in a block following a chamfering or corner–R block is not point c but point b shown in Figs. 13.5 (a) to (d). In incremental programming, specify a distance from point b.

#### **Examples**



#### NOTE

- 1 The following commands cause an alarm.
  - 1) One of I, K, or R is commanded when X and Z axes are specified by G01.
    - (P/S alarm No. 054)
  - Move amount of X or Z is less than chamfering value and corner R value in the block where chamfering and corner R are specified. (P/S alarm No. 055)
  - Next block to the block where chamfering and corner R were specified, has not G01 command. (P/S alarm No. 051, 052)
  - 4) If more than one of I, K, and R are specified in G01, P/S alarm No. 053 is issued.
- 2 A single block stops at point c in Fig. 13.5 (a) (d) not at point d.
- 3 Chamfering and corner R cannot be applied to a thread cutting block.
- 4 C can be used instead of I or K as an address for chamfering on the system which does not use C as an axis name. To use C for an address for chamfering, fix parameter CCR No. 3405#4 to 1.
- 5 If both C and R are specified with G01 in a block, the address specified last is valid.
- 6 Neither chamfering nor corner–R machining can be specified in direct drawing dimension programming.

# 13.6 MIRROR IMAGE FOR DOUBLE TURRET (G68, G69)

Format

#### G68 : Double turret mirror image on G69 : Mirror image cancel

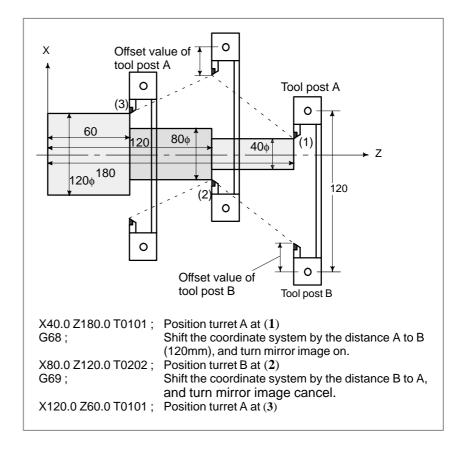
#### Explanations

Mirror image can be applied to X-axis with G code.

When G68 is designated, the coordinate system is shifted to the mating turret side, and the X-axis sign is reversed from the programmed command to perform symmetrical cutting. To use this function, set the distance between the two turrets to a parameter (No. 1290).

#### Examples

• Double turret programming



# 13.7 DIRECT DRAWING DIMENSIONS PROGRAMMING

Angles of straight lines, chamfering value, corner rounding values, and other dimensional values on machining drawings can be programmed by directly inputting these values. In addition, the chamfering and corner rounding can be inserted between straight lines having an optional angle. This programming is only valid in memory operation mode.

#### Format

|   | Table 13.7 Commands table   |  |  |  |
|---|---|--|--|--|
|   | Commands  | Movement of tool   |  |  |
| 1 | X <sub>2</sub> _ (Z <sub>2</sub> _), A_ ;   | $X = (X_2, Z_2)$   |  |  |
| 2 | $,A_{1-;}$<br>$X_{3_{-}}Z_{3_{-}}A_{2_{-};}$  | X<br>(X <sub>3</sub> , Z <sub>3</sub> )<br>(X <sub>2</sub> , Z <sub>2</sub> )<br>(X <sub>1</sub> , Z <sub>1</sub> )<br>Z |  |  |
| 3 | $\begin{array}{c} X_{2-}  Z_{2-},  R_{1-} ; \\ X_{3-}  Z_{3-} ; \\ \text{or} \\ , A_{1-},  R_{1-} ; \\ X_{3-}  Z_{3-},  A_{2-} ; \end{array}$ | $X = \begin{pmatrix} (X_3, Z_3) \\ & A_2 \\ & A_2 \\ & A_1 \\ & (X_2, Z_2) \\ & (X_1, Z_1) \\ & & Z \end{pmatrix}$       |  |  |
| 4 | $X_{2-} Z_{2-}, C_{1-};$<br>$X_{3-} Z_{3-};$<br>or<br>$A_{1-}, C_{1-};$<br>$X_{3-} Z_{3-}, A_{2-};$   | X<br>$(X_3, Z_3)$<br>$C_1$<br>$(X_2, Z_2)$<br>$(X_1, Z_1)$<br>X<br>Z   |  |  |

Table 13.7 Commands table

#### 13. FUNCTIONS TO SIMPLIFY PROGRAMMING

PROGRAMMING

|   | Commands   | Movement of tool  |
|---|--|---|
| 5 | $\begin{array}{c} X_{2-} Z_{2-}  , R_{1-}  ; \\ X_{3-} Z_{3-}  , R_{2-}  ; \\ X_{4-} Z_{4-}  ; \\ or \\ , A_{1-}  , R_{1-}  ; \\ X_{3-} Z_{3-}  , A_{2-}  , R_{2-}  ; \\ X_{4-} Z_{4-}  ; \end{array}$ | $X_{(X_{4}, Z_{4})} (X_{3}, Z_{3})$ $R_{2}$ $R_{2}$ $R_{2}$ $R_{1}$ $R_{1}$ $(X_{2}, Z_{2})$ $R_{1}$ $R_{1}$ $(X_{1}, Z_{1})$ $Z$   |
| 6 | $\begin{array}{c} X_{2-} Z_{2-} , C_{1-} ; \\ X_{3-} Z_{3-} , C_{2-} ; \\ X_{4-} Z_{4-} ; \\ or \\ , A_{1-} , C_{1-} ; \\ X_{3-} Z_{3-} , A_{2-} , C_{2-} ; \\ X_{4-} Z_{4-} ; \end{array}$            | X<br>$(X_4, Z_4)$ $(X_3, Z_3)$<br>$(X_2, Z_2)$<br>$C_1$ $(X_2, Z_2)$<br>$(X_1, Z_1)$ Z  |
| 7 | $\begin{array}{c} X_{2-} Z_{2-} , R_{1-} ; \\ X_{3-} Z_{3-} , C_{2-} ; \\ X_{4-} Z_{4-} ; \\ or \\ , A_{1-} , R_{1-} ; \\ X_{3-} Z_{3-} , A_{2-} , C_{2-} ; \\ X_{4-} Z_{4-} ; \end{array}$            | $X = \begin{pmatrix} C_2 \\ (X_4, Z_4) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_1) \\ (X_1, Z_1) \\ (X_2, Z_2) \\ (X_1, Z_2) \\ (X_2, Z_2) \\ (X_1, Z_2) \\ (X_2, Z_2) \\ (X_1, Z_2) \\ (X_2, Z_2) \\ (X_2$ |
| 8 | $\begin{array}{c} X_{2-} Z_{2-} , C_{1-} ; \\ X_{3-} Z_{3-} , R_{2-} ; \\ X_{4-} Z_{4-} ; \\ or \\ , A_{1-} , C_{1-} ; \\ X_{3-} Z_{3-} , A_{2-} , R_{2-} ; \\ X_{4-} Z_{4-} ; \end{array}$            | $X = \begin{pmatrix} (X_4, Z_4) & (X_3, Z_3) \\ R_2 & A_2 \\ C_1 & (X_2, Z_2) \\ C_1 & (X_1, Z_1) \\ (X_1, Z_1) & Z \end{pmatrix}$  |

#### **Explanations**

A program for machining along the curve shown in Fig. 13.7 (a) is as follows :

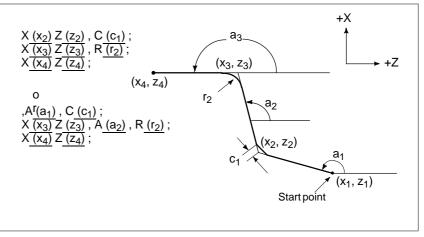


Fig. 13.7 Machining Drawing (example)

For command a straight line, specify one or two out of X, Z, and A. If only one is specified, the straight line must be primarily defined by a command in the next block.

To command the degree of a straight line or the value of chamfering or corner R, command with a comma (,) as follows :

- , A\_ , C\_
- , R\_

By specifying 1 to parameter CCR No. 3405#4 on the system which does not use A or C as an axis name, the degree of a straight line or the value of chamfering or corner R can be commanded without a comma (,) as follows :



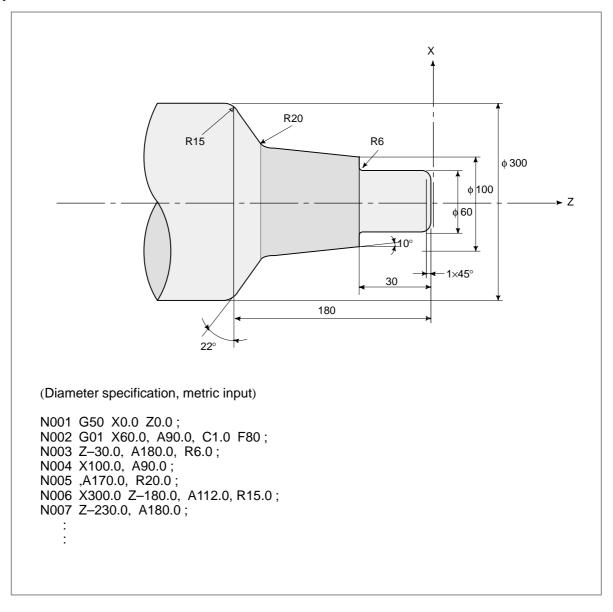
#### NOTE

- 1 The following G codes are not applicable to the same block as commanded by direct input of drawing dimensions or between blocks of direct input of drawing dimensions which define sequential figures.
  - 1) G codes (other than G04) in group 00.
  - 2) G02, G03, G90, G92, and G94 in group 01.
- 2 Corner rounding cannot be inserted into a threading block.
- 3 Chamfering and corner R using the direct input of drawing dimensions cannot be used simultaneously with the chamfering and corner R described in Section 13.5. (The option for chamfering and corner R and that for the direct input of drawing dimensions cannot be selected simultaneously.)
- 4 When the end point of the previous block is determined in the next block according to sequential commands of direct input of drawing dimensions, the single block stop is not done, but the feed hold stop is done at the end point of the previous block.
- 5 The angle allowance in calculating the point of intersection in the program below is ±1°.
  (Because the travel distance to be obtained in this calculation is too large.)
  - X\_, A\_; (If a value within 0°±1° or 180°±1° is specified for the angle instruction, the P/S alarm No.057 occurs.)
  - 2) Z\_ , A\_ ; (If a value within 90°±1° or 270°±1° is specified for the angle instruction, the P/S alarm No. 057 occurs.)
- 6 An alarm occurs if the angle made by the 2 lines is within  $\pm 1^{\circ}$  when calculating the point of intersection.
- 7 Chamfering or corner % is ignored if the angle made by the 2 lines is within  $\pm 1^{\circ}$ .
- 8 Both a dimensional command (absolute programming) and angle instruction must be specified in the block following a block in which only the angle instruction is specified. (Example)

N3 X\_ Z\_, A\_ ;

(In addition to the dimentional command, angle instruction must be specified in block No. 3.)

## Examples



# 13.8 RIGID TAPPING

Front face tapping cycles (G84) and side face tapping cycles (G88) can be performed either in conventional mode or rigid mode.

In conventional mode, the spindle is rotated or stopped, in synchronization with the motion along the tapping axis according to miscellaneous functions M03 (spindle CW rotation), M04 (spindle CCW rotation), and M05 (spindle stop).

In rigid mode, the spindle motor is controlled in the same way as a control motor, by the application of compensation to both motion along the tapping axis and that of the spindle.

For rigid tapping, each turn of the spindle corresponds to a certain amount of feed (screw lead) along the spindle axis. This also applies to acceleration/deceleration. This means that rigid tapping does not demand the use of float tappers as in the case of conventional tapping, thus enabling high–speed, high–precision tapping.

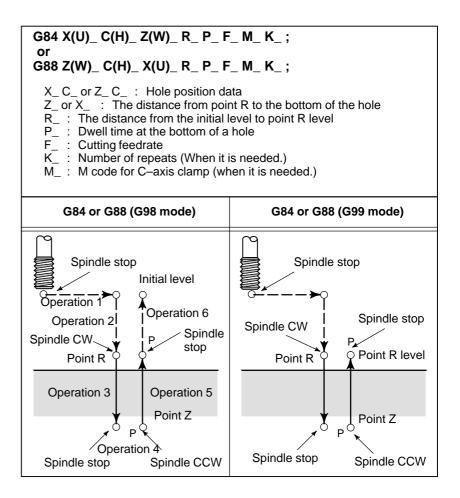
When the system is equipped with the optional multispindle control function, the second spindle can be used for rigid tapping.

# 13.8.1

Front Face Rigid Tapping Cycle (G84) / Side Face Rigid Tapping Cycle (G88)

Format

Controlling the spindle motor in the same way as a servo motor in rigid mode enables high–speed tapping.



#### **Explanations**

Once positioning for the X-axis (G84) or Z-axis (G88) has been completed, the spindle is moved, by rapid traverse, to point R. Tapping is performed from point R to point Z, after which the spindle stops and observes a dwell time. Then, the spindle starts reverse rotation, retracts to point R, stops rotating, then moves to the initial level by rapid traverse. During tapping, the feedrate override and spindle override are assumed to be 100%. For retraction (operation 5), however, a fixed override of up to 200% can be applied by setting parameter No. 5211 (RGOVR) and bit 4 (DOV) of parameter No. 5200.

Rigid mode can be specified by applying any of the following methods:

- Specifying M29S\*\*\*\*\* before a tapping block
- Specifying M29S\*\*\*\*\* within a tapping block
- Handling G84 or G88 as a G code for rigid tapping (Set bit 0 (G84) of parameter No. 5200 to 1.)

# Rigid mode

| 13. FUNCTIONS TO SIMPLIFY<br>PROGRAMMING  | PROGRAMMING B-63004EN/   |  |
|---|--|--|
| • Screw lead  | In feed per minute mode, the feedrate divided by th<br>to the screw lead. In feed per rotation mode, the<br>screw lead.  |  |
| Limitations   |  |  |
| • S commands  | When a value exceeding the maximum rotation spused is specified, P/S alarm No. 200 is issued.<br>when a command is specified such that more<br>generated during 8 ms (detection unit), P/S alarm<br>a serial spindle, when a command is specified suc<br>pulses are generated during 8 ms (detection unit)<br>issued.<br><example></example> | For an analog spindle,<br>than 4095 pulses are<br>No. 202 is issued. For<br>h that more than 32767 |
|   | For a built–in motor equipped with a detector<br>4095 pulses per rotation, the maximum spin<br>tapping is as follows:<br>For an analog spindle<br>(4095×1000÷8×60)÷4095 = 7500 (rpm)   | e e  |
|   | For a serial spindle<br>(32767×1000÷8×60)÷4095 = 60012 (rpm)   | [Note: Ideal value]  |
| • F commands  | Specifying a value larger than the upper limit for P/S alarm No. 201 to be issued.   | cutting feed will cause  |
| • M29   | Specifying an S command or axis movement betw<br>cause P/S alarm No. 203 to be issued. Specifying<br>cycle will cause P/S alarm No. 204 to be issued.  |  |
| <ul> <li>Rigid tapping command<br/>M code</li> </ul>  | The M code used to specify rigid tapping mode is a No. 5210. To set a value of more than 255, howe 5212.   | • •  |
| <ul> <li>Maximum position<br/>deviation during<br/>movement along the<br/>tapping axis</li> </ul> | The maximum position deviation during moven<br>axis in rigid tapping mode is usually set in para<br>parameter No. 5314, however, when setting a value<br>for example, according to the resolution of the de  | ameter No. 5310. Use<br>ue of more than 32767,   |
| • R   | The value of R must be specified in a block which<br>the value is specified in a block which does not per-<br>stored as modal data.  |  |
| Cancellation  | G00 to G03 (G codes in group 01) must not b containing G84 or G88. If specified, G84 or G88 in   | -  |
| <ul> <li>Tool position offset</li> </ul>  | Any tool position offset is ignored in canned cyc  | le mode.   |

• Units for F

|     | Metric input | Inch input     | Remark                |
|-----|--------------|----------------|-----------------------|
| G98 | 1 mm/min     | 0.01inch/min   | Decimal point allowed |
| G99 | 0.01mm/rev   | 0.0001inch/rev | Decimal point allowed |

# Examples

| Tapping axis feedrate: 1000 mm/min<br>Spindle speed: 1000 rpm<br>Screw lead: 1.0 mm |                                   |  |  |
|---|-----------------------------------|--|--|
| <programming feed="" for="" minu<="" per="" td=""><td>ite&gt;</td></programming>    | ite>                              |  |  |
| G98 ;   | Command for feed per minute       |  |  |
| G00 X100.0 ;  | Positioning                       |  |  |
| M29 S1000 ;   | Command for specifying rigid mode |  |  |
| G84 Z-100.0 R-20.0 F1000  | ; Rigid tapping                   |  |  |
| <programming feed="" for="" per="" rotat<="" td=""><td>ion&gt;</td></programming>   | ion>                              |  |  |
| G99 ;   | Command for feed per rotation     |  |  |
| G00 X100.0 ;  | Positioning                       |  |  |
| M29 S1000 ;   | Command for specifying rigid mode |  |  |
| G84 Z-100.0 R-20.0 F1.0;  | Rigid tapping                     |  |  |

# COMPENSATION FUNCTION

This chapter describes the following compensation functions:

- 14.1 TOOL OFFSET
- 14.2 OVERVIEW OF TOOL NOSE RADIUS COMPENSATION
- 14.3 DETAILS OF TOOL NOSE RADIUS COMPENSATION
- 14.4 CORNER CIRCULAR INTERPOLATION FUNCTION (G39)
- 14.5 TOOL COMPENSATION VALUES, NUMBER OF COMPENSATION VALUES, AND ENTERING VALUES FROM THE PROGRAM (G10)
- 14.6 AUTOMATIC TOOL OFFSET (G36, G37)
- 14.7 COORDINATE ROTATION (G68.1, G69.1)

# 14.1 TOOL OFFSET

Tool offset is used to compensate for the difference when the tool actually used differs from the imagined tool used in programming (usually, standard tool).

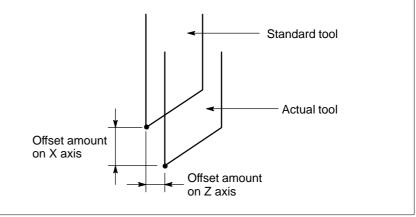


Fig. 14.1 Tool offset

In this unit, there is no G code to specify tool offset. The tool offset is specified by T code.

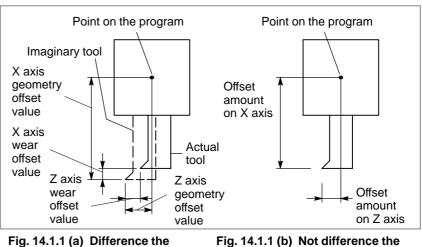
# 14.1.1 Tool Geometry Offset and Tool Wear Offset

Tool geometry offset and tool wear offset are possible to divide the tool offset to the tool geometry offset for compensating the tool shape or tool mounting position and the tool wear offset for compensating the tool nose wear.

Total value of tool geometry offset value and tool wear offset value is set as the tool wear offset value without option.

#### NOTE

Tool geometry offset and tool wear offset are optioned.



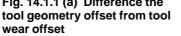


Fig. 14.1.1 (b) Not difference the tool geometry offset from tool wear offset

# 14.1.2

# T Code for Tool Offset

There are two methods for specifying a T code as shown in Table 14.1.2 (a) and Table 14.1.2 (b).

Table 14.1.2 (a)

#### Format

• Lower digit of T code specifies geometry and wear offset number

| Kind of<br>T code  | Meaning of T code  | Parameter setting<br>offse   |   |  |  |
|--------------------|--|--|---|--|--|
| 2-digit<br>command | T<br>Tool wear and tool<br>geometry offset<br>number<br>Tool selection     | When LD1, bit 0 of<br>parameter<br>No.5002, is set to<br>1, a tool wear off-<br>set number is spe-<br>cified with the last<br>digit of a T code.         | When LGN, bit 1<br>of parameter<br>No.5002, is set to<br>0, the tool geome-<br>try offset number<br>and tool wear off-<br>set number speci-<br>fied for a certain |  |  |
| 4-digit<br>command | T O O<br>Tool wear and tool<br>geometry offset<br>number<br>Tool selection | When LD1, bit 0 of<br>parameter<br>No.5002, is set to<br>0, a tool wear off-<br>set number is spe-<br>cified with the last<br>two digits of a T<br>code. | tool are the same.  |  |  |

• Lower digit of T code specifies wear offset number and higher digit number specifies tool selection number and geometry offset number

#### Table 14.1.2 (b)

| Kind of<br>T code  | Meaning of T code   | Parameter setting<br>offse   | for specifying of to.   |
|--------------------|---|--|---|
| 2–digit<br>command | T O<br>Tool wear offset<br>number<br>Tool selection and tool<br>geometry offset num-<br>ber | When LD1, bit 0 of<br>parameter<br>No.5002, is set to<br>1, a tool wear off-<br>set number is spe-<br>cified with the last<br>digit of a T code.         | When LGN, bit 1<br>of parameter<br>No.5002, is set to<br>1, the tool geome-<br>try offset number<br>and tool wear off-<br>set number speci-<br>fied for a certain |
| 4–digit<br>command | T O O<br>Tool wear offset<br>number<br>Tool selection and<br>tool geometry offset<br>number | When LD1, bit 0 of<br>parameter<br>No.5002, is set to<br>0, a tool wear off-<br>set number is spe-<br>cified with the last<br>two digits of a T<br>code. | tool are the same.  |

#### 14.1.3 Tool selection is made by specifying the T code corresponding to the tool number. Refer to the machine tool builder's manual for the relationship **Tool Selection** between the tool selection number and the tool. 14.1.4 Tool offset number has two meanings. It is specifies the offset distance corresponding to the number that is **Offset Number** selected to begin the offset function. A tool offset number of 0 or 00 indicates that the offset amount is 0 and the offset is cancelled.

## 14.1.5 Offset

#### **Explanations**

Tool wear offset

There are two types of offset. One is tool wear offset and the other is tool geometry offset.

The tool path is offset by the X, Y, and Z wear offset values for the programmed path. The offset distance corresponding to the number specified by the T code is added to or subtracted from the and position of each programmed block.

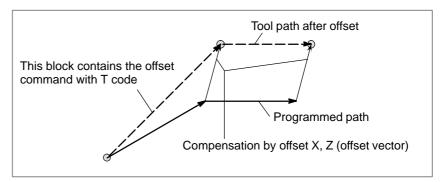


Fig. 14.1.5 (a) Movement of offset (1)

In Fig. 14.1.5 (a), the vector with offset X, Y, and Z is called the offset vector. Compensation is the same as the offset vector.

Offset is cancelled when T code offset number 0 or 00 is selected. At the end of the cancelled block, the offset vector becomes 0.

N1 X50.0 Z100.0 T0202 ; Creates the offset vector corresponding to offset number 02

#### N2 X200.0;

N3 X100.0 Z250.0 T0200 ; Specifying offset number 00 deletes the offset vector.

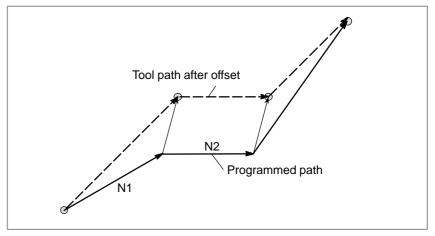


Fig. 14.1.5 (b) Movement of offset (2)

When the power is first turned on , and the reset key on the MDI units is pushed or the reset signal is input to the CNC from the machine tool, the offset is cancelled.

Parameter LVK (No. 5003#6) can be set so that offset will not be cancelled by pressing the reset key or by reset input.

Offset vector

Offset cancel

• Only T code

When only a T code is specified in a block, the tool is moved by the wear offset value without a move command. The movement is performed at rapid traverse rate in the G00 mode . It is performed at feedrate in other modes.

When a T code with offset number 0 or 00is specified by itself, movement is performed to cancel the offset.

#### WARNING

When G50 X\_Z\_T\_; is specified Tool is not moved.

The coordinate system in which the coordinate value of the tool position is (X,Z) is set. The tool position is obtained by subtracting the wear offset value corresponding to the offset number specified in the T code.

• Tool geometry offset

With the tool geometry offset, the work coordinate system is shifted by the X, Y, and Z geometry offset amounts. Namely, the offset amount corresponding to the number designated with the code is added to or subtracted from the current position.

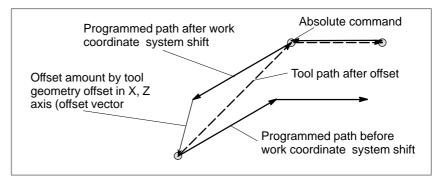


Fig. 14.1.5 (c) Movement of tool geometry offset

#### NOTE

As well as wear offset, the tool can be compensated by parameter setting LGT(No.5002#4) to add or subtract the programmed end point of each block.

#### Offset cancel

Specifying offset number 0, 00, or 0000 cancels offset.

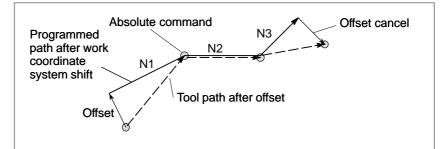
#### NOTE

When LGC, bit 5 of parameter No.5002, is set to 0, specifying offset number 0 or 00 does not cancel offset.

#### **Examples**

 When a tool geometry offset number and tool wear offset number are specified with the last two digits of a T code (when LGN, bit 1 of parameter No. 5002, is set 0), N1 X50.0 Z100.0 T0202 ; Specifies offset number 02 N2 Z200.0 ;

N3 X100.0 Z250.0 T0200 ; Cancels offset



#### NOTE

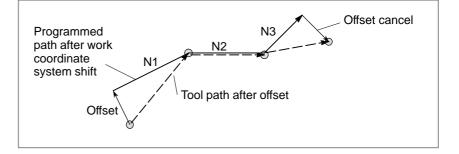
When LGC, bit 5 of parameter No.5002, is set to 0, specifying offset number 0 does not cancel tool geometry offset.

2. Assume that geometry offset is not cancelled with offset No. 0 (Set the parameter (No. 5002#1).)

**N1 X50.0 Z100.0 T0202 ;** Tool selection number (specified tool geometry offset number 02)

N2 Z200.0;

N3 X100.0 Z250.0 T0000 ; Cancels offset



| 14.1.6<br>G53, G28, G30, and<br>G30.1 Commands<br>When Tool Position<br>Offset is Applied | This section describes the following operations when tool position offset<br>is applied: G53, G28, G30, and G30.1 commands, manual reference<br>position return, and the canceling of tool position offset with a T00<br>command. |
|---|---|
| Explanations  |   |

 Reference position return (G28) and G53 command when tool position offset is applied Executing reference position return (G28) or a G53 command when tool position offset is applied does not cancel the tool position offset vector. The absolute position display is as follows, however, according to the setting of bit 4 (LGT) of parameter No. 5002.

| LGT = 0 ( | Tool geometr | y compensation is | based on shift | of the coordinate system. | ) |
|-----------|--------------|-------------------|----------------|---------------------------|---|
|-----------|--------------|-------------------|----------------|---------------------------|---|

|   |  | Tool position offset<br>(without option)   | Tool geometry compensation   | Tool wear<br>compensation  |
|---|--|--|--|--|
| Absolute<br>position<br>coordinate<br>display | Block for reference<br>position return or<br>G53 command | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The shift is reflected.<br>Coordinates shifted ac-<br>cording to the tool geome-<br>try compensation are dis-<br>played. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. |
|   | Next block   | The vector is reflected.   | Coordinates shifted ac-<br>cording to the tool geome-<br>try compensation are dis-<br>played.                            | The vector is reflected.   |

#### LGT = 1 (Tool geometry compensation is based on tool movement.)

|   |  | Tool position offset (without option)  | Tool geometry compensation   | Tool wear compensation   |
|---|--|--|--|--|
| Absolute<br>position<br>coordinate<br>display | Block for reference<br>position return or<br>G53 command | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. |
|   | Next block   | The vector is reflected.   | The vector is reflected.   | The vector is reflected.   |

#### NOTE

Bit 6 (DAL) of parameter No. 3104 is set to 0 (the actual positions to which the tool position offset is applied are displayed in the absolute position display).

#### Manual reference position return when tool position offset is applied

Executing manual reference position return when tool position offset is applied does not cancel the tool position offset vector. The absolute position display is as follows, however, according to the setting of bit 4 (LGT) of parameter No. 5002.

| LGT = 0 (Tool geometry compensation is bas | sed on shift of the coordinate system.) |
|--|---|
|--|---|

|   |  | Tool position offset<br>(without option)   | Tool geometry compensation   | Tool wear<br>compensation  |
|---|--|--|--|--|
| Absolute<br>position<br>coordinate<br>display | Upon manual refer-<br>ence position return | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The shift is reflected.<br>Coordinates shifted ac-<br>cording to tool geometry<br>compensation are dis-<br>played. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. |
|   | Next block                                 | The vector is reflected.   | Coordinates shifted ac-<br>cording to tool geometry<br>compensation are dis-<br>played.                            | The vector is reflected.   |

#### LGT = 1 (Tool geometry compensation is based on tool movement.)

|   |  | Tool position offset<br>(without option)   | Tool geometry compensation   | Tool wear<br>compensation  |
|---|--|--|--|--|
| Absolute<br>position<br>coordinate<br>display | Upon manual refer-<br>ence position return | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. | The vector is not reflected.<br>The coordinates are dis-<br>played as if the offset had<br>been temporarily can-<br>celed. |
|   | Next block                                 | The vector is reflected.   | The vector is reflected.   | The vector is reflected.   |

#### NOTE

Bit 6 (DAL) of parameter No. 3104 is set to 0 (the actual positions to which the tool position offset is applied are displayed in the absolute position display).

#### 14. COMPENSATION FUNCTION

#### • Canceling tool position offset with T00 Whether specifying T00 alone, while tool position offset is applied, cancels the offset depends on the settings of the following parameters:

When the tool geometry/wear compensation option is selected

| LGN (No.5002#1)   | LGT (No.5002#4)   | LGC (No.5002#5)   |                          |
|---|---|---|--------------------------|
| <ul><li>The geometry offset number is:</li><li>0: Same as the wear offset number</li><li>1: Same as the tool selection number</li></ul> | <ul><li>Geometry compensation is applied:</li><li>0: Based on shift of the coordinate system</li><li>1: Based on movement of the tool</li></ul> | The geometry offset is:<br>0: Not canceled with T00<br>1: Canceled with T00   | Result                   |
| LGT=0   | LGT=0   | LGC=0<br>LGC=1  | Not canceled<br>Canceled |
|   |   | LWM (No.5002#6)   |                          |
|   |   | <ul><li>Tool position offset is applied:</li><li>0: By means of T code</li><li>1: By means of movement along axis</li></ul> |                          |
|   | LGT=1   | LWM=0<br>LWM=1  | Canceled<br>Not canceled |

#### LGN = 0

#### NOTE

1 When LGT=0, LWM is unrelated.

2 When LGT=1, LGC is unrelated, even when LGN = 0.

| LGN = 1   |   |   |                          |  |
|---|---|---|--------------------------|--|
| LGN (No.5002#1)   | LGT (No.5002#4)   | LGC (No.5002#5)   |                          |  |
| <ul><li>The geometry offset number is:</li><li>0: Same as the wear offset<br/>number</li><li>1: Same as the tool selection<br/>number</li></ul> | <ul><li>Geometry compensation is applied:</li><li>0: Based on shift of the coordinate system</li><li>1: Based on movement of the tool</li></ul> | The geometry offset is:<br>0: Not canceled with T00<br>1: Canceled with T00   | Result                   |  |
| LGT=0   | LGT=0   | LGC is unrelated.   | Canceled                 |  |
|   |   | LWM (No.5002#6)<br>Tool position offset is applied:<br>0: By means of T code<br>1: By means of movement<br>along axis |                          |  |
|   | LGT=1   | LWM=0<br>LWM=1  | Canceled<br>Not canceled |  |

#### NOTE

1 When LGT = 0, LWM is unrelated.

2 When LGT = 1, LGC is unrelated.

| LGN (No.5002#1)   | LGT (No.5002#4)  | LGC (No.5002#5)   |                          |
|---|--|---|--------------------------|
| <ul><li>The geometry offset number is:</li><li>0: Same as the wear offset<br/>number</li><li>1: Same as the tool selection<br/>number</li></ul> | Geometry compensation is<br>applied:<br>0: Based on shift of the<br>coordinate system<br>1: Based on movement of the<br>tool | The geometry offset is:<br>0: Not canceled with T00<br>1: Canceled with T00   | Result                   |
| LGN is unrelated.   | LGT is unrelated.  | LGC is unrelated.   |                          |
| The tool position offset number   | Tool position offset is always   | LWM (No.5002#6)   |                          |
| always uses the low–order digits.   | applied based on the movement of the tool.   | <ul><li>Tool position offset is applied:</li><li>0: By means of T code</li><li>1: By means of movement<br/>along axis</li></ul> |                          |
|   |  | LWM=0<br>LWM=1  | Canceled<br>Not canceled |

When the tool geometry/wear compensation option is not selected

# 14.2 OVERVIEW OF TOOL NOSE RADIUS COMPENSATION

It is difficult to produce the compensation necessary to form accurate parts when using only the tool offset function due to tool nose roundness in taper cutting or circular cutting. The tool nose radius compensation function compensates automatically for the above errors.

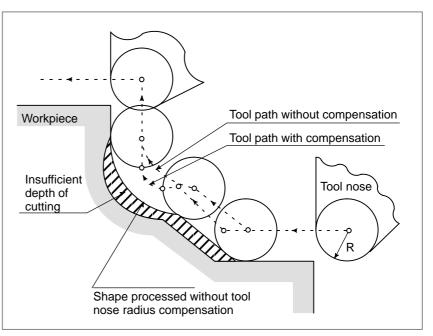


Fig 14.2 Tool path of tool nose radius compensation

# 14.2.1 Imaginary Tool Nose

The tool nose at position A in following figure does not actually exist. The imaginary tool nose is required because it is usually more difficult to set the actual tool nose radius center to the start position than the imaginary tool nose (Note).

Also when imaginary tool nose is used, the tool nose radius need not be considered in programming.

The position relationship when the tool is set to the start position is shown in the following figure.

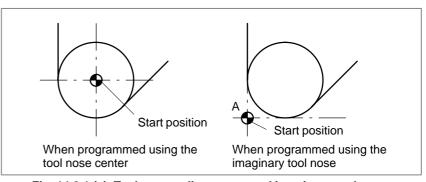
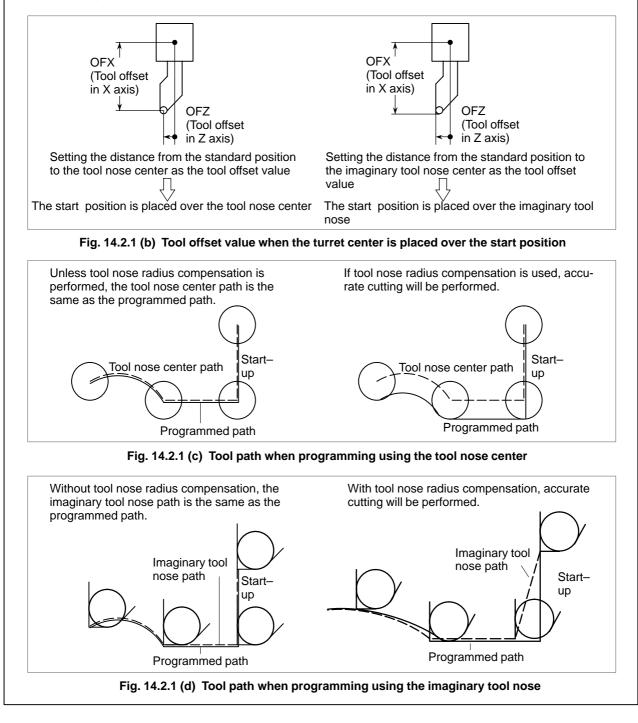


Fig. 14.2.1 (a) Tool nose radius center and imaginary tool nose

#### CAUTION

In a machine with reference positions, a standard position like the turret center can be placed over the start position. The distance from this standard position to the nose radius center or the imaginary tool nose is set as the tool offset value.

Setting the distance from the standard position to the tool nose radius center as the offset value is the same as placing the tool nose radius center over the start position, while setting the distance from the standard position to the imaginary tool nose is the same as placing the imaginary tool nose over the standard position. To set the offset value, it is usually easier to measure the distance from the standard position to the imaginary tool nose than from the standard position to the imaginary tool nose than from the standard position to the imaginary tool nose than from the standard position to the tool nose radius center.



# 14.2.2 Direction of Imaginary Tool Nose

The direction of the imaginary tool nose viewed from the tool nose center is determined by the direction of the tool during cutting, so it must be set in advance as well as offset values.

The direction of the imaginary tool nose can be selected from the eight specifications shown in the Fig. 14.2.2 below together with their corresponding codes.

This Fig 14.2.2 illustrates the relation between the tool and the start position. The following apply when the tool geometry offset and tool wear offset option are selected.

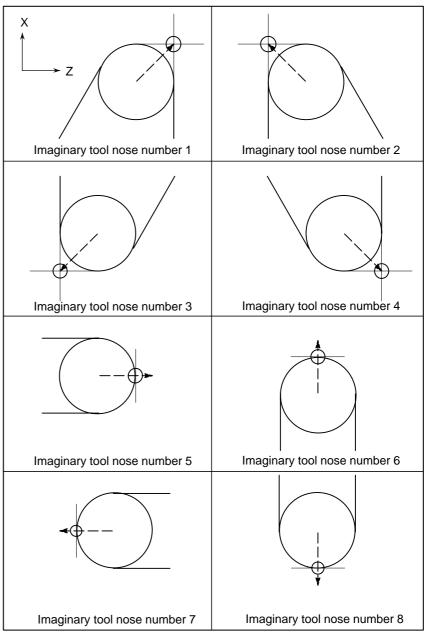
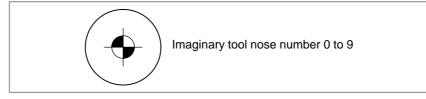


Fig. 14.2.2 Direction of imaginary tool nose

Imaginary tool nose numbers 0 and 9 are used when the tool nose center coincides with the start position. Set imaginary tool nose number to address OFT for each offset number.

Bit 7 (WNP) of parameter No. 5002 is used to determine whether the tool geometry offset number or the tool wear offset number specifies the direction of the virtual tool nose for tool nose radius compensation.



#### Limitations

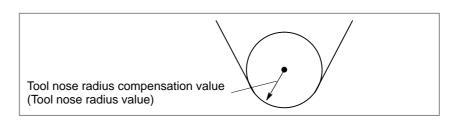
• Plane selection

Virtual tool nose directions 1 to 8 can be used only in the G18 (Z–X) plane. For virtual tool nose 0 or 9, compensation is applied in both the G17 and G19 planes.

# 14.2.3 Offset Number and Offset Value

#### **Explanations**

• Offset number and offset value



This value is set from the MDI according to the offset number. When the options of tool geometry compensation and tool wear compensation are selected, offset values become as follows :

#### Table 14.2.3 (a) Offset number and offset value

| Offset<br>number | OFX<br>(Offset<br>value on X<br>axis) | OFZ<br>(Offset<br>value on Z<br>axis) | OFR<br>(Tool nose<br>radius<br>com-<br>pensation<br>value) | OFT<br>(Direction<br>of imagi-<br>nary tool<br>nose) | OFY<br>(Offset<br>value on Y<br>axis) |
|------------------|---------------------------------------|---------------------------------------|--|--|---------------------------------------|
| 01               | 0.040                                 | 0.020                                 | 0.20   | 1  | 0.030                                 |
| 02               | 0.060                                 | 0.030                                 | 0.25   |  | 0.040                                 |
| :                | :                                     | :                                     | :  | :  | :                                     |
| 98               | 0.050                                 | 0.015                                 | 0.12   | 6  | 0.025                                 |
| 99               | 0.030                                 | 0.025                                 | 0.24   | 3  | 0.035                                 |

When the options of tool geometry compensation and tool wear compensation are selected, the offset values become as follows :

| Geome-<br>try<br>offset<br>number | OFGX<br>(X–axis<br>geometry<br>offset<br>amount) | OFGZ<br>(Z–axis<br>geometry<br>offset<br>amount) | OFGR<br>(Tool nose<br>radius ge-<br>ometry off-<br>set value) | OFT<br>(Imaginary<br>tool nose<br>direction) | OFGY<br>(Y–axis<br>geometry<br>offset<br>amount) |
|-----------------------------------|--|--|---|--|--|
| G01                               | 10.040   | 50.020   | 0   | 1  | 70.020   |
| G02                               | 20.060   | 30.030   | 0   | 2  | 90.030   |
| G03                               | 0  | 0  | 0.20  | 6  | 0  |
| G04                               | :  | :  | :   | :  | :  |
| G05                               | :  | :  | :   | :  | :  |
| :                                 | :  | :  | :   | :  | :  |

Table 14.2.3 (b) Tool geometry offset

| Table 14.2.3 (c) Tool wear | offset |  |
|----------------------------|--------|--|
|----------------------------|--------|--|

| Wear<br>offset<br>number | OFGX<br>(X–axis<br>wear offset<br>amount) | OFGZ<br>(Z–axis<br>wear offset<br>amount) | OFGR<br>(Tool nose<br>radius<br>wear offset<br>value) | OFT<br>(Imaginary<br>tool nose<br>direction) | OFGY<br>(Y–axis<br>wear offset<br>amount) |
|--------------------------|---|---|---|--|---|
| W01                      | 0.040                                     | 0.020                                     | 0   | 1  | 0.010                                     |
| W02                      | 0.060                                     | 0.030                                     | 0   | 2  | 0.020                                     |
| W03                      | 0   | 0   | 0.20  | 6  | 0   |
| W04                      | :   | :   | :   | :  | :   |
| W05                      | :   | :   | :   | :  | :   |
| :                        | :   | :   | :   | :  | :   |

#### Tool nose radius compensation

In this case, the tool nose radius compensation value is the sum of the geometry or the wear offset value.

#### OFR=OFGR+OFWR

- Imaginary tool nose direction
- Command of offset value

The imaginary tool nose direction may be set for either the geometry offset or the wear offset. However, the last designated direction later is effective.

A offset number is specified with the same T code as that used for tool offset. For details, see Subsec. II–14.1.2.

#### NOTE

Example)

When the geometry offset number is made common to the tool selection by the parameter LGT(No.5002#1)setting and a T code for which the geometry offset and wear offset number differ from each other is designated, the imaginary tool nose direction specified by the geometry offset number is valid.

T0102 OFR=RFGR<sub>01</sub>+OFWR<sub>02</sub> OFT=OFT<sub>01</sub>

PROGRAMMING

#### 14. COMPENSATION FUNCTION

# • Setting range of offset value

The range of the offset value is an follows :

| Increment system | metric system     | Inch system         |
|------------------|-------------------|---------------------|
| IS–B             | 0 to ±999.999 mm  | 0 to ±99.9999 inch  |
| IS–C             | 0 to ±999.9999 mm | 0 to ±99.99999 inch |

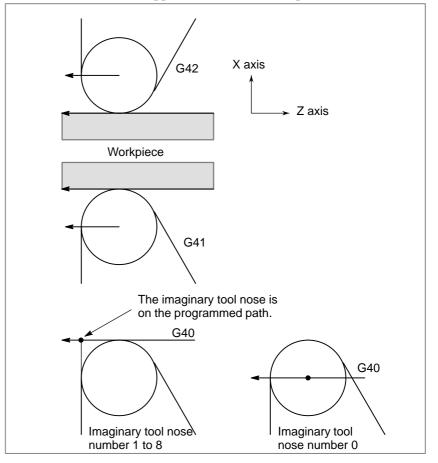
The offset value corresponding to the offset number 0 is always 0. No offset value can be set to offset number 0.

In tool nose radius compensation, the position of the workpiece with respect to the tool must be specified.

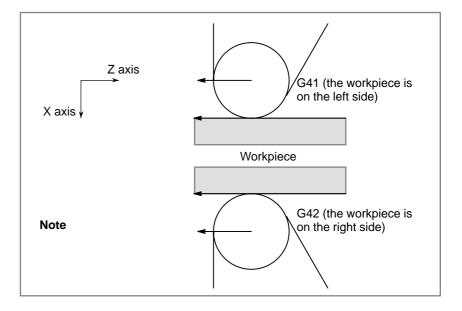
# 14.2.4 Work Position and Move Command

| G code | Workpiece position | Tool path                                    |
|--------|--------------------|--|
| G40    | (Cancel)           | Moving along the programmed path             |
| G41    | Right side         | Moving on the left side the programmed path  |
| G42    | Left side          | Moving on the right side the programmed path |

The tool is offset to the opposite side of the workpiece.



The workpiece position can be changed by setting the coordinate system as shown below.



#### NOTE

If the tool nose radius compensation value is negative, the workpiece position is changed.

G40, G41, and, G42 are modal.

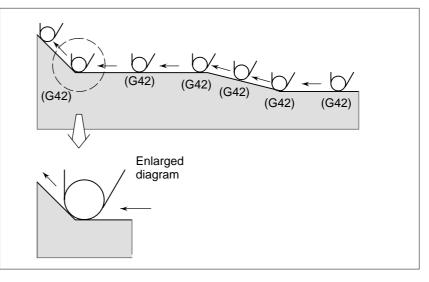
Don't specify G41 while in the G41 mode. If you do, compensation will not work properly.

Don't specify G42 while in the G42 mode for the same reason.

G41 or G42 mode blocks in which G41 or G42 are not specified are expressed by (G41) or (G42) respectively.

• Tool movement when the workpiece position does not change

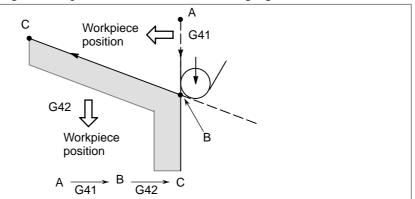
When the tool is moving, the tool nose maintains contact with the workpiece.



 Tool movement when the workpiece position changes

Start–up

The workpiece position against the toll changes at the corner of the programmed path as shown in the following figure.

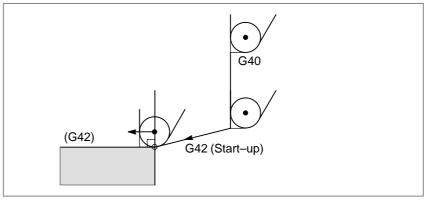


Although the workpiece does not exist on the right side of the programmed path in the above case. the existence of the workpiece is assumed in the movement from A to B. The workpiece position must not be changed in the block next to the start–up block. In the above example, if the block specifying motion from A to B were the start–up block, the tool path would not be the same as the one shown.

The block in which the mode changes to G41 or G42 from G40 is called the start–up block.

**G41**\_; (Start–up block)

Transient tool movements for offset are performed in the start–up block. In the block after the start–up block, the tool nose center is positioned Vertically to the programmed path of that block at the start position.

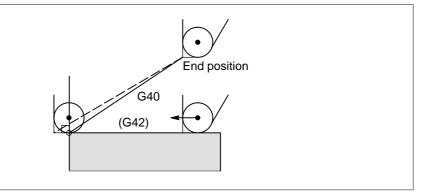


#### Offset cancel

The block in which the mode changes to G40 from G41 or G42 is called the offset cancel block.

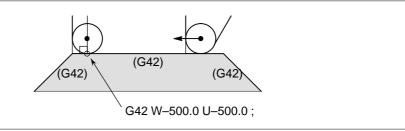
G41 \_; G40 \_; (Offset cancel block)

The tool nose center moves to a position vertical to the programmed path in the block before the cancel block. The tool is positioned at the end position in the offset cancel block (G40) as shown below.



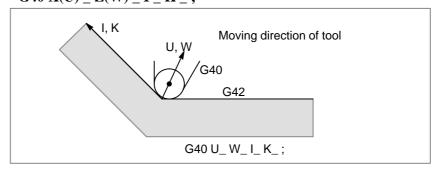
• Specification of G41/G42 in G41/G42 mode

When is specified again in G41/G42 mode, the tool nose center is positioned vertical to the programmed path of the preceding block at the end position of the preceding block.



In the block that first specifies G41/G42, the above positioning of the tool nose center is not performed.

When you wish to retract the tool in the direction specified by X(U) and Z(W) cancelling the tool nose radius compensation at the end of machining the first block in the figure below, specify the following :  $G40 X(U) _ Z(W) _ I _ K _;$ 



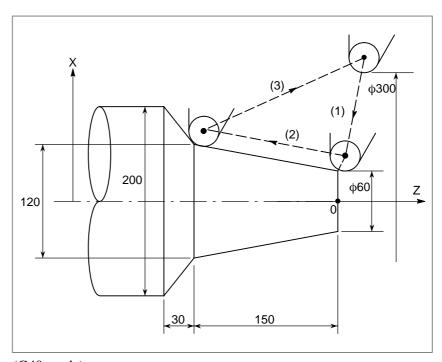
 Tool movement when the moving direction of the tool in a block which includes a G40 command is different from the direction of the workpiece

The workpiece position specified by addresses I and K is the same as that in the preceding block. If I and/or K is specified with G40 in the cancel mode, the I and/or K is ignored.

| G40 X_Z_I_K_;     | Tool nose radius compensation |
|-------------------|-------------------------------|
| G40 G02 X_Z_I_K_; | Circular interpolation        |

#### G40 G01 X\_Z\_;

**G40 G01 X\_Z\_I\_K\_;** Offset cancel mode (I and k are ineffective.) The numeral s followed I and K should always be specified as radius values.



(G40 mode) **1.G42 G00 X60.0 ; 2.G01 X120.0 W-150.0 F10 ; 3.G40 G00 X300.0 W150.0 I40.0 K-30.0 ;** 

Examples

# 14.2.5 Notes on Tool Nose Radius Compensation

### **Explanations**

 Tool movement when two or more blocks without a move command should not be programmed consecutively 

 1.M05;
 M code output

 2.S210;
 S code output

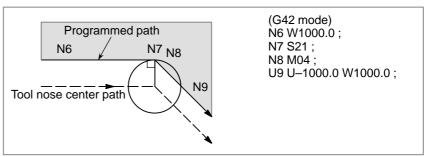
 3.G04 X1000;
 Dwell

 4.G01 U0;
 Feed distance of zero

 5.G98;
 G code only

 6.G10 P01 X10.0 Z20.0 R0.5 Q2;
 Offset change

If two or more of the above blocks are specified consecutively, the tool nose center comes to a position vertical to the programmed path of the preceding block at the end of the preceding block. However, if the no movement commands is **4** above, the above tool motion is attained only with one block.

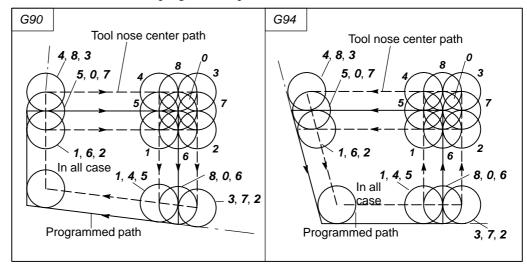


#### Tool nose radius compensation with G90 or G94

Tool nose radius compensation with G90 (outer diameter/internal diameter cutting cycle) or G94 (end face turning cycle) is as follows, :

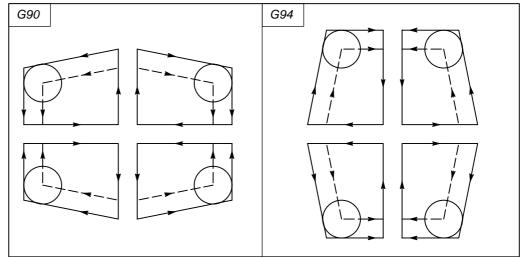
#### 1. Motion for imaginary tool nose numbers

For each path in the cycle, the tool nose center path is generally parallel to the programmed path.



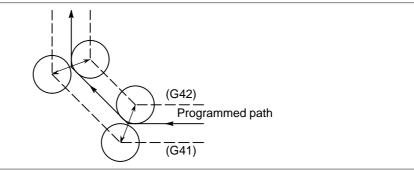
#### 2. Direction of the offset

The offset direction is indicated in the figure below regardless of the G41/G42 mode.

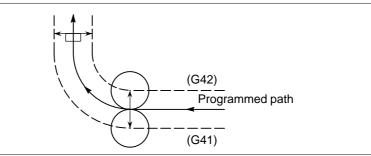


 Tool nose radius compensation with G71 to G76 or G78 When one of following cycles is specified, the cycle deviates by a tool nose radius compensation vector. During the cycle, no intersection calculation is performed.

- G71 (Stock removal in turning or traverse grinding cycle)
- G72 (Stock removal in facing or traverse direct constant-dimension grinding cycle)
- G73 (Pattern repeating or Oscillation grinding cycle)
- G74 (End face peck drilling)
- G75 (Outer diameter/internal diameter drilling)
- G76 (Multiple threading cycle)
- G78 (Threading cycle)
- Tool nose radius compensation when chamfering is performed
- Movement after after compensation is shown below.



- Tool nose radius compensation when a corner arc is inserted
- Movement after compensation is shown below.



• Tool nose radius compensation when the block is specified from the MDI In this case, tool nose radius compensation is not performed.

# 14.3 DETAILS OF TOOL NOSE RADIUS COMPENSATION

This section provides a detailed explanation of the movement of the tool for tool nose radius compensation outlined in Section 14.2. This section consists of the following subsections:

#### 14.3.1 General

- 14.3.2 Tool Movement in Start-up
- 14.3.3 Tool Movement in Offset Mode
- 14.3.4 Tool Movement in Offset Mode Cancel
- 14.3.5 Interference Check
- 14.3.6 Overcutting by Tool Nose Radius Compensation
- 14.3.7 Correction in Chamfering and Corner Arcs
- 14.3.8 Input Command from MDI
- 14.3.9 General Precautions for Offset Operations
- 14.3.10G53, G28, G30, and G30.1 Commands in Tool-tip Radius Compensation Mode

## 14.3.1 General

| to the offset<br>Its dimension<br>This offset we<br>by the contro-<br>path with exe<br>This vector<br>The vector a<br>Proper unde<br>Read the des<br>G40, G41 of<br>These codes | <ul> <li>The tool nose radius center offset vector is a two dimensional vector equal to the offset value specified in a T code, and the is calculated in the CNC. Its dimension changes block by block according to tool movement. This offset vector (simply called vector herein after) is internally crated by the control unit as required for proper offsetting and to calculate a tool path with exact offset (by tool nose radius) from the programmed path. This vector is deleted by resetting.</li> <li>The vector always accompanies the tool as the tool advances.</li> <li>Proper understanding of vector is essential to accurate programming. Read the description below on how vectors are created carefully.</li> <li>G40, G41 or G42 is used to delete or generate vectors. These codes are used together with G00, G01, G02, G03 or G33 to specify</li> </ul> |   |  |
|---|--|---|--|
| G code  | Function   | Workpiece position  |  |
| G40   | Tool nose radius compensation cancel   | Neither   |  |
| G41   | Left offset along tool path  | Right   |  |
| G42   | Right offset along tool path   | Left  |  |
|   | to the offset<br>Its dimension<br>This offset<br>by the contro-<br>path with ex-<br>This vector<br>The vector a<br>Proper unde<br>Read the de<br>G40, G41 o<br>These codes<br>a mode for the<br>G40<br>G40<br>G41  | to the offset value specified in a T code, and the isIts dimension changes block by block accordingThis offset vector (simply called vector herein affby the control unit as required for proper offsettingpath with exact offset (by tool nose radius) fromThis vector is deleted by resetting.The vector always accompanies the tool as the toProper understanding of vector is essential to accRead the description below on how vectors are crG40, G41 or G42 is used to delete or generate veThese codes are used together with G00, G01, G02a mode for tool motion (Offsetting).G40Tool nose radius compensation cancelG41Left offset along tool path |  |

G41 and G42 specify an off mode, while G40 specifies cancellation of the offset.

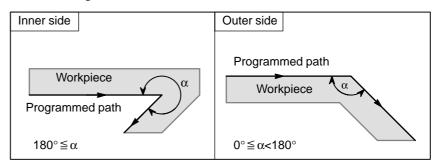
• **Cancel mode** The system enters the cancel mode immediately after the power is turned on, when the RESET button on the MDI is pushed or a program is forced to end by executing M02 or M30. (the system may not enter the cancel mode depending on the machine tool.) In the cancel mode, the vector is set to zero, and the path of the center of tool nose coincides with the programmed, path. A program must end in cancel mode. If it ends in the offset mode, the tool cannot be positioned at the end point, and the tool stops at a location the vector length away from the end point. • Start-up

When a block which satisfies all the following conditions is executed in cancel mode, the system enters the offset mode. Control during this operation is called start–up.

- G41 or G42 is contained in the block, or has been specified to set the system enters the offset mode. Control during this operation is called start–up.
- The offset number for tool nose radius compensation is not 00.
- X or Z moves is specified in the block and the move distance is not zero.

A circular command (G02 or G03) is not allowed in start–up. If specified, P/S alarm (PS34) will occur. Two blocks are read in during start– up. The first block is executed, and the second block is entered into the tool nose radius compensation buffer. In the single block mode, two blocks are read and the first block is executed, then the machine stops. In subsequent operations, two blocks are read in advance, so the CNC has the block currently being executed, and the next two blocks.

# • Inner side and outer side When an angle of intersection created by tool paths specified with move commands for two blocks is over 180°, it is referred to as "inner side." When the angle is between 0° and 180°, it is referred to as "outer side."



• Meaning of symbols

The following symbols are used in subsequent figures:

- -S indicates a position at which a single block is executed once.
- SS indicates a position at which a single block is executed twice.
- SSS indicates a position at which a single block is executed three times.
- -L indicates that the tool moves along a straight line.
- -C indicates that the tool moves along an arc.
- -r indicates the tool nose radius compensation value.
- An intersection is a position at which the programmed paths of two blocks intersect with each other after they are shifted by *r*.
- indicates  $\circ$  the center of the tool nose radius.

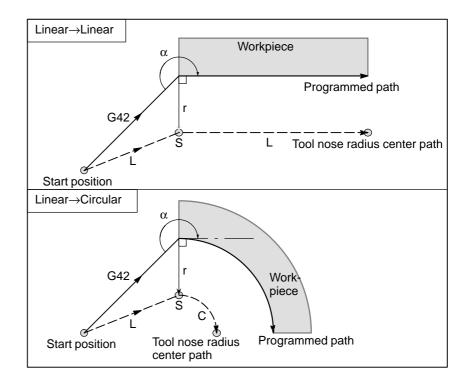
## 14.3.2 Tool Movement in

Start-up

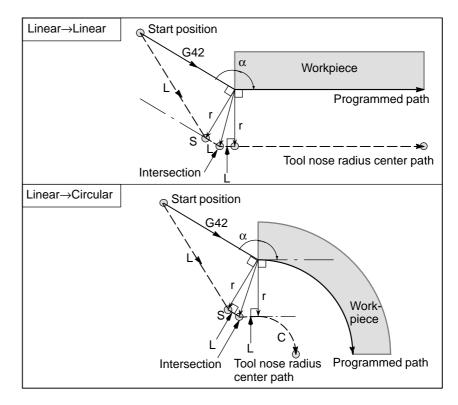
When the offset cancel mode is changed to offset mode, the tool moves as illustrated below (start–up):

# Explanations

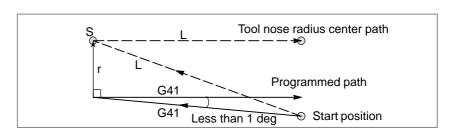
 Tool movement around an inner side of a corner (180°≦α)



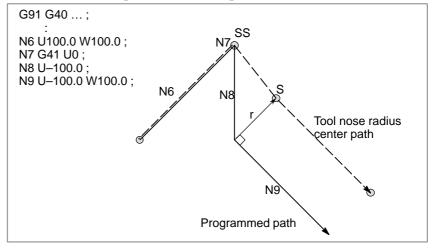
 Tool movement around the outside of a corner at an obtuse angle (90° ≤ α<180°)</li>



- Tool movement around the outside of an acute Linear→Linear Start position angle (α<90°) G42 Workpiece α Programmed path r Tool nose radius center path ---\* L L Linear→Circular Start position G G42 α r Work-Т C piece Tool nose radius center path Programmed path
- Tool movement around the outside linear→linear at an acute angle less than 1 degree (α<1°)</li>
- A block without tool movement specified at start–up



If the command is specified at start-up, the offset vector is not created.



#### NOTE

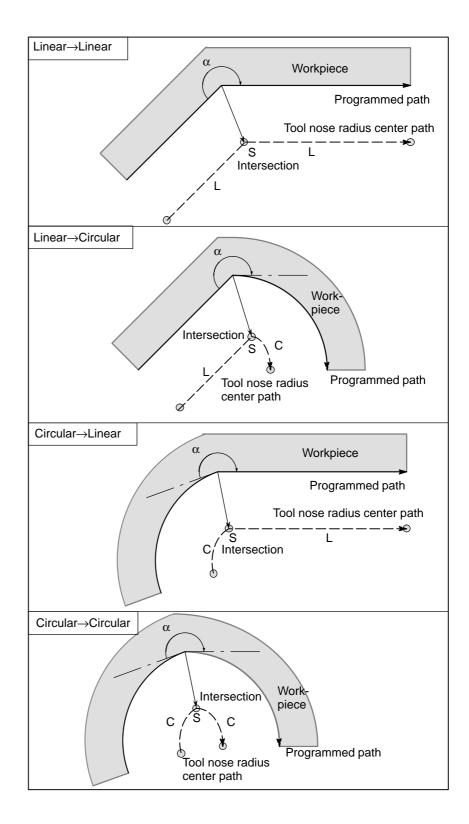
For the definition of blocks that do not move the tool, see Subsec. II–14.3.3.

In the offset mode, the tool moves as illustrated below:

# 14.3.3 Tool Movement in Offset Mode

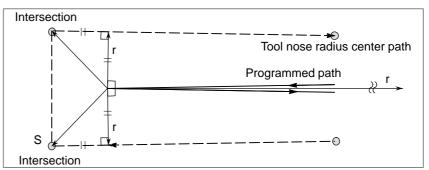
#### **Explanations**

 Tool movement around the inside of a corner (180° ≤ α)



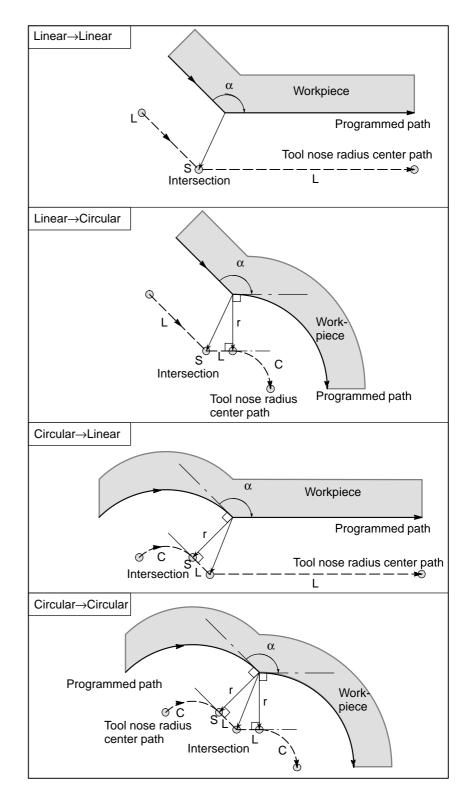
#### 14. COMPENSATION FUNCTION

 Tool movement around the inside (α<1°) with an abnormally long vector, linear → linear

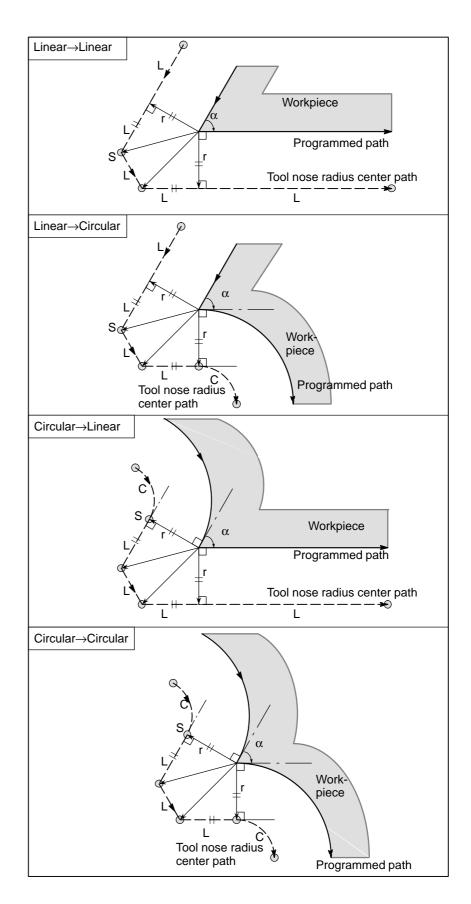


Also in case of arc to straight line, straight line to arc and arc to arc, the reader should infer in the same procedure.





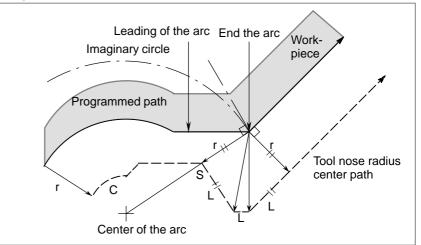
 Tool movement around the outside corner at an acute angle (α<90°)</li>



#### When it is exceptional

• End position for the arc is not on the arc

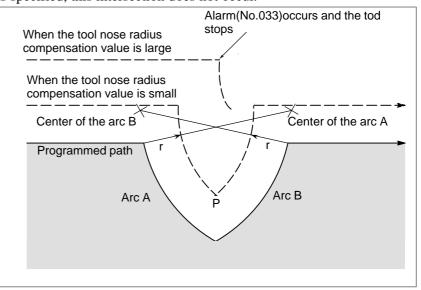
If the end of a line leading to an arc is programmed as the end of the arc by mistake as illustrated below, the system assumes that tool nose radius compensation has been executed with respect to an imaginary circle that has the same center as the arc and passes the specified end position. Based on this assumption, the system creates a vector and carries out compensation. The resulting tool nose radius center path is different from that created by applying tool nose radius compensation to the programmed path in which the line leading to the arc is considered straight.



The same description applies to tool movement between two circular paths.

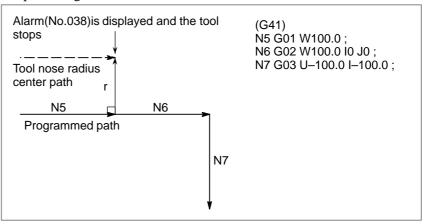
There is no inner intersection

If the tool nose radius compensation value is sufficiently small, the two circular Tool nose radius center paths made after compensation intersect at a position (P). Intersection P may not occur if an excessively large value is specified for tool nose radius compensation. When this is predicted, P/S alarm (No.33) occurs at the end of the previous block and the tool is stopped. In the example shown below, Tool nose radius center paths along arcs A and B intersect at P when a sufficiently small value is specified for tool nose radius compensation. If an excessively large value is specified, this intersection does not occur.



• The center of the arc is identical with the start position or the end position

If the center of the arc is identical with the start position or end point, P/S alarm (No. 038) is displayed, and the tool will stop at the end position of the preceding block.



# • Change in the offset direction in the offset mode

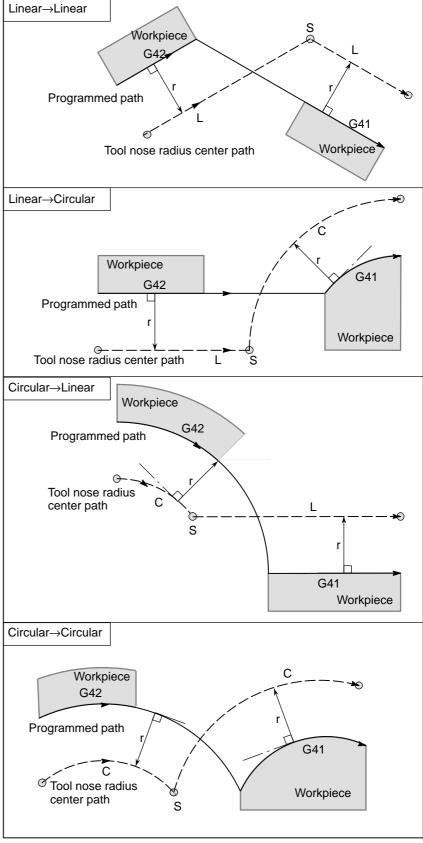
The offset direction is decided by G codes (G41 and G42) for tool nose radius and the sign of tool nose radius compensation value as follows.

| Sign of offset value<br>G code | +                 | _                 |
|--------------------------------|-------------------|-------------------|
| G41                            | Left side offset  | Right side offset |
| G42                            | Right side offset | Left side offset  |

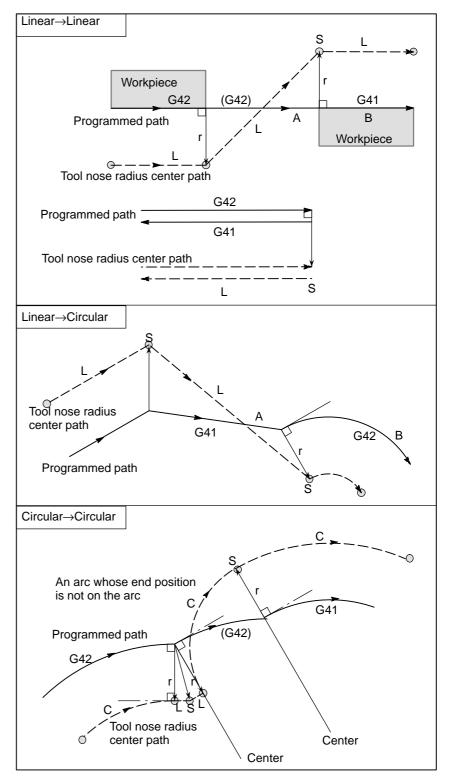
The offset direction can be changed in the offset mode. If the offset direction is changed in a block, a vector is generated at the intersection of the tool nose radius center path of that block and the tool nose radius center path of a preceding block. However, the change is not available in the start–up block and the block following it.

#### 14. COMPENSATION FUNCTION

 Tool nose radius center path with an intersection
 Linear→Linear
 Wo
 Programmed path
 €
 Tool nos
 Linear→Circular



 Tool nose radius center path without an intersection When changing the offset direction in block A to block B using G41 and G42, if intersection with the offset path is not required, the vector normal to block B is created at the start point of block B.

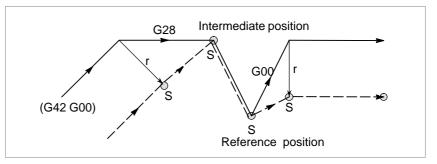


#### 14. COMPENSATION FUNCTION

#### Temporary tool nose radius compensation cancel

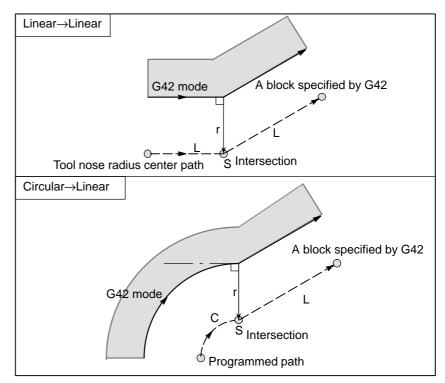
• Specifying G28 (automatic return to the reference position) in the offset mode If the following command is specified in the offset mode, the offset mode is temporarily canceled then automatically restored. The offset mode can be canceled and started as described in Subsections II–14.3.2 and II–14.3.4.

If G28 is specified in the offset mode, the offset mode is canceled at an intermediate position. If the vector still remains after the tool is returned to the reference position, the components of the vector are reset to zero with respect to each axis along which reference position return has been made.



 Tool nose radius compensation G code in the offset mode The offset vector can be set to form a right angle to the moving direction in the previous block, irrespective of machining inner or outer side, by commanding the tool nose radius compensation G code (G41, G42) in the offset mode, independently. If this code is specified in a circular command, correct circular motion will not be obtained.

When the direction of offset is expected to be changed by the command of tool nose radius compensation G code (G41, G42), refer to "Change in the offset direction in the offset mode" in Subsec.14.3.3.



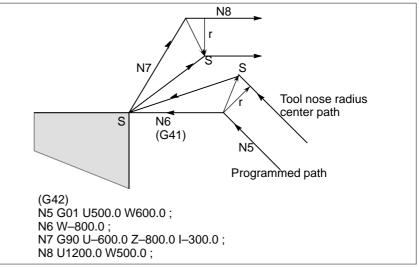
 Command cancelling the offset vector temporality During offset mode, if G50 is commanded, the offset vector is temporarily cancelled and thereafter offset mode is automatically restored.

In this case, without movement of offset cancel, the tool moves directly from the intersecting point to the commanded point where offset vector is canceled. Also when restored to offset mode, the tool moves directly to the intersecting point.

• Workpiece coordinate system setting (G50)

Tool nose radius center path L N5 Programmed path N5 G92 block (G41) N5 G91 G01 U700.0 W300.0 ; N6 U600.0 W-300.0 ; N7 G50 X200.0 Z100.0 ; N8 G01 X800.0 Z400.0 ;

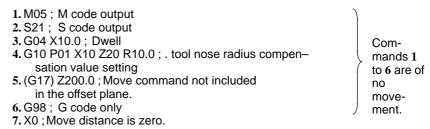
• Canned cycles (G90, G92, G94) and Multiple repetitive cycles (G71 to G76) See Sections II–14.1 (G90, G92, G94) and II–14.2 (G70 to G76) for the tool nose radius compensation is related canned cycles.



#### 14. COMPENSATION FUNCTION

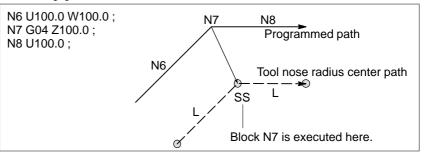
 A block without tool movement

The following blocks have no tool movement. In these blocks, the tool will not move even if tool nose radius compensation is effected.

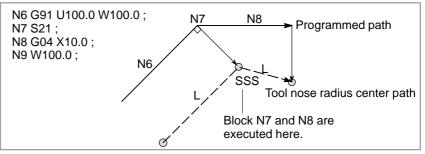


 A block without tool movement specified in offset mode

When a single block without tool movement is commanded in the offset mode, the vector and Tool nose radius center path are the same as those when the block is not commanded. This block is executed at the single block stop point.



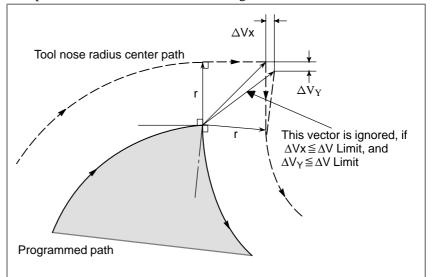
However, when the move distance is zero, even if the block is commanded singly, tool motion becomes the same as that when more than one block of without tool movement are commanded, which will be described subsequently.



#### Corner movement

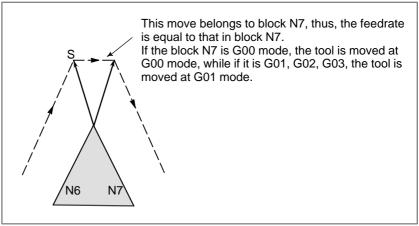
When two or more vectors are produced at the end of a block, the tool moves linearly from one vector to another. This movement is called the corner movement.

If these vectors almost coincide with each other, the corner movement isn't performed and the latter vector is ignored.



If  $\Delta Vx \leq \Delta V$  limit and  $\Delta Vy \leq \Delta V$  limit, the latter vector is ignored. The  $\Delta V$  limit is set in advance by parameter (No. 5010).

If these vectors do not coincide, a move is generated to turn around the corner. This move belongs to the latter block.



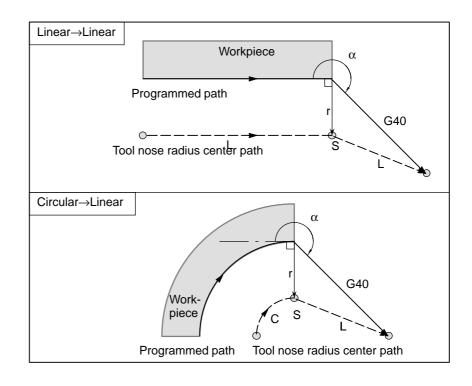
#### Interruption of manual operation

For manual operation during the tool nose radius compensation, refer to Section III–3.5, "Manual Absolute ON and OFF."

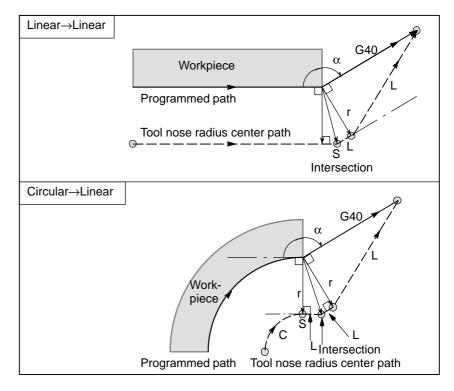
# 14.3.4 Tool Movement in Offset Mode Cancel

### **Explanations**

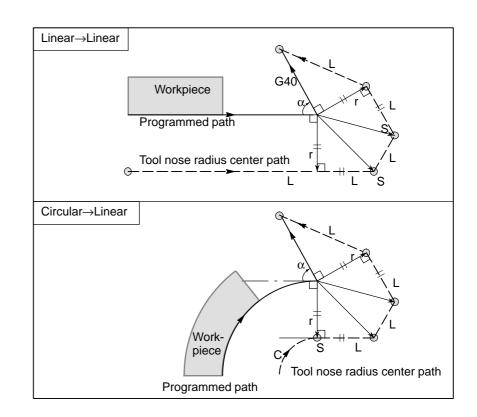
 Tool movement around an inside corner (180° ≦ α)



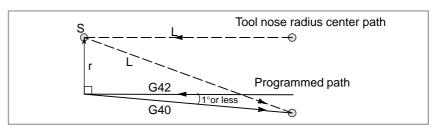
 Tool movement around an outside corner at an obtuse angle (90° ≦ α<180°)</li>



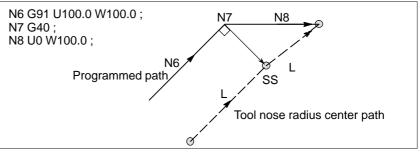
 Tool movement around an outside corner at an acute angle (α<90°)</li>



- Tool movement around the outside linear→linear at an acute angle less than 1 degree (α<1°)</li>
- A block without tool movement specified together with offset cancel

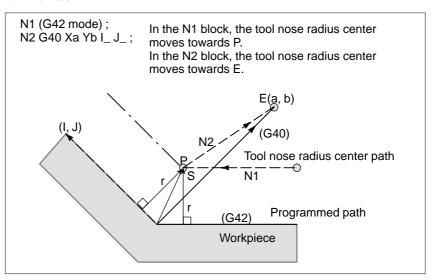


When a block without tool movement is commanded together with an offset cancel, a vector whose length is equal to the offset value is produced in a normal direction to tool motion in the earlier block, the vector is cancelled in the next move command.

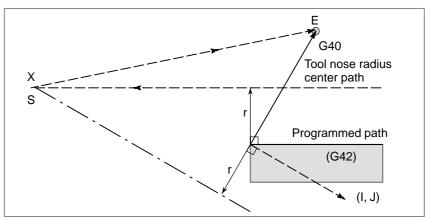


#### • Block containing G40 and I\_J\_K\_

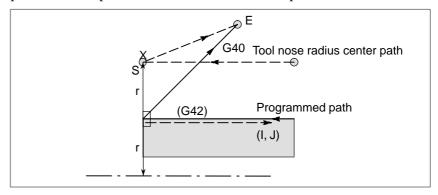
 The previous block contains G41 or G42 If a G41 or G42 block precedes a block in which G40 and  $I_{J}$ ,  $K_{a}$  are specified, the system assumes that the path is programmed as a path from the end position determined by the former block to a vector determined by (I,J), (I,K), or (J,K). The direction of compensation in the former block is inherited.



In this case, note that the CNC obtains an intersection of the tool path irrespective of whether inner or outer side machining is specified



When an intersection is not obtainable, the tool comes to the normal position to the previous block at the end of the previous block.



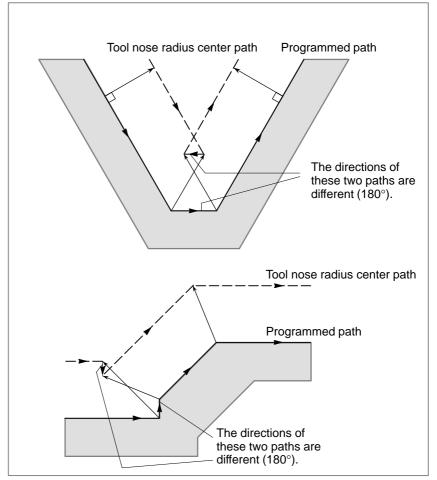
# 14.3.5 Interference Check

#### **Explanations**

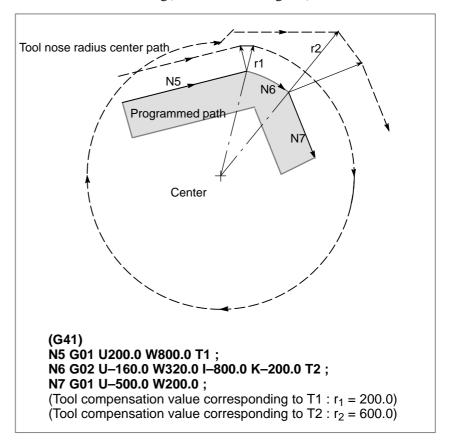
• Criteria for detecting interference

Tool overcutting is called interference. The interference check function checks for tool overcutting in advance. However, all interference cannot be checked by this function. The interference check is performed even if overcutting does not occur.

(1) The direction of the tool nose radius path is different from that of the programmed path (from 90 degrees to 270 degrees between these paths).



(2) In addition to the condition (1), the angle between the start point and end point on the Tool nose radius center path is quite different from that between the start point and end point on the programmed path in circular machining(more than 180 degrees).



In the above example, the arc in block N6 is placed in the one quadrant. But after tool nose radius compensation, the arc is placed in the four quadrants.

#### Correction of interference in advance

 Removal of the vector causing the interference When tool nose radius compensation is performed for blocks A, B and C and vectors V<sub>1</sub>, V<sub>2</sub>, V<sub>3</sub> and V<sub>4</sub> between blocks A and B, and

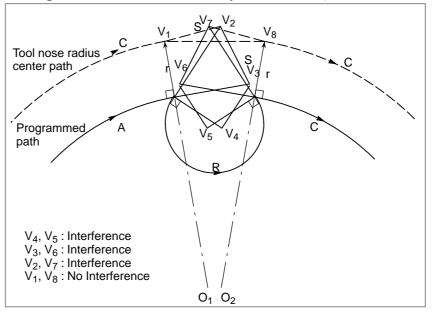
 $V_5$ ,  $V_6$ ,  $V_7$  and  $V_8$  between B and C are produced, the nearest vectors are checked first. If interference occurs, they are ignored. But if the vectors to be ignored due to interference are the last vectors at the corner, they cannot be ignored.

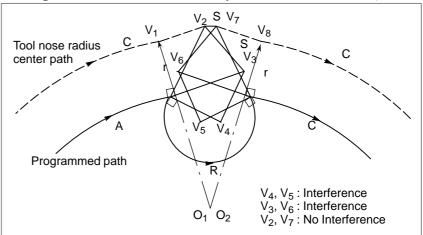
Check between vectors V<sub>4</sub> and V<sub>5</sub> Interference V<sub>4</sub> and V<sub>5</sub> are ignored. Check between V<sub>3</sub> and V<sub>6</sub> Interference V<sub>3</sub> and V<sub>6</sub> are ignored Check between V<sub>2</sub> and V<sub>7</sub> Interference V<sub>2</sub> and V<sub>7</sub> are Ignored Check between V<sub>1</sub> and V<sub>8</sub>

Interference  $V_1$  and  $V_8$  are cannot be ignored

If while checking, a vector without interference is detected, subsequent vectors are not checked. If block B is a circular movement, a linear movement is produced if the vectors are interfered.

(Example 1) The tool moves linearly from  $V_1$  to  $V_8$ 

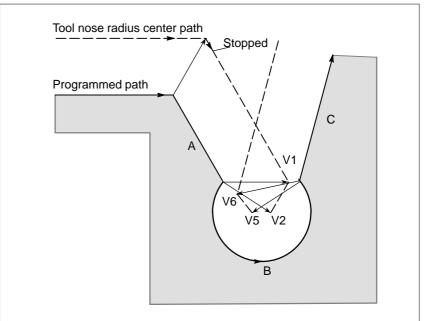




(Example 2) The tool moves linearly from V<sub>1</sub>, V<sub>2</sub>, V<sub>7</sub>, to V<sub>8</sub>

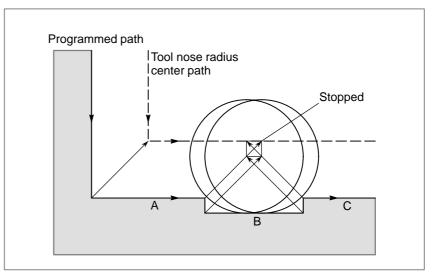
(2) If the interference occurs after correction (1), the tool is stopped with an alarm.

If the interference occurs after correction (1) or if there are only one pair of vectors from the beginning of checking and the vectors interfere, the P/S alarm (No. 41) is displayed and the tool is stopped immediately after execution of the preceding block. If the block is executed by the single block operation, the tool is stopped at the end of the block.



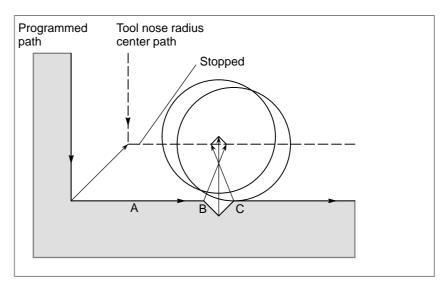
After ignoring vectors  $V_2$  and  $V_5$  because of interference, interference also occurs between vectors  $V_1$  and  $V_6$ . The alarm is displayed and the tool is stopped.

- When interference is assumed although actual interference does not occur
- (1) Depression which is smaller than the tool nose radius compensation value



There is no actual interference, but since the direction programmed in block B is opposite to that of the path after tool nose radius compensation the tool stops and an P/S alarm (No. 041) is displayed.

# (2) Groove which is smaller than the tool nose radius compensation value

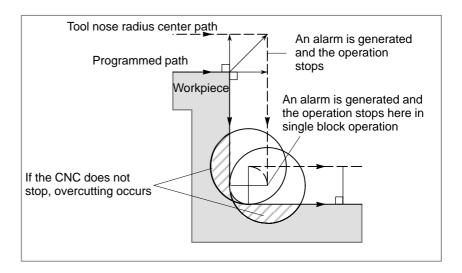


Like (1), the direction is reverse in block B.

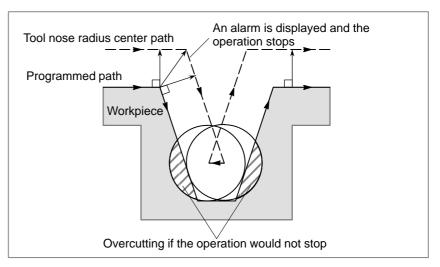
## 14.3.6 Overcutting by Tool Nose Radius Compensation

#### **Explanations**

 Machining an inside corner at a radius smaller than the tool nose radius When the radius of a corner is smaller than the cutter radius, because the inner offsetting of the cutter will result in overcuttings, an alarm is displayed and the CNC stops at the start of the block. In single block operation, the overcutting is generated because the tool is stopped after the block execution.



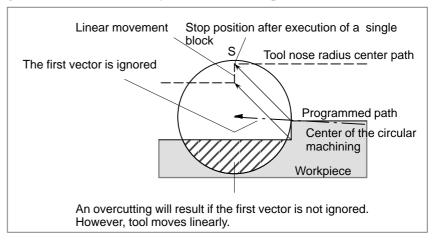
 Machining a groove smaller than the tool nose radius Since the tool nose radius compensation forces the path of the center of the tool to move in the reverse of the programmed direction, overcutting will result. In this case an alarm is displayed and the CNC stops at the start of the block.



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#### Machining a step smaller than the tool nose radius

When machining of the step is commanded by circular machining in the case of a program containing a step smaller than the tool nose radius, the path of the center of tool with the ordinary offset becomes reverse to the programmed direction. In this case, the first vector is ignored, and the tool moves linearly to the second vector position. The single block operation is stopped at this point. If the machining is not in the single block mode, the cycle operation is continued. If the step is of linear, no alarm will be generated and cut correctly. However uncut part will remain.

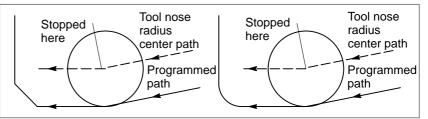


## 14.3.7 Correction in Chamfering and Corner Arcs

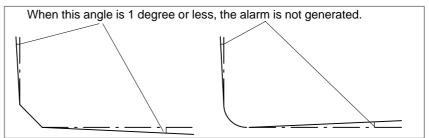
In chamfering or corner arcs, tool nose radius compensation only be performed when an ordinary intersection exists at the corner.

In offset cancel mode, a start–up block or when exchanging the offset direction, compensation cannot be performed, an P/S alarm (No. 39) is displayed and the tool is stopped.

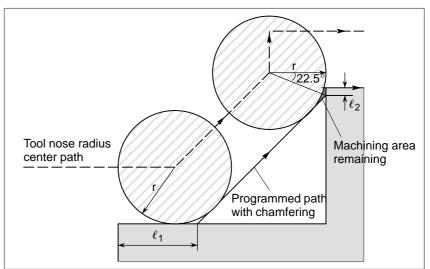
In inner chamfering or inner corner arcs, if the chamfering value or corner arc value is smaller than the tool nose radius value, the tool is stopped with an P/S alarm (No. 39) since overcutting will occur.



The valid inclination angle of the programmed path in the blocks before and after the corner is 1 degree or less so that the P/S alarm (No. 52, 54) generated by the calculating error of tool nose radius compensation does not occur.



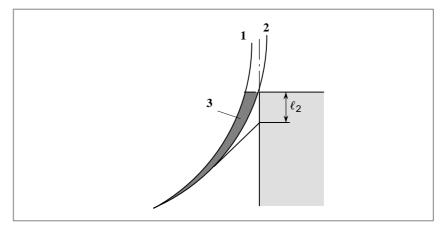
#### 14. COMPENSATION FUNCTION



The following example shows a machining area which cannot be cut sufficiently.

In inner chamfering, if the portion of the programmed path that is not a part of the chamfering (in the above figure  $\ell_1$  or  $\ell_2$ ) is in following range, insufficiently cut are will exist.

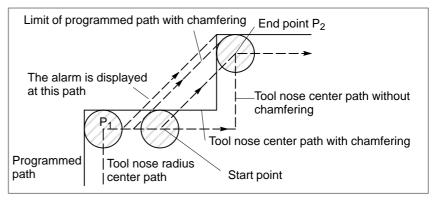
 $0 \le \ell_1$  or  $\ell_{2 < r} \cdot \tan 22.5^\circ$  (r: too nose radius) Enlarged view on the remaining machining area



Although the tool should be positioned at 2 in the above figure, the tool is positioned at 1 (the tool nose is tangent to line L).

Thus, area **3** is not machined.

P/S alarm No. 52 or 55 is displayed in the following cases :



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14.3.8

MDI

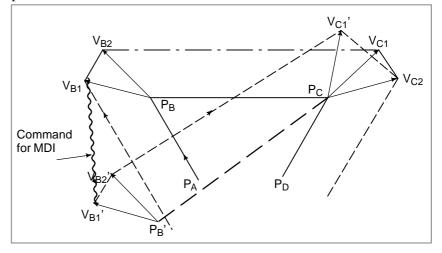
Input Command from

In outer chamfering with an offset, a limit is imposed on the programmed path. The path during chamfering coincides with the intersection points  $P_1$  or  $P_2$  without chamfering, therefore, outer chamfering is limited. In the figure above, the end point of the tool center path with chamfering coincides with the intersection point (P2) of the next block without chamfering. If the chamfering value is more than the limit value specified, P/S alarm No. 52 or 55 will be displayed.

Tool nose radius compensation is not performed for commands input from the MDI.

However, when automatic operation using absolute commands is temporarily stopped by the single block function, MDI operation is performed, then automatic operation starts again, the tool path is as follows :

In this case, the vectors at the start position of the next block are translated and the other vectors are produced by the next two blocks. Therefore, from next block but one, tool nose radius compensation is accurately performed.



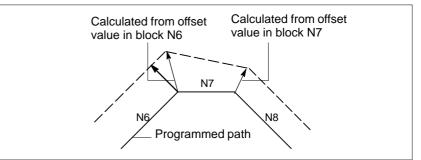
When position  $P_A$ ,  $P_B$ , and  $P_C$  are programmed in an absolute command, tool is stopped by the single block function after executing the block from  $P_A$  to  $P_B$  and the tool is moved by MDI operation. Vectors  $V_{B1}$  and  $V_{B2}$ are translated to  $V_{B1}$ ' and  $V_{B2}$ ' and offset vectors are recalculated for the vectors  $V_{C1}$  and  $V_{C2}$  between block  $P_B$ – $P_C$  and  $P_C$ – $P_D$ .

However, since vector  $V_{B2}$  is not calculated again, compensation is accurately performed from position  $P_{C}$ .

# 14.3.9 General Precautions for Offset Operations

• Changing the offset value

In general, the offset value is changed in cancel mode, or when changing tools. If the offset value is changed in offset mode, the vector at the end point of the block is calculated for the new offset value.

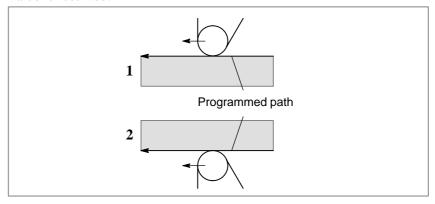


When some vectors are produced between blocks N6 and N7, the vector at the end point of the present blocks is calculated using the offset value of the block N6.

When a negative offset value is specified, the program is executed for the figure which is created by exchanging G41 for G42 or G42 for G41 in the process sheet.

A tool machining an inner profile will machine the occur profile, and tool machining the outer profile will machine the inner profile.

An example is shown below. In general, CNC machining is programmed assuming a positive offset value. When a program specifies a tool path as shown in 1, the tool will move as shown in 2 if a negative offset is specified. The tool in 2 will move as shown in 1 when the sign of the offset value is reserved.



#### WARNING

When the sign of the offset value is reversed, the offset vector of the tool nose is reversed but the imaginary tool nose direction does not change.

Therefore, do not reverse the sign of the offset value when starting the machining meeting the imaginary tool nose to the start point.

• The polarity of the offset amount and the tool nose center path

# 14.3.10 G53, G28, G30, and G30.1 Commands in Tool–tip Radius Compensation Mode

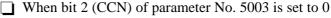
- When a G53 command is executed in tool-tip radius compensation mode, the tool-tip radius compensation vector is automatically canceled before positioning, that vector being automatically restored by a subsequent move command. The format for restoring the tool-tip radius compensation vector is the FS16 type when bit 2 (CCN) of parameter No. 5003 is set to 0, or the FS15 type when the bit is set to 1.
- When a G28, G30, or G30.1 command is executed in tool-tip radius compensation mode, the tool-tip radius compensation vector is automatically canceled before automatic reference position return, that vector being automatically restored by a subsequent move command. The timing and format for canceling and restoring the tool-tip radius compensation vector are the FS15 type when bit 2 (CCN) of parameter No. 5003 is set to 1, or the FS16 type when the bit is set to 0.

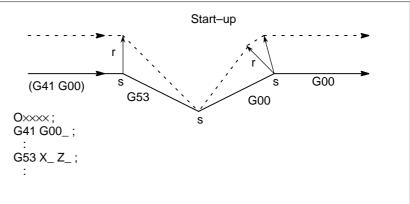
#### **Explanations**

G53 command in tool–tip radius compensation mode

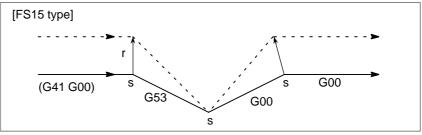
When a G53 command is executed in tool-tip radius compensation mode, a vector having a length equal to the offset is created, at the end of the preceding block, perpendicular to the direction in which the tool moves. When the tool moves to a specified position according to the G53 command, the offset vector is canceled. When the tool moves according to the next command, the offset vector is automatically restored. The format for restoring the tool-tip radius compensation vector is the start-up type when bit 2 (CCN) of parameter No. 5003 is set to 0, or the intersection vector type (FS15 type) when the bit is set to 1.

G53 command in offset
 mode

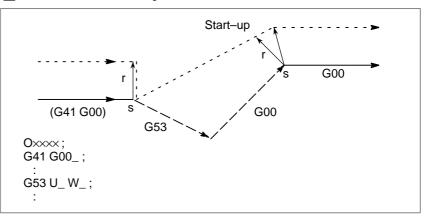




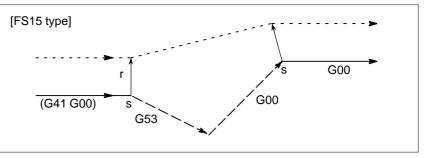
#### When bit 2 (CCN) of parameter No. 5003 is set to 1



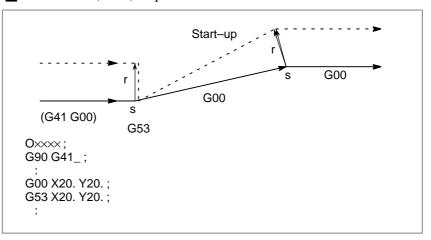
- Incremental G53
   command in offset mode
- When bit 2 (CCN) of parameter No. 5003 is set to 0



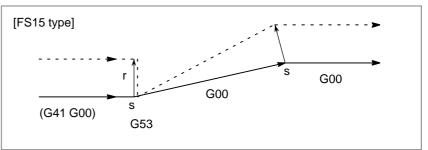
#### U When bit 2 (CCN) of parameter No. 5003 is set to 1



U When bit 2 (CCN) of parameter No. 5003 is set to 0



#### U When bit 2 (CCN) of parameter No. 5003 is set to 1



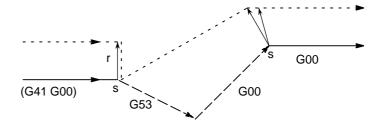
 G53 command specifying no movement in offset mode

#### WARNING

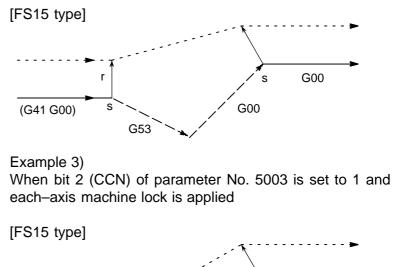
1 When a G53 command is executed in tool-tip radius compensation mode when all-axis machine lock is applied, positioning is not performed for those axes to which machine lock is applied and the offset vector is not canceled. When bit 2 (CCN) of parameter No. 5003 is set to 0 or each-axis machine lock is applied, the offset vector is canceled.

#### Example 1) When bit 2 (CC

When bit 2 (CCN) of parameter No. 5003 is set to 0 and all-axis machine lock is applied



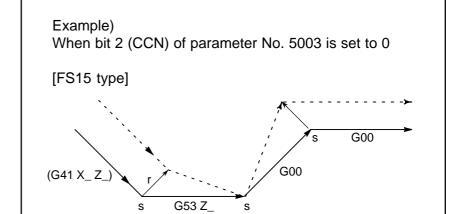
Example 2) When bit 2 (CCN) of parameter No. 5003 is set to 1 and all-axis machine lock is applied





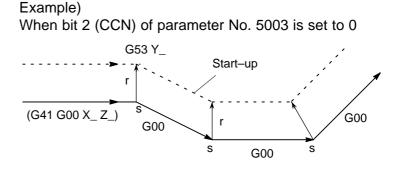
#### WARNING

2 When a compensation axis is specified in a G53 command in tool-tip radius compensation mode, the vectors for other compensation axes are also canceled. This also applies when bit 2 (CCN) of parameter No. 5003 is set to 1. (The FS15 cancels only the vector for the specified axis. Note that the FS15 type cancellation differs from the actual FS15 specification in this point.)

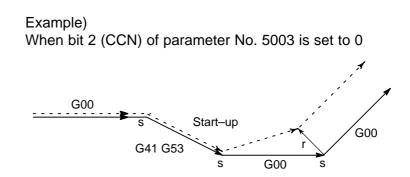


#### NOTE

1 When an axis not included in the tool-tip radius compensation plane is specified in a G53 command, a vector perpendicular to the direction in which the tool moves is created at the end of the preceding block and the tool does not move. Offset mode is automatically resumed from the next block (in the same way as when two or more blocks specifying no movement are consecutively executed).



2 When a G53 command is specified as a start-up block, the next block actually becomes the start-up block. When bit 2 (CCN) of parameter No. 5003 is set to 1, however, the next block creates an intersection vector.



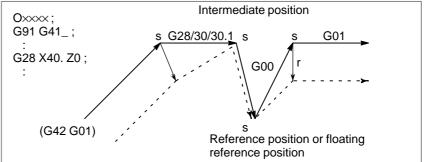
• G28, G30, G30.1 command in tool–tip radius compensation mode

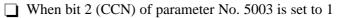
When a G28, G30, or G30.1 command is executed in tool-tip radius compensation mode, the operation specified in the command is performed according to the FS15 format if bit 2 (CCN) of parameter No. 5003 is set to 1. An intersection vector is created at the end of the preceding block and a perpendicular vector is created at the intermediate position. The offset vector is canceled when the tool moves from the intermediate position to the reference position. The offset vector is restored as an intersection vector by the next block.

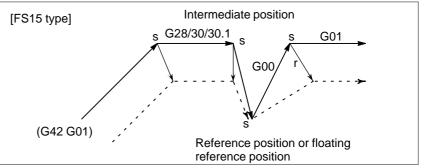
#### 14. COMPENSATION FUNCTION

PROGRAMMING

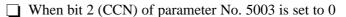
 G28, G30, or G30.1 command in offset mode (with movement to both an intermediate position and reference position performed) When bit 2 (CCN) of parameter No. 5003 is set to 0

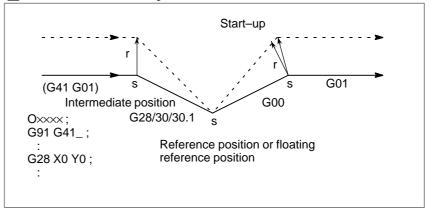




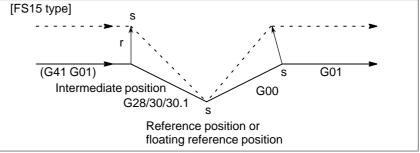


 G28, G30, or G30.1 command in offset mode (with movement to an intermediate position not performed)

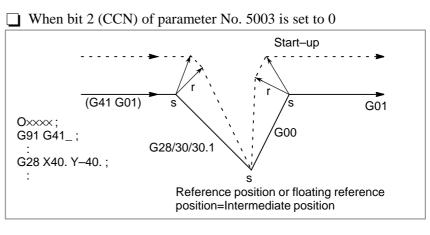


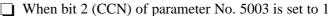


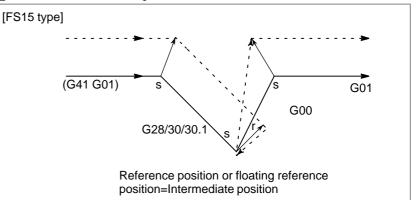
#### When bit 2 (CCN) of parameter No. 5003 is set to 1



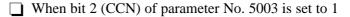
 G28, G30, or G30.1 command in offset mode (with movement to a reference position not performed)

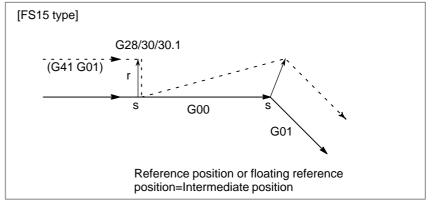






- When bit 2 (CCN) of parameter No. 5003 is set to 0

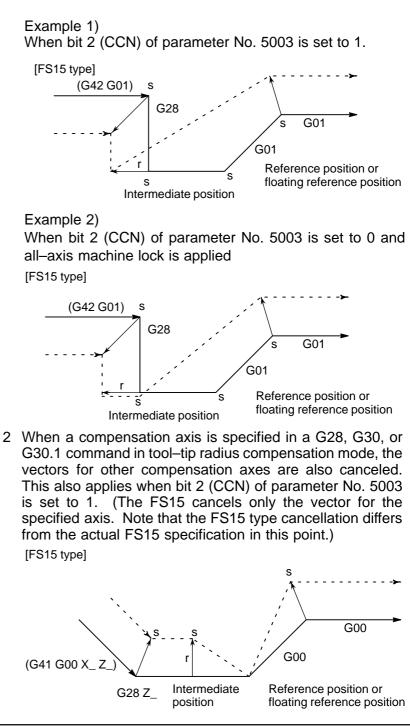




 G28, G30, or G30.1 command in offset mode (with no movement)

#### WARNING

1 When a G28, G30, or G30.1 command is executed when all-axis machine lock is applied, a vector perpendicular to the direction in which the tool moves is created at the intermediate position. In this case, the tool does not move to the reference position and the offset vector is not canceled. When bit 2 (CCN) of parameter No. 5003 is set to 0 or each-axis machine lock is applied, the offset vector is canceled.

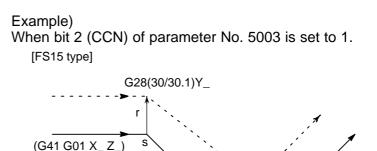


, G01

s

#### NOTE

1 When an axis not included in the tool-tip radius compensation plane is specified in a G28, G30, or G30.1 command, a vector perpendicular to the direction in which the tool moves is created at the end of the preceding block and the tool does not move. Offset mode is automatically resumed from the next block (in the same way as when two or more blocks specifying no movement are consecutively executed).



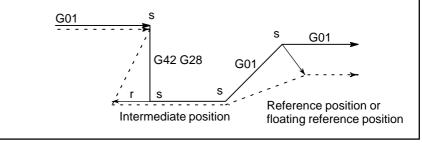
2 When a G28, G30, or G30.1 command is specified as a start–up block, a vector perpendicular to the direction in which the tool moves is created at the intermediate position. The vector is then canceled at the reference position. The next block creates an intersection vector.

s

G01

G01

Example 1) When bit 2 (CCN) of parameter No. 5003 is set to 1. [FS15 type]



# 14.4 CORNER CIRCULAR INTERPOLATION FUNCTION (G39)

During radius compensation for the tool tip, corner circularinterpolation, with the specified compensation value used as the radius, can be performed by specifying G39 in offset mode.

#### Format

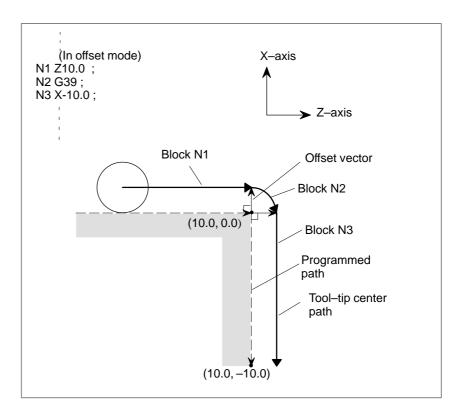
| In offset mode, specify                                      |  |
|--|--|
| G39;   |  |
| or   |  |
| G39 $iggl\{ egin{matrix} I\_J_\ I\_K_\ J_K_\ \end{bmatrix};$ |  |

#### **Explanations**

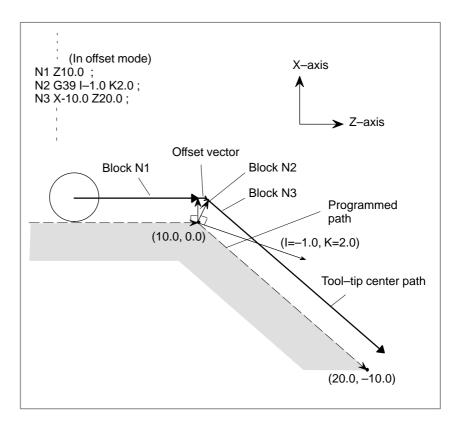
 Corner Corner circular-interpolation, with the specified compensation value circular-interpolation used as a radius, can be performed by specifying the operation as shown above. Whether the tool moves clockwise or counterclockwise depends on whether the last-specified direction code is G41 or G42. G39 is a single-shot G code. • G39 without I, J, and K Specifying G39; creates a corner arc for which the end vector is perpendicular to the start point of the next block. Specifying G39 I\_J\_K\_; creates a corner arc for which the end vector is • G39 with I, J, and K perpendicular to the vector specified with I, J, and K. Limitations Move command A move operation cannot be specified in a block in which G39 is specified. Two or more contiguous blocks with no move operations can not be Non–move command specified immediately after a block in which G39, without I, J, and K, is specified. (If a move command is specified in a block with a move distance of 0, it is assumed to be two or more contiguous blocks with no more operations.) If those blocks are specified, the offset vector momentarily disappears and the system automatically returns to offset mode.

#### Examples

• G39 without I, J, and K



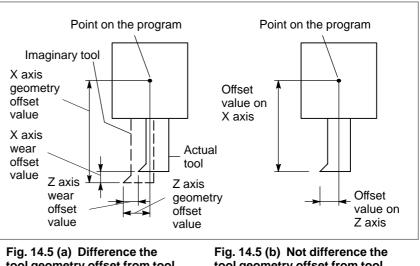
• G39 with I, J, and K



# 14.5 TOOL COMPENSATION VALUES, NUMBER OF COMPENSATION VALUES, AND ENTERING VALUES FROM THE PROGRAM (G10)

Tool compensation values include tool geometry compensation values and tool wear compensation (Fig. 14.5 (a)).

Tool compensation can be specified without differentiating compensation for tool geometry from that for tool wear.



tool geometry offset from tool wear offset

Fig. 14.5 (b) Not difference the tool geometry offset from tool wear offset

Tool compensation values can be entered into CNC memory from the MDI panel (see section III–9.1) or from a program.

A tool compensation value is selected from the CNC memory when the corresponding code is specified after address T in a program. The value is used for tool offset or tool nose radius compensation. See subsec. II–14.1.2 for details.

### 14.5.1 Tool Compensation and Number of Tool Compensation

 Valid range of tool compensation values Table 14.5.1 (a) shows the valid input range of tool compensation values.

#### Table 14.5.1 (a) Valid range of tool compensation values

| Increment system | Tool compensation value      |                                |  |
|------------------|------------------------------|--------------------------------|--|
| increment system | Metric input (mm)            | Inch input (inch)              |  |
| IS–B             | -999.999 to +999.999 mm      | -99.9999 to +99.9999 inch      |  |
| IS–C             | –999.9999 to +999.9999<br>mm | -99.99999 to +99.99999<br>inch |  |

The maximum tool wear compensation can be changed by setting parameter No. 5013.

#### Seven-digit tool offset specification

The number of digits used to specify a tool geometry/wear compensation value can be expanded by selecting the option which enables seven-digit tool offset specification. When this option is used, tool compensation values can be specified using up to seven digits for IS–B and eight digits for IS–C. The valid data range for tool compensation values will thus be as listed in Table 14.5.1(b).

| Table | 14.5.1 | (b) |
|-------|--------|-----|
|-------|--------|-----|

| Increment system | Tool compensation value                              |  |  |
|------------------|--|--|--|
|                  | Metric input (mm)                                    | Inch input (inch)  |  |
| IS-B             | 0 to ±9999.999 mm                                    | 0 to $\pm$ 999.9999 inch                                 |  |
| IS-C             | 0 to $\pm$ 9999.9999 mm<br>(0 to $\pm$ 4000.0000 mm) | 0 to $\pm$ 999.99999 inch<br>(0 to $\pm$ 160.00000 inch) |  |

#### NOTE

- 1 The range enclosed in parentheses applies when automatic inch/metric conversion is enabled (bit 0 (OIM) of parameter No. 5006 is set to 1).
- 2 The option enabling seven-digit tool offset specification cannot be used for B-axis offsets for B-axis control.
- Number of tool compensation

The memory can hold 16, 32, 64, or 99 tool compensation values.

#### NOTE

With the two-path control, the number of specified tool compensation values equals the number of tool compensations for each tool post.

## 14.5.2 Changing of Tool Offset Value (Programmable Data Input ) (G10)

Format

G10 P\_ X\_ Y\_ Z\_ R\_ Q\_ ; or G10 P\_U\_V\_W\_C\_Q\_; P: Offset number 0 : Command of work coordinate system shift value 1-64 : Command of tool wear offset value Command value is offset number 10000+(1-64): Command of tool geometry offset value (1-64) : Offset number X: Offset value on X axis (absolute) Y: Offset value on Y axis (absolute) Z: Offset value on Z axis (absolute) U: Offset value on X axis (incremental) V: Offset value on Y axis (incremental) W: Offset value on Z axis (incremental) R: Tool nose radius offset value (absolute) R: Tool nose radius offset value (incremental) Q: Imaginary tool nose number

Offset values can be input by a program using the following command :

In an absolute command, the values specified in addresses X, Y, Z, and R are set as the offset value corresponding to the offset number specified by address P. In an incremental command, the value specified in addresses U, V, W, and C is added to the current offset value corresponding to the offset number.

#### NOTE

- 1 Addresses X, Y, Z, U, V, and W can be specified in the same block.
- 2 Use of this command in a program allows the tool to advance little by little. This command can also be used input offset values one at a time from a program by specifying this command successively instead of inputting these values one at a time from the MDI unit.

# 14.6 AUTOMATIC TOOL OFFSET (G36, G37)

When a tool is moved to the measurement position by execution of a command given to the CNC, the CNC automatically measures the difference between the current coordinate value and the coordinate value of the command measurement position and uses it as the offset value for the tool. When the tool has been already offset, it is moved to the measurement position with that offset value. If the CNC judges that further offset is needed after calculating the difference between the coordinate values, the current offset value is further offset.

Refer to the instruction manuals of the machine tool builder for details.

#### **Explanations**

• Coordinate system

 Movement to measurement position

Offset

When moving the tool to a position for measurement, the coordinate system must be set in advance. (The work coordinate system for programming is used in common.)

A movement to a measurement position is performed by specifying as follows in the MDI, or MEM mode :

#### $G36 Xx_a$ ; or $G37 Zz_a$ ;

In this case, the measurement position should be  $x_a$  or  $z_a$  (absolute command).

Execution of this command moves the tool at the rapid traverse rate toward the measurement position, lowers the feedrate halfway, then continues to move it until the approach end signal from the measuring instrument is issued. When the tool tip reaches the measurement position, the measuring instrument outputs the measurement position reach signal to the CNC which stops the tool.

The current tool offset value is further offset by the difference between the coordinate value ( $\alpha$  or  $\beta$ ) when the tool has reached the measurement position and the value of  $x_a$  or  $z_a$  specified in G36Xx<sub>a</sub> or G37Zz<sub>a</sub>.

**Offset value**  $x = Current offset value x + (\alpha - x_a)$ 

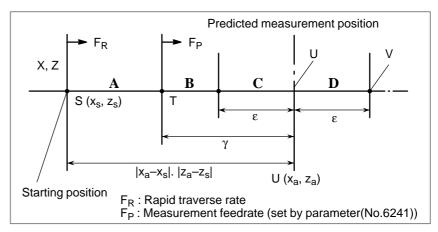
**Offset value**  $z = Current offset value z + (\beta - z_a)$ 

x<sub>a</sub> : Programmed X-axis measurement point

z<sub>a</sub> : Programmed Z-axis measurement point

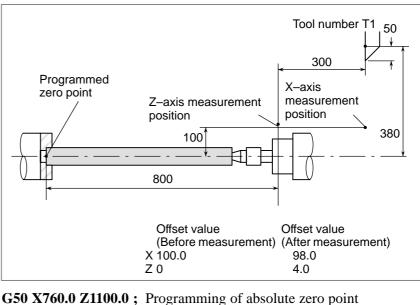
These offset values can also be altered from the MDI keyboard.

• Feedrate and alarm The tool, when moving from the stating position toward the measurement position predicted by  $x_a$  or  $z_a$  in G36 or G37, is fed at the rapid traverse rate across area **A**. Then the tool stops at point T ( $x_a-\gamma_x$  or  $z_a-\gamma_z$ ) and moves at the measurement feedrate set by parameter (No. 6241) across areas **B**, **C**, and **D**. If the approach end signal turns on during movement across area B, alarm is generated. If the approach end signal does not turn on before point V, and tool stops at point V and P/S alarm (No. 080) is generated.



#### Fig. 14.6 Feedrate and Alarm

If bit 3 (G36) of parameter No. 3405 has been set to 1, G37.1 and G37.2 are used as the G codes for automatic tool compensation for the X- and Z-axes, respectively.



**GS0 X760.0 Z1100.0**; Programming of absolute zero point (Coordinate system setting) **S01 M03 T0101**; Specifies tool T1, offset number 1, and spindle revolution

#### • G code

#### **Examples**

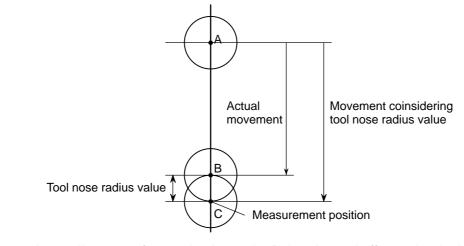
| G36 X200.0 ;   | Moves to the measurement position<br>If the tool has reached the measurement position<br>at X198.0 ; since the correct measurement<br>position is 200 mm, the offset value is altered by<br>198.0–200.0=–2.0mm. |
|----------------|---|
| G00 X204.0 ;   | Refracts a little along the X axis.   |
| G37 Z800.0 ;   | Moves to the Z-axis measurement position.   |
|                | If the tool has reached the measurement position<br>at X804.0, the offset value is altered by<br>804.0–800.0=4.0mm.   |
| <b>T0101 ;</b> | Further offsets by the difference.  |
|                | The new offset value becomes valid when the T code is specified again.  |

#### WARNING

1 Measurement speed(Fp),  $\gamma$ , and  $\varepsilon$  are set as parameters (Fp : No.6241,  $\gamma$  : No.6251,  $\varepsilon$  : No.6254) by machine tool builder.  $\varepsilon$  must be positive numbers so that  $\gamma > \varepsilon$ .

- 2 Cancel the tool nose radius compensation before G36, G37.
- 3 When a manual movement is inserted into a movement at a measurement feedrate, return the tool to the position before the inserted manual movement for restart.
- 4 When using the optional tool nose radius compensation function, the tool offset amount is determined considering the value of tool nose R. Make sure that tool nose radius value is set correctly.

Example) When the tool nose center coincides with the start point.



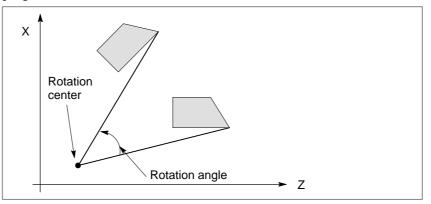
The tool actually moves from point A to point B, but the tool offset value is determined assuming that the tool moves to point C considering the tool nose radius value.

#### NOTE

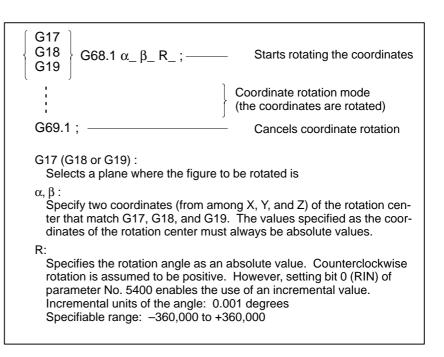
- 1 When there is no T code command before G36 or G37, P/S alarm No.81 is generated.
- 2 When a T code is specified in the same block as G36 or G37, P/S alarm No.82 is generated.

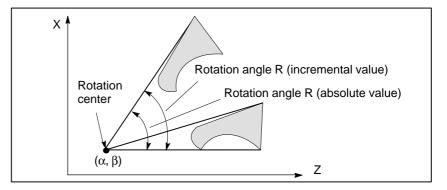
# 14.7 COORDINATE ROTATION (G68.1, G69.1)

With the coordinate rotation function, it is possible to rotate a figure specified in a program. For example, a program that produces patterns of a figure rotated at increasingly larger angles can be created as a pair of subprograms, one of which defines a figure, the other of which calls the figure definition subprogram by specifying rotation. This method is useful for reducing the program development time and the size of the program.



Format





# Explanations

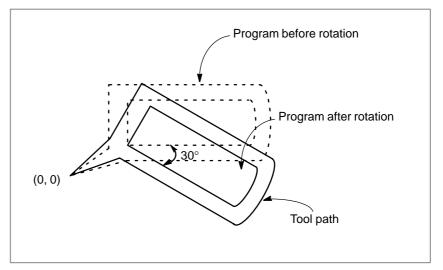
| <ul> <li>Plane selection G code,<br/>G17, G18, or G19</li> </ul> | Plane selection G code (G17, G18, or G19) can be specified in a block ahead of the coordinate rotation G code (G68.1). Do not specify G17, G18, or G19 in coordinate rotation mode.  |
|--|--|
| <ul> <li>Rotation center</li> </ul>                              | If the rotation center $(\alpha_{-}, \beta_{-})$ is not specified, the location of the tool when G68.1 is issued is assumed as the rotation center.  |
| <ul> <li>Rotation angle command</li> </ul>                       | If the rotation angle command (R_) is not specified, the value specified in parameter No. 5410 is used as the rotation angle.  |
| <ul> <li>Coordinate rotation<br/>cancel</li> </ul>               | The coordinate rotation cancel G code (G69.1) can be specified in the same block as other commands.  |
| <ul> <li>Tool compensation</li> </ul>                            | Tool compensation, such as tool offset or tool nose radius compensation,<br>is processed after coordinate rotation is performed for a program defining<br>a figure.<br>G68.1 can be used in either G00 or G01 mode.  |
| Limitations  |  |
| <ul> <li>Reference position<br/>return</li> </ul>                | A reference position return command G27, G28, G29, or G30 can be issued only in G69.1 mode.  |
| <ul> <li>Changes to coordinates</li> </ul>                       | Do not attempt to change coordinates in G68.1 mode (commands such as G50, G54 to G59, and the tool offset command).  |
| • Canned cycles  | Coordinate rotation cannot be used in simple canned cycles, multiple<br>repetitive canned cycles, or canned drilling cycles.   |
| <ul> <li>Incremental command</li> </ul>                          | Always use absolute values in a move command that immediately follows<br>the coordinate rotation command (G68.1) or coordinate rotation cancel<br>command (G69.1). Specifying an incremental value results in the move<br>command failing to operate normally. |

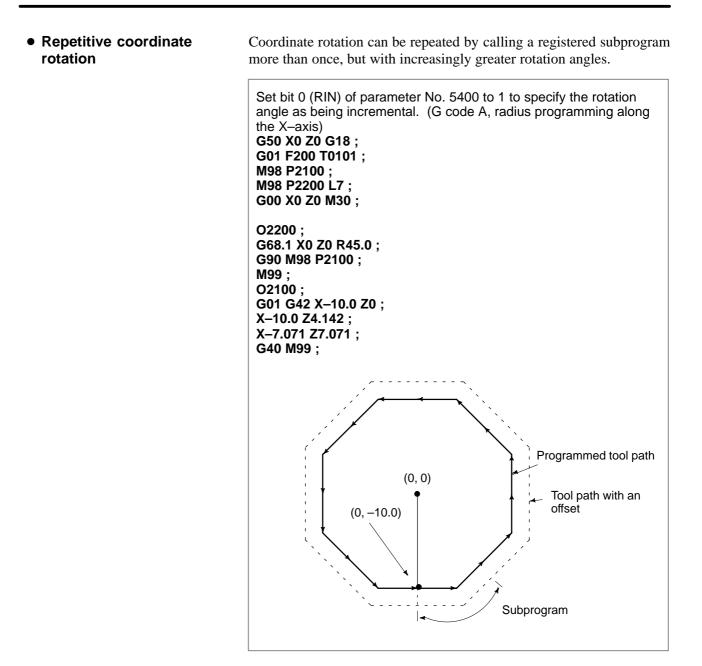
#### Examples

• Tool nose radius and coordinate rotation

G68.1 and G69.1 can be specified during tool nose radius compensation, provided that the coordinate rotation plane coincides with the tool nose radius compensation plane.

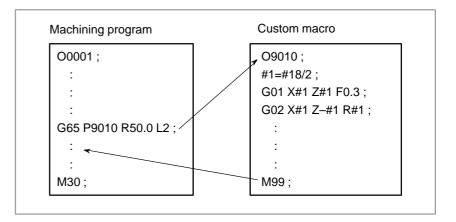
N1 G50 X0 Z0 G69.1 G01 ; N2 G42 X1000 Z1000 F1000 T0101 ; N3 G68 R-30000 ; N4 Z3000 ; N5 G03 U1000 R1000 ; N6 G01 Z1000 ; N7 U-1000 ; N8 G69.1 G40 X0 Z0 ;





# 15 CUSTOM MACRO

Although subprograms are useful for repeating the same operation, the custom macro function also allows use of variables, arithmetic and logic operations, and conditional branches for easy development of general programs such as pocketing and user–defined canned cycles. A machining program can call a custom macro with a simple command, just like a subprogram.



# 15.1 VARIABLES

An ordinary machining program specifies a G code and the travel distance directly with a numeric value; examples are G100 and X100.0. With a custom macro, numeric values can be specified directly or using a variable number. When a variable number is used, the variable value can be changed by a program or using operations on the MDI panel.

#1=#2+100;

G01 X#1 F0.3;

#### Explanation

• Variable representation

When specifying a variable, specify a number sign (#) followed by a variable number. General–purpose programming languages allow a name to be assigned to a variable, but this capability is not available for custom macros.

#### Example: #1

An expression can be used to specify a variable number. In such a case, the expression must be enclosed in brackets.

#### Example: #[#1+#2–12]

• Types of variables

Variables are classified into four types by variable number.

Table 15.1 Types of variables

| Variable<br>number                             | Type of variable    | Function   |
|--|---------------------|--|
| #0   | Always<br>null      | This variable is always null. No value can be assigned to this variable.   |
| #1 – #33                                       | Local<br>variables  | Local variables can only be used within a macro to hold data such as the results of operations. When the power is turned off, local variables are initialized to null. When a macro is called, arguments are assigned to local variables.  |
| #100 – #149<br>(#199)<br>#500 – #531<br>(#999) | Common<br>variables | Common variables can be shared among dif-<br>ferent macro programs. When the power is<br>turned off, variables #100 to #149 are initial-<br>ized to null. Variables #500 to #531 hold data<br>even when the power is turned off. As an op-<br>tion, common variables #150 to #199 and<br>#532 to #999 are also available. However,<br>when these values are using, the length of the<br>tape that can be used for storage decreases<br>by 8.5 m. |
| #1000 -  | System<br>variables | System variables are used to read and write a variety of NC data items such as the current position and tool compensation values.  |

#### NOTE

Common variables #150 to #199 and #532 to #999 are optional.

| 15. CUSTOM MACRO                                      | PROGRAMMING  | B-63004EN/02                          |
|---|--|---------------------------------------|
| <ul> <li>Range of variable values</li> </ul>          | Local and common variables can have value (<br>ranges :<br>-10 <sup>47</sup> to -10 <sup>-29</sup><br>0  | ) or a value in the following         |
|   | +10 <sup>-29</sup> to +10 <sup>47</sup><br>If the result of calculation turns out to be invitis issued.  | alid, an P/S alarm No. 111            |
| <ul> <li>Omission of the decimal<br/>point</li> </ul> | When a variable value is defined in a program omitted.   | n, the decimal point can be           |
|   | Example:<br>When #1=123; is defined, the actual<br>123.000.  | value of variable #1 is               |
| <ul> <li>Referencing variables</li> </ul>             | To reference the value of a variable in a progr<br>followed by the variable number. When an ex<br>a variable, enclose the expression in brackets | xpression is used to specify          |
|   | Example: G01X[#1+#2]F#3;   |                                       |
|   | A referenced variable value is automatically least input increment of the address.   | <sup>7</sup> rounded according to the |
|   | Example:<br>When G00X#1; is executed on a 1/1000<br>assigned to variable #1, the actual con<br>G00X12.346;.                                      |                                       |
|   | To reverse the sign of a referenced variable va<br>to #.   | ılue, prefix a minus sign (–)         |
|   | Example: G00X-#1;  |                                       |
|   | When an undefined variable is referenced, the address word.  | variable is ignored up to an          |
|   | Example:<br>When the value of variable #1 is 0, and<br>null, execution of G00X#1Z#2; results i   |                                       |
| <ul> <li>Undefined variable</li> </ul>                | When the value of a variable is not defined, so<br>as a "null" variable. Variable #0 is always a<br>written to, but it can be read.              |                                       |
|   | (a) Quotation<br>When an undefined variable is quotated<br>ignored.  | d, the address itself is also         |
|   | When #1 = < vacant >   | When #1 = 0                           |

| When #1 = < vacant > | When #1 = 0  |
|----------------------|--------------|
| G90 X100 Y#1         | G90 X100 Y#1 |
| Ļ                    | Ļ            |
| G90 X100             | G90 X100 Y0  |

#### (b)Operation

< vacant > is the same as 0 except when replaced by < vacant>

| When #1 = < vacant > | When #1 = 0  |
|----------------------|--------------|
| #2 = #1              | #2 = #1      |
| Ļ                    | Ļ            |
| #2 = < vacant >      | #2 = 0       |
| #2 = #1*5            | #2 = #1*5    |
| Ļ                    | Ļ            |
| #2 = 0               | #2 = 0       |
| #2 = #1+#1           | #2 = #1 + #1 |
| ↓ ↓                  | Ļ            |
| #2 = 0               | #2 = 0       |

#### (c) Conditional expressions

< vacant > differs from 0 only for EQ and NE.

| When #1 = < vacant > | When #1 = 0    |
|----------------------|----------------|
| #1 EQ #0             | #1 EQ #0       |
| Ļ                    | Ļ              |
| Established          | Notestablished |
| #1 NE 0              | #1 NE 0        |
| Ļ                    | Ļ              |
| Established          | Notestablished |
| #1 GE #0             | #1 GE #0       |
| Ļ                    | Ļ              |
| Established          | Established    |
| #1 GT 0              | #1 GT 0        |
| Ļ                    | Ļ              |
| Not established      | Notestablished |

 Custom macro variables common to tool posts (two-path control) With the two–path control, macro variables are provided for each tool post. Specifying parameter Nos. 6036 and 6037 allows some of the common variables to be used for all tool posts.

# • Displaying variable values

| /ARIABLE   |                 |          | 01234 N12345 |
|------------|-----------------|----------|--------------|
| NO.        | DATA            | NO.      | DATA         |
| 100        | 123.456         | 108      |              |
| 101        | 0.000           | 109      |              |
| 102        |                 | 110      |              |
| 103        | * * * * * * * * | 111      |              |
| 104        |                 | 112      |              |
| 105        |                 | 113      |              |
| 106        |                 | 114      |              |
| 107        |                 | 115      |              |
| ACTUAL POS | SITION (RELATI  | VE)      |              |
| Х          | 0.000           | Y        | 0.000        |
| Z          | 0.000           | В        | 0.000        |
| /IEM ****  | * * * * * *     | 18:42:15 |              |
| MACRO ]    | [ MENU ] [ (    | OPR ] [  | ] [ (OPRT) ] |

- When the value of a variable is blank, the variable is null.
- The mark \*\*\*\*\*\*\* indicates an overflow (when the absolute value of a variable is greater than 99999999) or an underflow (when the absolute value of a variable is less than 0.0000001).

Limitations

Program numbers, sequence numbers, and optional block skip numbers cannot be referenced using variables.

#### **Example:**

Variables cannot be used in the following ways: O#1; /#2G00X100.0; N#3Z200.0;

# 15.2 SYSTEM VARIABLES

System variables can be used to read and write internal NC data such as tool compensation values and current position data. Note, however, that some system variables can only be read. System variables are essential for automation and general–purpose program development.

#### **Explanations**

• Interface signals

Signals can be exchanged between the programmable machine controller (PMC) and custom macros.

| Variable<br>number   | Function   |
|----------------------|--|
| #1000-#1015<br>#1032 | A 16–bit signal can be sent from the PMC to a custom macro. Variables #1000 to #1015 are used to read a signal bit by bit. Variable #1032 is used to read all 16 bits of a signal at one time.   |
| #1100–#1115<br>#1132 | A 16–bit signal can be sent from a custom macro to the PMC. Variables #1100 to #1115 are used to write a signal bit by bit. Variable #1132 is used to write all 16 bits of a signal at one time. |
| #1133                | Variable #1133 is used to write all 32 bits of a signal at one time from a custom macro to the PMC.<br>Note, that values from –999999999 to +999999999 can be used for #1133.                    |

Table 15.2 (a) System variables for interface signals

For detailed information, refer to the connection manual (B-63003EN-1).

# Tool compensation values

When the system does not differentiate tool geometry compensation from tool wear compensation, use variable numbers for wear compensation.

Table 15.2 (b) System variables for tool compensation memory C

| Compensation number     | X axis<br>compensation<br>value   |                     | Z axis<br>compensation<br>value |                     | Tool nose radius<br>compensation<br>value  |  | Imaginary<br>tool nose | compe               | xis<br>nsation<br>lue |
|-------------------------|---|---------------------|---------------------------------|---------------------|--|--|------------------------|---------------------|-----------------------|
| number                  | Wear  | Geome-<br>try       | Wear                            | Geome-<br>try       | Wear   | Geome-<br>try  | position T             | Wear                | Geome-<br>try         |
| 1<br>:<br>49<br>:<br>64 | #2001<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>: | #2701<br>:<br>#2749 | #2101<br>#2164                  | #2801<br>:<br>#2849 | #2201<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>: | #2901<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>: | #2301<br>              | #2401<br>:<br>#2449 | #2451<br>:<br>#2499   |

#### Table 15.2 (c) System variables for 99 tool compensation values

| Compensation number | X axis<br>compensation<br>value |                       | Z axis<br>compensation<br>value |                       | compe      | Tool nose radius<br>compensation<br>value<br>tool nose |                       |            | xis<br>nsation<br>lue |
|---------------------|---------------------------------|-----------------------|---------------------------------|-----------------------|------------|--|-----------------------|------------|-----------------------|
| number              | Wear                            | Geome-<br>try         | Wear                            | Geome-<br>try         | Wear       | Geome-<br>try  | position T            | Wear       | Geome-<br>try         |
| 1<br>:<br>99        | #10001<br>                      | #15001<br>:<br>#15099 | #11001<br>:<br>#11099           | #16001<br>:<br>#16099 | #12001<br> | #17001<br>:<br>#17099                                  | #13001<br>:<br>#13099 | #14001<br> | #19001<br>:<br>#19099 |

#### NOTE

System variables #2001 to #2964 can also be used to determine Y-axis wear or geometry compensation values No. 1 to 49, X-axis or Z-axis geometry compensation values No. 1 to 49, and other compensation values No. 1 to 64.

#### • Macro alarms

#### Table 15.2 (d) System variable for macro alarms

| Variable<br>number | Function  |
|--------------------|---|
| #3000              | When a value from 0 to 200 is assigned to variable #3000, the CNC stops with an alarm. After an expression, an alarm message not longer than 26 characters can be described. The CRT screen displays alarm numbers by adding 3000 to the value in variable #3000 along with an alarm message. |

#### **Example:**

#### #3000=1(TOOL NOT FOUND); → The alarm screen displays "3001 TOOL NOT FOUND."

• Time information

Time information can be read and written.

#### Table 15.2 (e) System variables for time information

| Variable<br>number | Function  |
|--------------------|---|
| #3001              | This variable functions as a timer that counts in 1–millisecond increments at all times. When the power is turned on, the value of this variable is reset to 0. When 2147483648 milliseconds is reached, the value of this timer returns to 0.                |
| #3002              | This variable functions as a timer that counts in 1-hour incre-<br>ments when the cycle start lamp is on. This timer preserves<br>its value even when the power is turned off. When<br>9544.371767 hours is reached, the value of this timer returns<br>to 0. |
| #3011              | This variable can be used to read the current date (year/<br>month/day). Year/month/day information is converted to an<br>apparent decimal number. For example, March 28, 1993 is<br>represented as 19930328.   |
| #3012              | This variable can be used to read the current time (hours/min-<br>utes/seconds). Hours/minutes/seconds information is con-<br>verted to an apparent decimal number. For example, 34 min-<br>utes and 56 seconds after 3 p.m. is represented as 153456.        |

#### Automatic operation control

The control state of automatic operation can be changed.

Table 15.2 (f) System variable (#3003) for automatic operation control

| #3003 | Single block | Completion of an auxiliary function |
|-------|--------------|-------------------------------------|
| 0     | Enabled      | To be awaited                       |
| 1     | Disabled     | To be awaited                       |
| 2     | Enabled      | Not to be awaited                   |
| 3     | Disabled     | Not to be awaited                   |

- When the power is turned on, the value of this variable is 0.
- When single block stop is disabled, single block stop operation is not performed even if the single block switch is set to ON.
- When a wait for the completion of auxiliary functions (M, S, and T functions) is not specified, program execution proceeds to the next block before completion of auxiliary functions. Also, distribution completion signal DEN is not output.

| #3004 | Feed hold | Feedrate Override | Exact stop |
|-------|-----------|-------------------|------------|
| 0     | Enabled   | Enabled           | Enabled    |
| 1     | Disabled  | Enabled           | Enabled    |
| 2     | Enabled   | Disabled          | Enabled    |
| 3     | Disabled  | Disabled          | Enabled    |
| 4     | Enabled   | Enabled           | Disabled   |
| 5     | Disabled  | Enabled           | Disabled   |
| 6     | Enabled   | Disabled          | Disabled   |
| 7     | Disabled  | Disabled          | Disabled   |

Table 15.2 (g) System variable (#3004) for automatic operation control

- When the power is turned on, the value of this variable is 0.
- When feed hold is disabled:
  - (1) When the feed hold button is held down, the machine stops in the single block stop mode. However, single block stop operation is not performed when the single block mode is disabled with variable #3003.
  - (2) When the feed hold button is pressed then released, the feed hold lamp comes on, but the machine does not stop; program execution continues and the machine stops at the first block where feed hold is enabled.
- When feedrate override is disabled, an override of 100% is always applied regardless of the setting of the feedrate override switch on the machine operator's panel.
- When exact stop check is disabled, no exact stop check (position check) is made even in blocks including those which do not perform cutting.

#### • Settings

Settings can be read and written. Binary values are converted to decimals.

| #3005  |     |     |     |     |     |     |     |     |
|--|-----|-----|-----|-----|-----|-----|-----|-----|
| Setting  | #15 | #14 | #13 | #12 | #11 | #10 | #9  | #8  |
| Setting  |     |     |     |     |     |     | FCV |     |
|  | #7  | #6  | #5  | #4  | #3  | #2  | #1  | #0  |
| Setting  |     |     | SEQ |     |     | INI | ISO | TVC |
| #9 (FCV)       : Whether to use the FS15 tape format conversion capability         #5 (SEQ)       : Whether to automatically insert sequence numbers         #2 (INI)       : Millimeter input or inch input         #1 (ISO)       : Whether to use EIA or ISO as the output code         #0 (TVC)       : Whether to make a TV check |     |     |     |     |     |     |     |     |

#### • Stop with a message

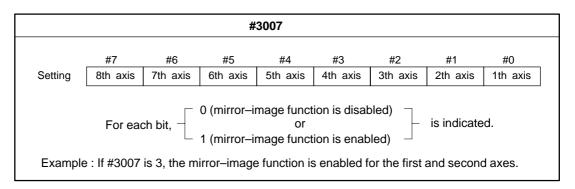
Execution of the program can be stopped, and then a message can be displayed.

| Variable number | Function   |
|-----------------|--|
| #3006           | When "#3006=1 (MESSAGE);" is commanded in the macro, the program executes blocks up to the immediate-<br>ly previous one and then stops.   |
|                 | When a message of up to 26 characters, which is en-<br>closed by a control–in character ("(") and control–out<br>character (")"), is programmed in the same block, the<br>message is displayed on the external operator message<br>screen. |

#### • Mirror image

The mirror-image status for each axis set using an external switch or setting operation can be read through the output signal (mirror-image check signal). The mirror-image status present at that time can be checked. (See Section 4.7 in III.)

The value obtained in binary is converted into decimal notation.



- When the mirror-image function is set for a certain axis by both the mirror-image signal and setting, the signal value and setting value are ORed and then output.
- When mirror-image signals for axes other than the controlled axes are turned on, they are still read into system variable #3007.
- System variable #3007 is a write-protected system variable. If an attempt is made to write data in the variable, P/S 116 alarm "WRITE PROTECTED VARIABLE" is issued.

 Number of machined parts The number (target number) of parts required and the number (completion number) of machined parts can be read and written.

# Table 15.2 (h) System variables for the number of parts required and the number of machined parts

| Variable number | Function                                     |
|-----------------|--|
| #3901           | Number of machined parts (completion number) |
| #3902           | Number of required parts (target number)     |

#### NOTE

Do not substitute a negative value.

#### • Modal information

Modal information specified in blocks up to the immediately preceding block can be read.

Table 15.2 (i) System variables for modal information

| Variable<br>number   | Function   |   |
|--|--|---|
| #4001<br>#4002<br>#4003<br>#4004<br>#4005<br>#4006<br>#4007<br>#4008<br>#4009<br>#4010<br>#4010<br>#4011<br>#4012<br>#4014<br>#4015<br>#4015<br>#4015<br>#4016<br>:<br>#4022<br>#4109<br>#4113<br>#4114<br>#4115<br>#4119<br>#4120 | G00, G01, G02, G03, G33, G34<br>G96, G97<br>G68, G69<br>G98, G99<br>G20, G21<br>G40, G41, G42<br>G25, G26<br>G22, G23<br>G80 – G89<br>G66, G67<br>G54–G59<br>G17 – G19<br>:<br>F code<br>M code<br>Sequence number<br>Program number<br>S code<br>T code | (Group 01)<br>(Group 02)<br>(Group 03)<br>(Group 04)<br>(Group 05)<br>(Group 06)<br>(Group 07)<br>(Group 09)<br>(Group 10)<br>(Group 11)<br>(Group 12)<br>(Group 14)<br>(Group 15)<br>(Group 15)<br>(Group 16)<br>:<br>(Group 22) |

#### **Example:**

When #1=#4001; is executed, the resulting value in #1 is 0, 1, 2, 3, or 33.

When a modal information reading system variable corresponding to a G code group which cannot be used is specified, a P/S alarm is issued.

#### • Current position

Position information cannot be written but can be read.

#### Table 15.2 (j) System variables for position information

| Variable<br>number | Position<br>information | Coordinate<br>system              | Tool com-<br>pensation<br>value | Read<br>operation<br>during<br>movement |
|--------------------|-------------------------|-----------------------------------|---------------------------------|---|
| #5001–#5008        | Block end point         | Workpiece<br>coordinate<br>system | Not<br>included                 | Enabled                                 |
| #5021-#5028        | Current position        | Machine<br>coordinate<br>system   | Included                        | Disabled                                |
| #5041-#5048        | Current position        | Workpiece                         |                                 |   |
| #5061-#5068        | Skip signal position    | system                            |                                 | Enabled                                 |
| #5081, #5082       | Tool offset value       |                                   |                                 | Disabled                                |
| #5101–#5108        | Deviated servo position |                                   |                                 |   |

- The first digit (from 1 to 8) represents an axis number.
- The tool offset value currently used for execution rather than the immediately preceding tool offset value is held in variables #5081 to 5088.
- The tool position where the skip signal is turned on in a G31 (skip function) block is held in variables #5061 to #5068. When the skip signal is not turned on in a G31 block, the end point of the specified block is held in these variables.
- When read during movement is "disabled," this means that expected values cannot be read due to the buffering (preread) function.

#### Workpiece coordinate system compensation values (workpiece zero point offset values)

Workpiece zero point offset values can be read and written.

#### Table 15.2 (k) System variables for workpiece zero point offset values

| Variable<br>number | Function   |
|--------------------|--|
| #5201              | First–axis external workpiece zero point offset value  |
| #5208              | Eighth–axis external workpiece zero point offset value |
| #5221              | First–axis G54 workpiece zero point offset value       |
| #5228              | Eighth–axis G54 workpiece zero point offset value      |
| #5241              | First–axis G55 workpiece zero point offset value       |
| #5248              | Eighth–axis G55 workpiece zero point offset value      |
| #5261              | First–axis G56 workpiece zero point offset value       |
| #5268              | Eighth–axis G56 workpiece zero point offset value      |
| #5281              | First–axis G57 workpiece zero point offset value       |
| #5288              | Eighth–axis G57 workpiece zero point offset value      |
| #5301              | First–axis G58 workpiece zero point offset value       |
| #5308              | Eighth–axis G58 workpiece zero point offset value      |
| #5321              | First–axis G59 workpiece zero point offset value       |
| #5328              | Eighth-axis G59 workpiece zero point offset value      |

#### NOTE

To use variables #5201 to #5328, the workpiece coordinate system option is necessary.

# 15.3 ARITHMETIC AND LOGIC OPERATION

The operations listed in Table 15.3 (a) can be performed on variables. The expression to the right of the operator can contain constants and/or variables combined by a function or operator. Variables #j and #K in an expression can be replaced with a constant. Variables on the left can also be replaced with an expression.

| Function                   | Format            | Remarks  |
|----------------------------|-------------------|--|
| Definition                 | #i=#j             |  |
| Sum                        | #i=#j+#k;         |  |
| Difference                 | #i=#j—#k;         |  |
| Product                    | #i=#j*#k;         |  |
| Quotient                   | #i=#j/#k;         |  |
| Sine                       | #i=SIN[#j];       | An angle is specified in de-                       |
| Arc sine                   | #i=ASIN[#j];      | grees. 90 degrees and 30 minutes is represented as |
| Cosine                     | #i=COS[#j];       | 90.5 degrees.                                      |
| Arc cosine                 | #i=ACOS[#j];      |  |
| Tangent                    | #i=TAN[#j];       |  |
| Arctangent                 | #i=ATAN[#j]/[#k]; |  |
| Square root                | #i=SQRT[#j];      |  |
| Absolute value             | #i=ABS[#j];       |  |
| Rounding off               | #i=ROUND[#j];     |  |
| Rounding down              | #i=FIX[#j];       |  |
| Rounding up                | #i=FUP[#j];       |  |
| Natural logarithm          | #i=LN[#j]         |  |
| Exponential function       | #i=EXP[#j];       |  |
| OR                         | #i=#j OR #k;      | A logical operation is per-                        |
| XOR                        | #i=#j XOR #k;     | formed on binary numbers bit by bit.               |
| AND                        | #i=#j AND #k;     |  |
| Conversion from BCD to BIN | #i=BIN[#j];       | Used for signal exchange                           |
| Conversion from BIN to BCD | #i=BCD[#j];       | to and from the PMC                                |

#### **Explanations**

- Angle units
- ARCSIN #i = ASIN[#j];

The units of angles used with the SIN, COS, TAN, ASIN, ACOS and ATAN functions are degrees. For example, 90 degrees and 30 minutes is represented as 90.5 degrees.

- The solution ranges are as indicated below: When the NAT bit (bit 0 of parameter 6004) is set to 0: 270° to 90° When the NAT bit (bit 0 of parameter 6004) is set to 1: -90° to 90°
- When #j is beyond the range of -1 to 1, P/S alarm No. 111 is issued.
- A constant can be used instead of the #j variable.

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|--|--|--|
| • ARCCOS #i = ACOS[#j];                                    | <ul> <li>The solution ranges from 180° to 0°.</li> <li>When #j is beyond the range of -1 to 1, P/S alarm No. 111 is issued.</li> <li>A constant can be used instead of the #j variable.</li> </ul>   |  |
| <ul> <li>ARCTAN<br/>#i = ATAN[#j]/[#k];</li> </ul>         | <ul> <li>Specify the lengths of two sides, sep</li> <li>The solution ranges are as follows:<br/>When the NAT bit (bit 0 of paramet</li> </ul>  |  |
|  | Example:<br>When #1 = ATAN[-1]/[-1]; is spec<br>When the NAT bit (bit 0 of paran<br>180°   |  |
|  | <ul> <li>Example:<br/>When #1 = ATAN[-1]/[-1]; is spec</li> <li>A constant can be used instead of the</li> </ul>   |  |
| <ul> <li>Natural logarithm<br/>#i = LN[#j];</li> </ul>     | <ul> <li>Note that the relative error may become the antilogarithm (#j) is zero issued.</li> <li>A constant can be used instead of the second constant can be used constant</li></ul> | or smaller, P/S alarm No. 111 is                                   |
| <ul> <li>Exponential function<br/>#i = EXP[#j];</li> </ul> | <ul> <li>Note that the relative error may become when the result of the operation excess an overflow occurs and P/S alarm N</li> <li>A constant can be used instead of the second second</li></ul> | eeds $3.65 \times 10^{47}$ (j is about 110),<br>No. 111 is issued. |
| <ul> <li>ROUND function</li> </ul>                         | • When the ROUND function is incorporation command, IF statement, or function rounds off at the first decimation function functio           | r WHILE statement, the ROUND                                       |
|  | Example:<br>When #1=ROUND[#2]; is execut<br>value of variable #1 is 1.0.   | ed where #2 holds 1.2345, the                                      |
|  | • When the ROUND function is used ROUND function rounds off the specinput increment of the address.  |  |
|  | Example:<br>Creation of a drilling program th<br>of variables #1 and #2, then return<br>Suppose that the increment syste<br>holds 1.2345, and variable #2 hold<br>C00 C01 X #1: Moves 1.235 mm   | ns to the original position<br>em is 1/1000 mm, variable #1        |

G00 G91 X-#1; Moves 1.235 mm.

G01 X-#2 F300; Moves 2.346 mm.

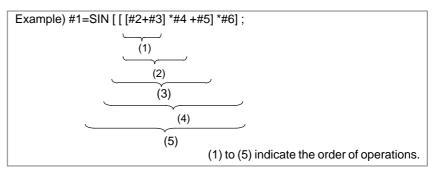
G00 X[#1+#2];

Since 1.2345 + 2.3456 = 3.5801, the travel distance is 3.580, which does not return the tool to the original position. This difference comes from whether addition is performed before or after rounding off. G00X–[ROUND[#1]+ROUND[#2]] must be specified to return the tool to the original position.

| <ul> <li>Rounding up and down<br/>to an integer</li> </ul>                           | With CNC, when the absolute value of the integer produced by an operation on a number is greater than the absolute value of the original number, such an operation is referred to as rounding up to an integer. Conversely, when the absolute value of the integer produced by an operation on a number is less than the absolute value of the original number, such an operation is referred to as rounding down to an integer. Be particularly careful when handling negative numbers. |
|--|--|
|  | Example:<br>Suppose that #1=1.2 and #2=–1.2.<br>When #3=FUP[#1] is executed, 2.0 is assigned to #3.<br>When #3=FIX[#1] is executed, 1.0 is assigned to #3.<br>When #3=FUP[#2] is executed, -2.0 is assigned to #3.<br>When #3=FIX[#2] is executed, -1.0 is assigned to #3.   |
| <ul> <li>Abbreviations of<br/>arithmetic and logic<br/>operation commands</li> </ul> | When a function is specified in a program, the first two characters of the function name can be used to specify the function. (See III–9.7)  |
|  | Example:<br>ROUND $\rightarrow$ RO<br>FIX $\rightarrow$ FI   |
| <ul> <li>Priority of operations</li> </ul>   | <ol> <li>(1) Functions</li> <li>(2) Operations such as multiplication and division (*, /, AND, MOD)</li> <li>(3) Operations such as addition and subtraction (+, -, OR, XOR)</li> </ol>  |
|  | Example) #1=#2+#3*SIN[#4];   |
|  |  |
|  | (3)<br>(1), (2), and (3) indicate the order of operations.   |

• Bracket nesting

Brackets are used to change the order of operations. Brackets can be used to a depth of five levels including the brackets used to enclose a function. When a depth of five levels is exceeded, alarm No. 118 occurs.



#### Limitations

Brackets

Brackets ([, ]) are used to enclose an expression. Note that parentheses are used for comments.

#### • Operation error

Errors may occur when operations are performed.

Table 15.3 (b) Errors involved in operations

| Operation              | Average<br>error       | Maximum<br>error       | Type of error   |
|------------------------|------------------------|------------------------|---|
| a = b*c                | 1.55×10 <sup>-10</sup> | 4.66×10 <sup>-10</sup> | Relative error(*1)  |
| a = b/c                | 4.66×10 <sup>-10</sup> | 1.88×10 <sup>-9</sup>  | $\left  \frac{\varepsilon}{h} \right $  |
| $a = \sqrt{b}$         | 1.24×10 <sup>-9</sup>  | 3.73×10 <sup>−9</sup>  | b   |
| a = b + c<br>a = b - c | 2.33×10 <sup>-10</sup> | 5.32×10 <sup>-10</sup> | $\operatorname{Min} \left  \begin{array}{c} \varepsilon \\ b \end{array} \right  \left  \begin{array}{c} \varepsilon \\ c \end{array} \right  $ |
| a = SIN [ b ]          | 5.0×10 <sup>-9</sup>   | 1.0×10 <sup>-8</sup>   | Absolute error(*3)  |
| a = COS [ b ]          |                        |                        |   |
| a = ATAN [b]/[c] (*4)  | 1.8×10 <sup>-6</sup>   | 3.6×10 <sup>-6</sup>   | l ε ∣ degrees   |

#### NOTE

- 1 The relative error depends on the result of the operation.
- 2 Smaller of the two types of errors is used.
- 3 The absolute error is constant, regardless of the result of the operation.
- 4 Function TAN performs SIN/COS.
- The precision of variable values is about 8 decimal digits. When very large numbers are handled in an addition or subtraction, the expected results may not be obtained.

#### **Example:**

When an attempt is made to assign the following values to variables #1 and #2:

#1=9876543210123.456

#2=9876543277777.777

the values of the variables become:

#1=9876543200000.000

#2=9876543300000.000

In this case, when #3=#2-#1; is calculated, #3=100000.000 results. (The actual result of this calculation is slightly different because it is performed in binary.)

• Also be aware of errors that can result from conditional expressions using EQ, NE, GE, GT, LE, and LT.

#### **Example:**

IF [#1 EQ #2] is effected by errors in both #1 and #2, possibly resulting in an incorrect decision.

Therefore, instead find the difference between the two variables with IF[ABS[#1–#2]LT0.001].

Then, assume that the values of the two variables are equal when the difference does not exceed an allowable limit (0.001 in this case). • Also, be careful when rounding down a value.

#### **Example:**

When #2=#1\*1000; is calculated where #1=0.002;, the resulting value of variable #2 is not exactly 2 but 1.99999997. Here, when #3=FIX[#2]; is specified, the resulting value of variable #1 is not 2.0 but 1.0. In this case, round down the value after correcting the error so that the result is greater than the expected number, or round it off as follows: #3=FIX[#2+0.001] #3=ROUND[#2]

• Divisor

When a divisor of zero is specified in a division or TAN[90], alarm No. 112 occurs.

# 15.4 MACRO STATEMENTS AND NC STATEMENTS

The following blocks are referred to as macro statements:

- Blocks containing an arithmetic or logic operation (=)
- Blocks containing a control statement (such as GOTO, DO, END)
- Blocks containing a macro call command (such as macro calls by G65, G66, G67, or other G codes, or by M codes)

Any block other than a macro statement is referred to as an NC statement.

#### Explanations

- Differences from NC statements
- Even when single block mode is on, the machine does not stop. Note, however, that the machine stops in the single block mode when bit 5 (SBM) of parameter 6000 is 1.
- Macro blocks are not regarded as blocks that involve no movement in the tool nose radius compensation mode (see Section II–15.7).
- NC statements that have the same property as macro statements
- If a block contains a subprogram call command (M98, a subprogram call using an M code, or a subprogram call using a T code) and does not contain any command address other than O, N, P, or L, that block is equivalent to a macro statement.
- If a block contains M99 and does not contain any command address other than O, N, P, or L, that block is equivalent to a macro statement.

| 15.5<br>BRANCH AND | In a program, the flow of control can be changed using the GOTO statement and IF statement. Three types of branch and repetition operations are used: |
|--------------------|---|
| REPETITION         | Branch and repetition GOTO statement (unconditional branch)   |
|                    | IF statement (conditional branch: if, then)   |
|                    | WHILE statement (repetition while)  |

# 15.5.1 Unconditional Branch (GOTO Statement)

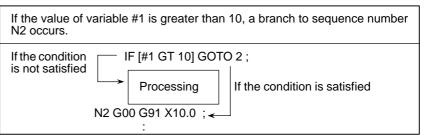
A branch to sequence number n occurs. When a sequence number outside of the range 1 to 99999 is specified, P/S alarm No. 128 occurs. A sequence number can also be specified using an expression.

GOTO n; n: Sequence number (1 to 99999)

Example: GOTO1; GOTO#10;

# 15.5.2 Conditional Branch (IF Statement)

Specify a conditional expression after IF. IF [<conditional expression>] GOTO n If the specified conditional expression is satisfied, a branch to sequence number n occurs. If the specified condition is not satisfied, the next block is executed.



If the specified conditional expression is satisfied, a predetermined macro statement is executed. Only a single macro statement is executed.

| If the values of #1 and #2 are the sam | ne, 0 is assigned to #3. |
|--|--------------------------|
| IF [#1 EQ #2] THEN                     | #3=0;                    |

#### Explanations

**IF**[<conditional

expression>]THEN

• Conditional expression

• Operators

A conditional expression must include an operator inserted between two variables or between a variable and constant, and must be enclosed in brackets ([, ]). An expression can be used instead of a variable.

Operators each consist of two letters and are used to compare two values to determine whether they are equal or one value is smaller or greater than the other value. Note that the inequality sign cannot be used.

| Operator | Meaning                           |
|----------|-----------------------------------|
| EQ       | Equal to(=)                       |
| NE       | Not equal to(≠)                   |
| GT       | Greater than(>)                   |
| GE       | Greater than or equal to $(\geq)$ |
| LT       | Less than(<)                      |
| LE       | Less than or equal to( $\leq$ )   |

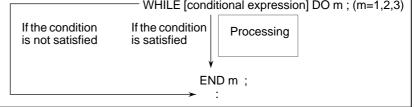
Table 15.5.2 Operators

#### Sample program

#### The sample program below finds the total of numbers 1 to 10.

O9500; #1=0;Initial value of the variable to hold the sum #2=1;Initial value of the variable as an addend N1 IF[#2 GT 10] GOTO 2; . Branch to N2 when the addend is greater than 10 #1=#1+#2; Calculation to find the sum #2=#2+1; Next addend GOTO 1; Branch to N1 N2 M30;End of program

# **15.5.3** Specify a conditional expression after WHILE. While the specified condition is satisfied, the program from DO to END is executed. If the specified condition is not satisfied, program execution proceeds to the block after END. WHILE [conditional expression] DO m; (m=1,2,3) If the condition is not satisfied If the condition is not satisfied



**Explanations** 

While the specified condition is satisfied, the program from DO to END after WHILE is executed. If the specified condition is not satisfied, program execution proceeds to the block after END. The same format as for the IF statement applies. A number after DO and a number after END are identification numbers for specifying the range of execution. The numbers 1, 2, and 3 can be used. When a number other than 1, 2, and 3 is used, P/S alarm No. 126 occurs.

#### Nesting

The identification numbers (1 to 3) in a DO–END loop can be used as many times as desired. Note, however, when a program includes crossing repetition loops (overlapped DO ranges), P/S alarm No. 124 occurs.

| 1. The identification numbers<br>(1 to 3) can be used as many<br>times as required.                    | 3. DO loops can be nested to a maximum depth of three levels.   |
|--|---|
| WHILE [ ] DO 1 ;<br>Processing<br>END 1 ;<br>:<br>WHILE [ ] DO 1 ;<br>Processing<br>END 1 ;<br>END 1 ; | :<br>WHILE [ ] DO 2 ;<br>:<br>WHILE [ ] DO 3 ;<br>Processing<br>END 3 ;<br>:<br>END 2 ;                     |
| 2. DO ranges cannot overlap.   | END 1 ;<br>4. Control can be transferred to the outside of a loop.  |
| Processing<br>WHILE [ ] DO 2 ;<br>:<br>END 1 ;<br>Processing   | WHILE [ ] DO 1 ;<br>IF [ ] GOTO n ;<br>END 1 ;<br>Nn  |
| END 2 ;  | 5. Branches cannot be made to a location within a loop.<br>IF [ ] GOTO n ;<br>:<br>WHILE [ ] DO 1 ;<br>Nn ; |
|  | └─ END 1 ;  |

#### Limitations

• Infinite loops

Processing time

• Undefined variable

When DO m is specified without specifying the WHILE statement, an infinite loop ranging from DO to END is produced.

When a branch to the sequence number specified in a GOTO statement occurs, the sequence number is searched for. For this reason, processing in the reverse direction takes a longer time than processing in the forward direction. Using the WHILE statement for repetition reduces processing time.

In a conditional expression that uses EQ or NE, a null value and zero have different effects. In other types of conditional expressions, a null value is regarded as zero.

#### Sample program

The sample program below finds the total of numbers 1 to 10.

O0001; #1=0; #2=1; WHILE[#2 LE 10]DO 1; #1=#1+#2; #2=#2+1; END 1; M30;

# 15.6 MACRO CALL

A macro program can be called using the following methods:

| Macro call | <ul> <li>Simple call ((G65)</li> <li>modal call (G66, G67)</li> <li>Macro call with G code</li> <li>Macro call with M code</li> <li>Subprogram call with M code</li> <li>Subprogram call with T code</li> </ul> |
|------------|---|
|            |   |
|            | Macro call  |

#### Restrictions

 Differences between macro calls and subprogram calls Macro call (G65) differs from subprogram call (M98) as described below.

- With G65, an argument (data passed to a macro) can be specified. M98 does not have this capability.
- When an M98 block contains another NC command (for example, G01 X100.0 M98Pp), the subprogram is called after the command is executed. On the other hand, G65 unconditionally calls a macro.
- When an M98 block contains another NC command (for example, G01 X100.0 M98Pp), the machine stops in the single block mode. On the other hand, G65 does not stops the machine.
- With G65, the level of local variables changes. With M98, the level of local variables does not change.

15.6.1

#### When G65 is specified, the custom macro specified at address P is called. Data (argument) can be passed to the custom macro program. Simple Call (G65) G65 P\_ L\_ <argument-specification>; Number of the program to call P\_: : Repetition count (1 by default) Argument : Data passed to the macro O0001; O9010; #3=#1+#2; G65 P9010 L2 A1.0 B2.0 : IF [#3 GT 360] GOTO 9 ; G00 X#3; M30 : N9 M99 ;

#### **Explanations**

Call

- After G65, specify at address P the program number of the custom macro to call.
- When a number of repetitions is required, specify a number from 1 to 9999 after address L. When L is omitted, 1 is assumed.
- By using argument specification, values are assigned to corresponding local variables.

Two types of argument specification are available. Argument specification I uses letters other than G, L, O, N, and P once each. Argument specification II uses A, B, and C once each and also uses I, J, and K up to ten times. The type of argument specification is determined automatically according to the letters used.

#### **Argument specification I**

| Address | Variable<br>number | Address | Variable<br>number | Address | Variable<br>number |
|---------|--------------------|---------|--------------------|---------|--------------------|
| А       | #1                 | I       | #4                 | Т       | #20                |
| В       | #2                 | J       | #5                 | U       | #21                |
| С       | #3                 | K       | #6                 | V       | #22                |
| D       | #7                 | М       | #13                | W       | #23                |
| E       | #8                 | Q       | #17                | Х       | #24                |
| F       | #9                 | R       | #18                | Y       | #25                |
| Н       | #11                | S       | #19                | Z       | #26                |

- Addresses G, L, N, O, and P cannot be used in arguments.
- Addresses that need not be specified can be omitted. Local variables corresponding to an omitted address are set to null.
- Addresses do not need to be specified alphabetically. They conform to word address format.

I, J, and K need to be specified alphabetically, however.

#### Example

B\_A\_D\_ ... J\_K\_ Correct B\_A\_D\_ ... J\_I\_ Incorrect

Argument specification

#### **Argument specification II**

Argument specification II uses A, B, and C once each and uses I, J, and K up to ten times. Argument specification II is used to pass values such as three–dimensional coordinates as arguments.

| Address                          | Variable<br>number | Address        | Variable<br>number | Address         | Variable<br>number |
|----------------------------------|--------------------|----------------|--------------------|-----------------|--------------------|
| А                                | #1                 | K <sub>3</sub> | #12                | J <sub>7</sub>  | #23                |
| В                                | #2                 | I4             | #13                | K <sub>7</sub>  | #24                |
| С                                | #3                 | $J_4$          | #14                | l <sub>8</sub>  | #25                |
| I <sub>1</sub>                   | #4                 | K <sub>4</sub> | #15                | J <sub>8</sub>  | #26                |
| $J_1$                            | #5                 | 1 <sub>5</sub> | #16                | K <sub>8</sub>  | #27                |
| K <sub>1</sub>                   | #6                 | $J_5$          | #17                | l <sub>9</sub>  | #28                |
| $I_2$                            | #7                 | $K_5$          | #18                | $J_9$           | #29                |
| $\overline{J}_2$                 | #8                 | I <sub>6</sub> | #19                | Kg              | #30                |
| J <sub>2</sub><br>K <sub>2</sub> | #9                 | J <sub>6</sub> | #20                | I <sub>10</sub> | #31                |
| l <sub>3</sub>                   | #10                | К <sub>6</sub> | #21                | J <sub>10</sub> | #32                |
| $J_3$                            | #11                | l <sub>7</sub> | #22                | K <sub>10</sub> | #33                |

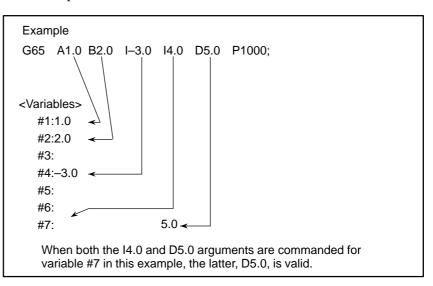
• Subscripts of I, J, and K for indicating the order of argument specification are not written in the actual program.

#### Restrictions

- Format
- Mixture of argument specifications I and II

G65 must be specified before any argument.

The CNC internally identifies argument specification I and argument specification II. If a mixture of argument specification I and argument specification II is specified, the type of argument specification specified later takes precedence.



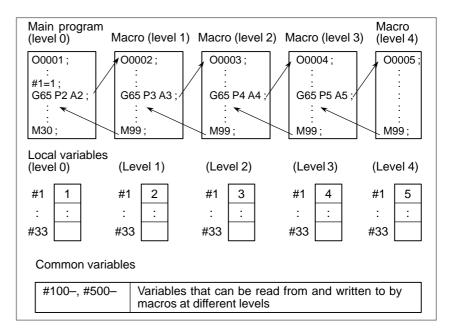
• Position of the decimal point

Call nesting

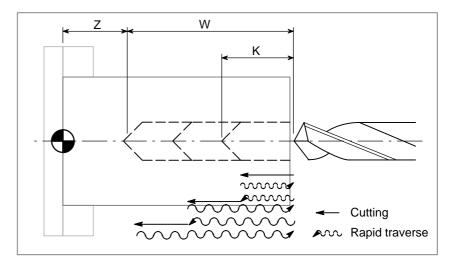
The units used for argument data passed without a decimal point correspond to the least input increment of each address. The value of an argument passed without a decimal point may vary according to the system configuration of the machine. It is good practice to use decimal points in macro call arguments to maintain program compatibility.

Calls can be nested to a depth of four levels including simple calls (G65) and modal calls (G66). This does not include subprogram calls (M98).

- Local variable levels
- Local variables from level 0 to 4 are provided for nesting.
- The level of the main program is 0.
- Each time a macro is called (with G65 or G66), the local variable level is incremented by one. The values of the local variables at the previous level are saved in the CNC.
- When M99 is executed in a macro program, control returns to the calling program. At that time, the local variable level is decremented by one; the values of the local variables saved when the macro was called are restored.



Move the tool beforehand along the X- and Z-axes to the position where a drilling cycle starts. Specify Z or W for the depth of a hole, K for the depth of a cut, and F for the cutting feedrate to drill the hole.



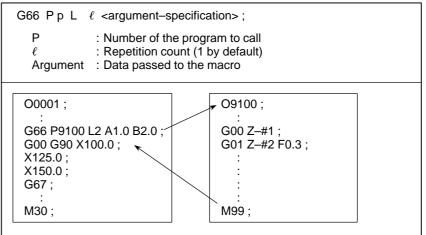
# Sample program (Drill cycle)

| • Calli | ng f | ormat |
|---------|------|-------|
|---------|------|-------|

| • Gaining format                            |  |
|---|--|
|   | G65 P9100 $\left\{ \begin{array}{c} Zz \\ Ww \end{array} \right\}$ Kk Ff;            |
|   | Z: Hole depth (absolute specification)<br>U: Hole depth (incremental specification)  |
|   | K: Cutting amount per cycle  |
|   | F: Cutting feedrate  |
|   |  |
| <ul> <li>Program calling a macro</li> </ul> | 00002;   |
| program                                     | G50 X100.0 Z200.0 ;  |
|   | G00 X0 Z102.0 S1000 M03 ;  |
|   | G65 P9100 Z50.0 K20.0 F0.3 ;   |
|   | G00 X100.0 Z200.0 M05 ;  |
|   | M30 ;  |
| <ul> <li>Macro program</li> </ul>           | O9100;   |
| (called program)                            | <b>#1=0</b> ; Clear the data for the depth of the current hole.                      |
|   | <b>#2=0 ;</b> Clear the data for the depth of the preceding                          |
|   | hole.  |
|   | <b>IF [#23 NE #0] GOTO 1 ;</b> If incremental programming, specifies the jump to N1. |
|   | IF [#26 EQ #0] GOTO 8; If neither Z nor W is specified, an error occurs.             |
|   | #23=#5002-#26; Calculates the depth of a hole.                                       |
|   | N1 #1=#1+#6; Calculates the depth of the current hole.                               |
|   | IF [#1 LE #23] GOTO 2; Determines whether the hole to be cut is too deep?            |
|   | #1=#23; Clamps at the depth of the current hole.                                     |
|   | N2 G00 W-#2; Moves the tool to the depth of the preceding                            |
|   | hole at the cutting feedrate.  |
|   | <b>G01 W</b> - [#1-#2] F#9; Drills the hole.   |
|   | <b>G00 W#1</b> ; Moves the tool to the drilling start point.                         |
|   | IF [#1 GE #23] GOTO 9; Checks whether drilling is completed.                         |
|   | #2=#1; Stores the depth of the current hole.   |
|   | GOTO 1;  |
|   | N9 M99;  |
|   | N8 #3000=1 (NOT Z OR U COMMAND)  |
|   |  |

## 15.6.2 Modal Call (G66)

Once G66 is issued to specify a modal call a macro is called after a block specifying movement along axes is executed. This continues until G67 is issued to cancel a modal call.



#### **Explanations**

Cancellation

Call nesting

Restrictions

Modal call nesting

• Call

- After G66, specify at address P a program number subject to a modal call.
- When a number of repetitions is required, a number from 1 to 9999 can be specified at address L.
- As with a simple call (G65), data passed to a macro program is specified in arguments.
- When a G67 code is specified, modal macro calls are no longer performed in subsequent blocks.
- Calls can be nested to a depth of four levels including simple calls (G65) and modal calls (G66). This does not include subprogram calls (M98).

Modal calls can be nested by specifying another G66 code during a modal call.

- In a G66 block, no macros can be called.
- G66 needs to be specified before any arguments.
- No macros can be called in a block which contains a code such as a miscellaneous function that does not involve movement along an axis.
- Local variables (arguments) can only be set in G66 blocks. Note that local variables are not set each time a modal call is performed.

## U • Calling format G66 P9110 Uu Ff; U: Groove depth (incremental specification) F: Cutting feed of grooving • Program that calls a **O0003**; macro program G50 X100.0 Z200.0; S1000 M03; G66 P9110 U5.0 F0.5; G00 X60.0 Z80.0; Z50.0; Z30.0; G67; G00 X00.0 Z200.0 M05; M30; • Macro program **O9110;** (program called) G01 U-#21 F#9 ; ..... Cuts the workpiece. **G00 U#21 ;** ..... Retracts the tool.

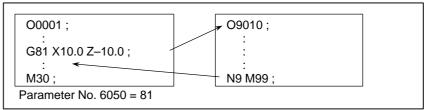
M99;

#### Sample program

#### This program makes a groove at a specified position.

## 15.6.3 Macro Call Using G Code

By setting a G code number used to call a macro program in a parameter, the macro program can be called in the same way as for a simple call (G65).



#### **Explanations**

By setting a G code number from 1 to 9999 used to call a custom macro program (9010 to 9019) in the corresponding parameter (Nos. 6050 to 6059), the macro program can be called in the same way as with G65. For example, when a parameter is set so that macro program O9010 can be called with G81, a user–specific cycle created using a custom macro can be called without modifying the machining program.

| Correspondence      |  |
|---------------------|--|
| between parameter   |  |
| numbers and program |  |
| numbers             |  |
|                     |  |

| 6050 |
|------|
| 6051 |
| 6052 |
| 6053 |
| 6054 |
| 6055 |
| 6056 |
| 6057 |
| 6058 |
| 6059 |
|      |

• Repetition

As with a simple call, a number of repetitions from 1 to 9999 can be specified at address L.

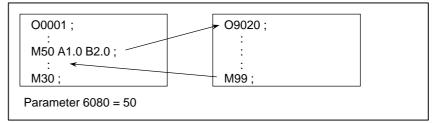
• Argument specification As with a simple call, two types of argument specification are available: Argument specification I and argument specification II. The type of argument specification is determined automatically according to the addresses used.

#### Restrictions

 Nesting of calls using G codes
 In a program called with a G code, no macros can be called using a G code. A G code in such a program is treated as an ordinary G code. In a program called as a subprogram with an M or T code, no macros can be called using a G code. A G code in such a program is also treated as an ordinary G code.

## 15.6.4 Macro Call Using an M Code

By setting an M code number used to call a macro program in a parameter, the macro program can be called in the same way as with a simple call (G65).



#### Explanations

By setting an M code number from 1 to 99999999 used to call a custom macro program (O9020 to O9029) in the corresponding parameter (Nos. 6080 to 6089), the macro program can be called in the same way as with G65.

| • | Correspondence      |
|---|---------------------|
|   | between parameter   |
|   | numbers and program |
|   | numbers             |

| Program number | Parameter number |
|----------------|------------------|
| O9020          | 6080             |
| O9021          | 6081             |
| O9022          | 6082             |
| O9023          | 6083             |
| O9024          | 6084             |
| O9025          | 6085             |
| O9026          | 6086             |
| O9027          | 6087             |
| O9028          | 6088             |
| O9029          | 6089             |

- **Repetition** As with a simple call, a number of repetitions from 1 to 9999 can be specified at address L.
- Argument specification As with a simple call, two types of argument specification are available: Argument specification I and argument specification II. The type of argument specification is determined automatically according to the addresses used.

#### Restrictions

- An M code used to call a macro program must be specified at the start of a block.
- In a macro called with a G code or in a program called as a subprogram with an M or T code, no macros can be called using an M code. An M code in such a macro or program is treated as an ordinary M code.

## 15.6.5 Subprogram Call Using an M Code

By setting an M code number used to call a subprogram (macro program) in a parameter, the macro program can be called in the same way as with a subprogram call (M98).

| O0001 ;             | ► O9001 ;     |  |
|---------------------|---------------|--|
| :<br>M03 ;          |               |  |
| : <<br>M30 ;        | :<br>—— M99 ; |  |
| Parameter 6071 = 03 |               |  |

#### **Explanations**

By setting an M code number from 1 to 99999999 used to call a subprogram in a parameter (Nos. 6071 to 6076), the corresponding custom macro program (O9001 to O9006) can be called in the same way as with M98.

| • | Correspondence      |
|---|---------------------|
|   | between parameter   |
|   | numbers and program |
|   | numbers             |

| Program number | Parameter number |
|----------------|------------------|
| O9001          | 6071             |
| O9002          | 6072             |
| O9003          | 6073             |
| O9004          | 6074             |
| O9005          | 6075             |
| O9006          | 6076             |
| O9007          | 6077             |
| O9008          | 6078             |
| O9009          | 6079             |

Repetition

- As with a simple call, a number of repetitions from 1 to 9999 can be specified at address L.
- Argument specification Argument specification is not allowed.
- M code

Limitations

ordinary M code. In a macro called with a G code or in a program called with an M or T code,

An M code in a macro program that has been called is treated as an

no subprograms can be called using an M code. An M code in such a macro or program is treated as an ordinary M code.

## 15.6.6 By enabling subprograms (macro program) to be called with a T code in a parameter, a macro program can be called each time the T code is **Subprogram Calls** specified in the machining program. Using a T Code O0001; O9000; T0203 ; -M30; M99 ; Bit 5(TCS) of parameter No. 6001 = 1 **Explanations** • Call By setting bit 5 (TCS) of parameter No. 6001 to 1, the macro program O9000 can be called when a T code is specified in the machining program. A T code specified in a machining program is assigned to common variable #149. Limitations In a macro called with a G code or in a program called with an M or T code, no subprograms can be called using a T code. A T code in such a macro or program is treated as an ordinary T code.

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| 15.6.7<br>Sample Program                                   | By using the subprogram call function that uses M codes, the cumulative usage time of each tool is measured.   |  |
|--|--|--|
| Conditions   | <ul> <li>The cumulative usage time of each of tool numbers 1 to 5 is measured. The time is not measured for tools whose number is 6 or more.</li> <li>The following variables are used to store the tool numbers and measured times:         <ul> <li>#501</li> <li>Cumulative usage time of tool number 1</li> <li>#502</li> <li>Cumulative usage time of tool number 2</li> <li>#503</li> <li>Cumulative usage time of tool number 3</li> <li>#504</li> <li>Cumulative usage time of tool number 4</li> <li>#505</li> </ul> </li> <li>Usage time starts being counted when the M03 command is specified</li> </ul> |  |
|  | and stops when M05 is specified. System variable #3002 is used to<br>measure the time during which the cycle start lamp is on. The time<br>during which the machine is stopped by feed hold and single block<br>stop operation is not counted, but the time used to change tools and<br>pallets is included.   |  |
| Operation check  |  |  |
| • Parameter setting  | Set 3 in parameter No. 6071, and set 05 in parameter No. 6072.   |  |
| • Variable value setting                                   | Set 0 in variables #501 to #505.   |  |
| <ul> <li>Program that calls a<br/>macro program</li> </ul> | O0001;<br>T0100 M06;<br>M03;<br>:  |  |
|  | M05; Changes #501.<br>T0200 M06;<br>M03;<br>:  |  |
|  | M05; Changes #502.<br>T0300 M06;<br>M03;   |  |
|  | :<br>M05; Changes #503.<br>T0400 M06;<br>M03;<br>:   |  |
|  | M05; Changes #504.<br>T0500 M06;<br>M03;<br>:  |  |
|  | M05; Changes #505.<br>M30;   |  |

## Macro program (program called)

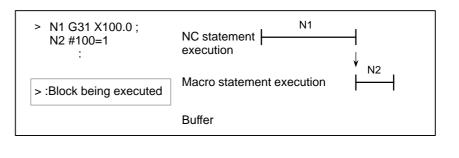
| O9001(M03);<br>M01;   | Macro to start counting  |
|---|--|
| IF[FIX[#4120/100] EQ 0]GOTO<br>IF[FIX[#4120/100] GT 5]GOTO                                  | 9; No tool specified<br>9; Out–of–range tool number<br>Clears the timer. |
| <b>N9 M03;</b> Rotate <b>M99;</b>   | es the spindle in the forward direction.                                 |
| O9002(M05);<br>M01;   | Macro to end counting  |
| IF[FIX[#4120/100] EQ 0]GOTO<br>IF[FIX[#4120/100] GT 5]GOTO<br>#[500+FIX[#4120/100]]=#3002+# | ,  |
|   | Calculates cumulative time.  |
| N9 M05;<br>M99;   | Stops the spindle.   |

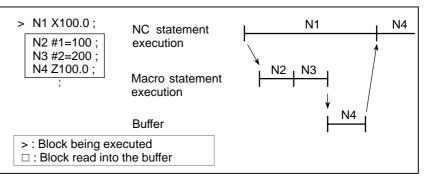
## 15.7 PROCESSING MACRO STATEMENTS

For smooth machining, the CNC prereads the CNC statement to be performed next. This operation is referred to as buffering. In tool nose radius compensation mode (G41, G42), the NC prereads NC statements two or three blocks ahead to find intersections. Macro statements for arithmetic expressions and conditional branches are processed as soon as they are read into the buffer. Blocks containing M00, M01, M02, or M30, blocks containing M codes for which buffering is suppressed by setting parameter(Nos. 3411 to 3420), and blocks containing G31 are not preread.

#### Explanations

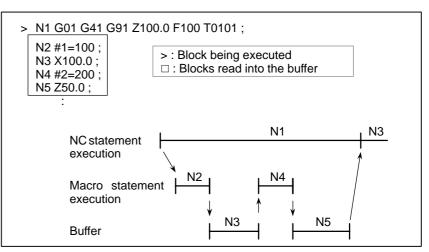
- When the next block is not buffered (M codes that are not buffered, G31, etc.)
- Buffering the next block in other than tool nose radius compensation mode (G41, G42) (normally prereading one block)





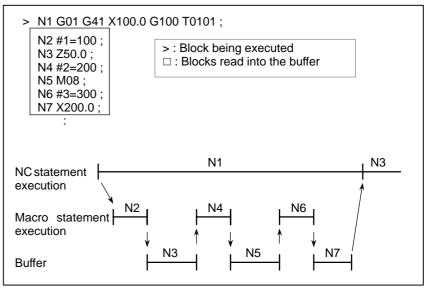
When N1 is being executed, the next NC statement (N4) is read into the buffer. The macro statements (N2, N3) between N1 and N4 are processed during execution of N1.

 Buffering the next block in tool nose radius compensation mode (G41, G42)



When N1 is being executed, the NC statements in the next two blocks (up to N5) are read into the buffer. The macro statements (N2, N4) between N1 and N5 are processed during execution of N1.

 When the next block involves no movement in tool nose radius compensation C (G41, G42) mode



When the NC1 block is being executed, the NC statements in the next two blocks (up to N5) are read into the buffer. Since N5 is a block that involves no movement, an intersection cannot be calculated. In this case, the NC statements in the next three blocks (up to N7) are read. The macro statements (N2, N4, and N6) between N1 and N7 are processed during execution of N1.

## 15.8 REGISTERING CUSTOM MACRO PROGRAMS

Custom macro programs are similar to subprograms. They can be registered and edited in the same way as subprograms. The storage capacity is determined by the total length of tape used to store both custom macros and subprograms.

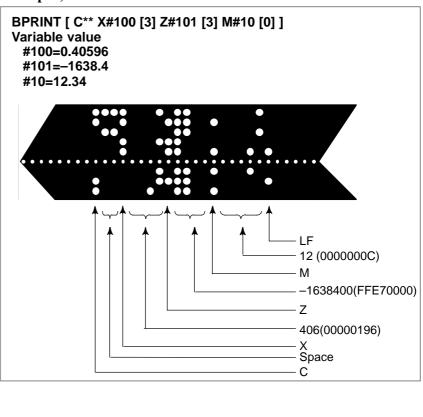
## 15.9 LIMITATIONS

| MDI operation   | The macro call command can be specified in MDI mode too. During<br>automatic operation, however, it is impossible to switch to the MDI mode<br>for a macro program call.   |
|---|--|
| <ul> <li>Sequence number<br/>search</li> </ul>  | A custom macro program cannot be searched for a sequence number.   |
| • Single block  | Even while a macro program is being executed, blocks can be stopped in<br>the single block mode (except blocks containing macro call commands,<br>arithmetic operation commands, and control commands).<br>A block containing a macro call command (G65, G66, or G67) does not<br>stop even when the single block mode is on. Blocks containing arithmetic<br>operation commands and control commands can be stopped in single<br>block mode by setting SBM (bit 5 of parameter 6000) to 1.<br>Single block stop operation is used for testing custom macro programs.<br>Note that when a single block stop occurs at a macro statement in tool nose<br>radius compensation mode, the statement is assumed to be a block that<br>does not involve movement, and proper compensation cannot be<br>performed in some cases. (Strictly speaking, the block is regarded as<br>specifying a movement with a travel distance 0.) |
| <ul> <li>Optional block skip</li> </ul>   | A / appearing in the middle of an <expression> (enclosed in brackets [] on the right-hand side of an arithmetic expression) is regarded as a division operator; it is not regarded as the specifier for an optional block skip code.</expression>  |
| <ul> <li>Operation in EDIT mode</li> </ul>  | By setting NE8 (bit 0 of parameter 3202) and NE9 (bit 4 of parameter 3202) to 1, deletion and editing are disabled for custom macro programs and subprograms with program numbers 8000 to 8999 and 9000 to 9999. Registered custom macro programs and subprograms should be protected from being destroyed by accident. When the entire memory is cleared (by pressing the RESET and DELETE keys at the same time to turn on the power), the contents of memory such as custom macro programs are deleted.   |
|   | the contents of memory such as custom macro programs are deleted.  |
| • Reset   | With a reset operation, local variables and common variables #100 to #149 are cleared to null values. They can be prevented from being cleared by setting, CLV and CCV (bits 7 and 6 of parameter 6001). System variables #1000 to #1133 are not cleared.<br>A reset operation clears any called states of custom macro programs and subprograms, and any DO states, and returns control to the main program.  |
| <ul> <li>Display of the PROGRAM<br/>RESTART screen</li> </ul>                         | As with M98, the M and T codes used for subprogram calls are not displayed.  |
| Feed hold   | When a feed hold is enabled during execution of a macro statement, the machine stops after execution of the macro statement. The machine also stops when a reset or alarm occurs.  |
| <ul> <li>Constant values that can<br/>be used in <expression></expression></li> </ul> | +0.0000001 to +99999999<br>-99999999 to -0.0000001<br>The number of significant digits is 8 (decimal). If this range is exceeded,<br>P/S alarm No. 003 occurs.   |

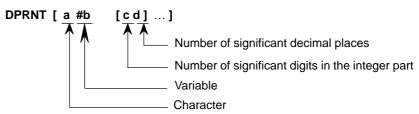
| In addition to the standard custom macro commands, the following macro<br>commands are available. They are referred to as external output<br>commands.<br>- BPRNT<br>- DPRNT<br>- POPEN<br>- PCLOS<br>These commands are provided to output variable values and characters<br>through the reader/punch interface.  |
|--|
| Specify these commands in the following order:   |
| <b>Open command: POPEN</b><br>Before specifying a sequence of data output commands, specify this command to establish a connection to an external input/output device.   |
| Data output command: BPRNT or DPRNT<br>Specify necessary data output.  |
| <b>Close command: PCLOS</b><br>When all data output commands have completed, specify PCLOS to release a connection to an external input/output device.   |
| <b>POPEN</b><br>POPEN establishes a connection to an external input/output device. It<br>must be specified before a sequence of data output commands. The CNC<br>outputs a DC2 control code.   |
| <ul> <li>BPRNT [ a #b [c]]<br/>Number of significant decimal places<br/>Variable<br/>Character</li> <li>The BPRNT command outputs characters and variable values in binary.</li> <li>(i) Specified characters are converted to corresponding ISO codes<br/>according to the setting data (ISO) that is output at that time.<br/>Specifiable characters are as follows: <ul> <li>Letters (A to Z)</li> <li>Numbers</li> <li>Special characters (*, /, +, -, etc.)<br/>An asterisk (*) is output by a space code.</li> </ul> </li> </ul> |
|  |

- (ii) All variables are stored with a decimal point. Specify a variable followed by the number of significant decimal places enclosed in brackets. A variable value is treated as 2–word (32–bit) data, including the decimal digits. It is output as binary data starting from the highest byte.
- (iii)When specified data has been output, an EOB code is output according to the ISO code settings.
- (iv) Null variables are regarded as 0.





 Data output command DPRNT



The DPRNT command outputs characters and each digit in the value of a variable according to the code set in the settings (ISO).

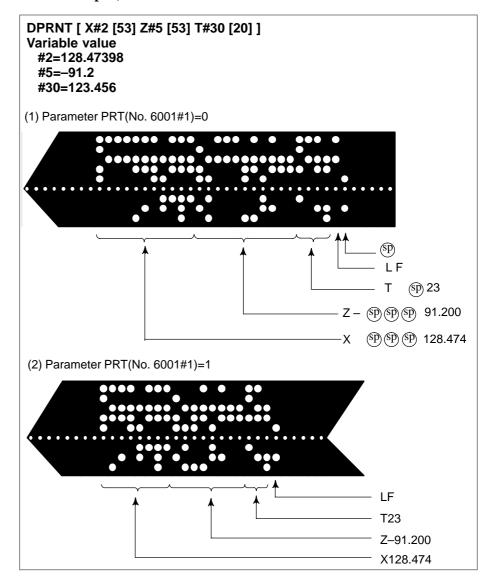
- (i) For an explanation of the DPRNT command, see Items (i), (iii), and (iv) for the BPRNT command.
- (ii) When outputting a variable, specify # followed by the variable number, then specify the number of digits in the integer part and the number of decimal places enclosed in brackets.

One code is output for each of the specified number of digits, starting with the highest digit. For each digit, a code is output according to the settings (ISO). The decimal point is also output using a code set in the settings (ISO).

Each variable must be a numeric value consisting of up to eight digits. When high–order digits are zeros, these zeros are not output if PRT (bit1 of parameter 6001) is 1. If PRT (bit 1 of parameter 6001) is 0, a space code is output each time a zero is encountered.

When the number of decimal places is not zero, digits in the decimal part are always output. If the number of decimal places is zero, no decimal point is output. When PRT (bit 1 of parameter 6001) is 0, a space code is output to indicate a positive number instead of +; if PRT(bit 1 of parameter 6001) is 1, no code is output.

Example)



Close command PCLOS

#### PCLOS;

The PCLOS command releases a connection to an external input/output device. Specify this command when all data output commands have terminated. DC4 control code is output from the CNC.

• Required setting

Specify the channel use for parameter 020. According to the specification of this parameter, set data items (such as the baud rate) for the reader/punch interface.

I/O channel 0 : Parameters 101, 102 and 103
I/O channel 1 : Parameters 111, 112 and 113
I/O channel 2 : Parameters 121, 122 and 123
Never specify output to the Fanuc Cassette or floppy disks.)
When specifying a DPRNT command to output data, specify whether leading zeros are output as spaces (by setting PRT (bit 1 of parameter 6001) to 1 or 0). To indicate the end of a line of data in ISO code, specify whether to use only an LF (NCR, of bit 3 of parameter 0103 is 0) or an LF and CR (NCR is 1).

#### NOTE

- 1 It is not necessary to always specify the open command (POPEN), data output command (BPRNT, DPRNT), and close command (PCLOS) together. Once an open command is specified at the beginning of a program, it does not need to be specified again except after a close command was specified.
- 2 Be sure to specify open commands and close commands in pairs. Specify the close command at the end of the program. However, do not specify a close command if no open command has been specified.
- 3 When a reset operation is performed while commands are being output by a data output command, output is stopped and subsequent data is erased. Therefore, when a reset operation is performed by a code such as M30 at the end of a program that performs data output, specify a close command at the end of the program so that processing such as M30 is not performed until all data is output.
- 4 Abbreviated macro words enclosed in brackets [] remains unchanged. However, note that when the characters in brackets are divided and input several times, the second and subsequent abbreviations are converted and input.
- 5 O can be specified in brackets []. Note that when the characters in brackets [] are divided and input several times, O is omitted in the second and subsequent inputs.

## 15.11 INTERRUPTION TYPE CUSTOM MACRO

#### Format

When a program is being executed, another program can be called by inputting an interrupt signal (UINT) from the machine. This function is referred to as an interruption type custom macro function. Program an interrupt command in the following format:

| M96 P0000 ; | Enables custom macro interrupt  |
|-------------|---------------------------------|
| M97;        | Disables custom macro interrupt |

#### Explanations

Use of the interruption type custom macro function allows the user to call a program during execution of an arbitrary block of another program. This allows programs to be operated to match situations which vary from time to time.

- (1) When a tool abnormality is detected, processing to handle the abnormality is started by an external signal.
- (2) A sequence of machining operations is interrupted by another machining operation without the cancellation of the current operation.
- (3) At regular intervals, information on current machining is read. Listed above are examples like adaptive control applications of the interruption type custom macro function.

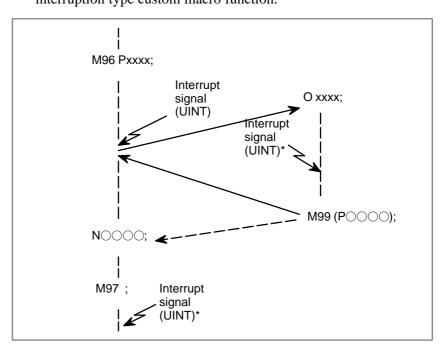


Fig. 15.11 Interruption type custom macro function

When M96Pxxxx is specified in a program, subsequent program operation can be interrupted by an interrupt signal (UINT) input to execute the program specified by Pxxxx.

#### CAUTION

When the interrupt signal (UINT, marked by \* in Fig. 15.11) is input after M97 is specified, it is ignored. And the interrupt signal must not be input during execution of the interrupt program.

## 15.11.1 Specification Method

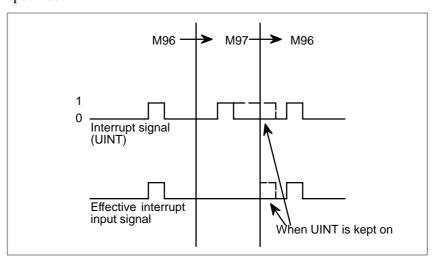
#### **Explanations**

• Interrupt conditions

A custom macro interrupt is available only during program execution. It is enabled under the following conditions

- When memory operation or MDI operation is selected
- When STL (start lamp) is on
- When a custom macro interrupt is not currently being processed

Generally, the custom macro interrupt function is used by specifying M96 to enable the interrupt signal (UINT) and M97 to disable the signal. Once M96 is specified, a custom macro interrupt can be initiated by the input of the interrupt signal (UINT) until M97 is specified or the NC is reset. After M97 is specified or the NC is reset, no custom macro interrupts are initiated even when the interrupt signal (UINT) is input. The interrupt signal (UINT) is ignored until another M96 command is specified.



The interrupt signal (UINT) becomes valid after M96 is specified. Even when the signal is input in M97 mode, it is ignored. When the signal input in M97 mode is kept on until M96 is specified, a custom macro interrupt is initiated as soon as M96 is specified (only when the status–triggered scheme is employed); when the edge–triggered scheme is employed, the custom macro interrupt is not initiated even when M96 is specified.

Specification

#### NOTE

For the status-triggered and edge-triggered schemes, see Item "Custom macro interrupt signal (UINT)" of Subsec. 16.11.2.

### 15.11.2 **Details of Functions**

#### **Explanations**

• ubprogram-type interrupt and macro-type interrupt

There are two types of custom macro interrupts: Subprogram-type interrupts and macro-type interrupts. The interrupt type used is selected by MSB (bit 5 of parameter 6003).

#### (a) Subprogram-type interrupt

An interrupt program is called as a subprogram. This means that the levels of local variables remain unchanged before and after the interrupt. This interrupt is not included in the nesting level of subprogram calls.

#### (b) Macro-type interrupt

An interrupt program is called as a custom macro. This means that the levels of local variables change before and after the interrupt. The interrupt is not included in the nesting level of custom macro calls. When a subprogram call or a custom macro call is performed within the interrupt program, this call is included in the nesting level of subprogram calls or custom macro calls. Arguments cannot be passed from the current program even when the custom macro interrupt is a macro-type interrupt.

In general, custom macro interrupts are controlled by M96 and M97. However, these M codes, may already being used for other purposes (such as an M function or macro M code call) by some machine tool builders. For this reason, MPR (bit 4 of parameter 6003) is provided to set M codes for custom macro interrupt control.

When specifying this parameter to use the custom macro interrupt control M codes set by parameters, set parameters 6033 and 6034 as follows:

Set the M code to enable custom macro interrupts in parameter 6033, and set the M code to disable custom macro interrupts in parameter 6034.

When specifying that parameter-set M codes are not used, M96 and M97 are used as the custom macro control M codes regardless of the settings of parameters 6033 and 6034.

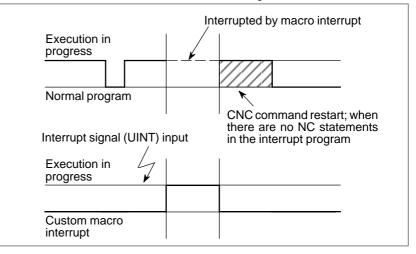
The M codes used for custom macro interrupt control are processed internally (they are not output to external units). However, in terms of program compatibility, it is undesirable to use M codes other than M96 and M97 to control custom macro interrupts.

 Custom macro interrupts When performing a custom macro interrupt, the user may want to interrupt the NC statement being executed, or the user may not want to perform the interrupt until the execution of the current block is completed. MIN (bit 2 of parameter 6003) is used to select whether to perform interrupts even in the middle of a block or to wait until the end of the block.

#### M codes for custom macro interrupt control

and NC statements

- Type I (when an interrupt is performed even in the middle of the block)
- (i) When the interrupt signal (UINT) is input, any movement or dwell being performed is stopped immediately and the interrupt program is executed.
- (ii) If there are NC statements in the interrupt program, the command in the interrupted block is lost and the NC statement in the interrupt program is executed. When control is returned to the interrupted program, the program is restarted from the next block after the interrupted block.
- (iii)If there are no NC statements in the interrupt program, control is returned to the interrupted program by M99, then the program is restarted from the command in the interrupted block.



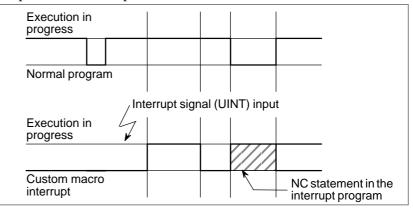
Type II

(when an interrupt is performed at the end of the block) (i) If the block being executed is not a block that consists of several cycle operations such as a drilling canned cycle and automatic reference position return (G28), an interrupt is performed as follows:

When an interrupt signal (UINT) is input, macro statements in the interrupt program are executed immediately unless an NC statement is encountered in the interrupt program. NC statements are not executed until the current block is completed.

(ii) If the block being executed consists of several cycle operations, an interrupt is performed as follows:

When the last movement in the cycle operations is started, macro statements in the interrupt program are executed unless an NC statement is encountered. NC statements are executed after all cycle operations are completed.



• Conditions for enabling and disabling the custom macro interrupt signal The interrupt signal becomes valid after execution starts of a block that contains M96 for enabling custom macro interrupts. The signal becomes invalid when execution starts of a block that contains M97. While an interrupt program is being executed, the interrupt signal becomes invalid. The signal become valid when the execution of the

becomes invalid. The signal become valid when the execution of the block that immediately follows the interrupted block in the main program is started after control returns from the interrupt program. In type I, if the interrupt program consists of only macro statements, the interrupt signal becomes valid when execution of the interrupted block is started after control returns from the interrupt program.

#### Custom macro interrupt during execution of a block that involves cycle operation

- For type I Even when cycle operation is in progress, movement is interrupted, and the interrupt program is executed. If the interrupt program contains no NC statements, the cycle operation is restarted after control is returned to the interrupted program. If there are NC statements, the remaining operations in the interrupted cycle are discarded, and the next block is executed.
   For type II When the last movement of the cycle operation is started, macro statements in the interrupt program are executed unless an NC statement
  - or type II when the last movement of the cycle operation is started, macro statements in the interrupt program are executed unless an NC statement is encountered. NC statements are executed after cycle operation is completed.

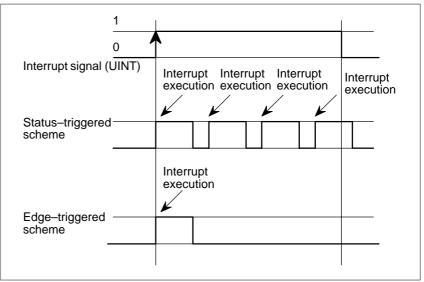
#### Custom macro interrupt signal (UINT)

There are two schemes for custom macro interrupt signal (UINT) input: The status-triggered scheme and edge- triggered scheme. When the status-triggered scheme is used, the signal is valid when it is on. When the edge triggered scheme is used, the signal becomes valid on the rising edge when it switches from off to on status.

One of the two schemes is selected with TSE (bit 3 of parameter 6003). When the status-triggered scheme is selected by this parameter, a custom macro interrupt is generated if the interrupt signal (UINT) is on at the time the signal becomes valid. By keeping the interrupt signal (UINT) on, the interrupt program can be executed repeatedly.

When the edge-triggered scheme is selected, the interrupt signal (UINT) becomes valid only on its rising edge. Therefore, the interrupt program is executed only momentarily (in cases when the program consists of only macro statements). When the status-triggered scheme is inappropriate, or when a custom macro interrupt is to be performed just once for the entire program (in this case, the interrupt signal may be kept on), the edge-triggered scheme is useful.

Except for the specific applications mentioned above, use of either scheme results in the same effects. The time from signal input until a custom macro interrupt is executed does not vary between the two schemes.



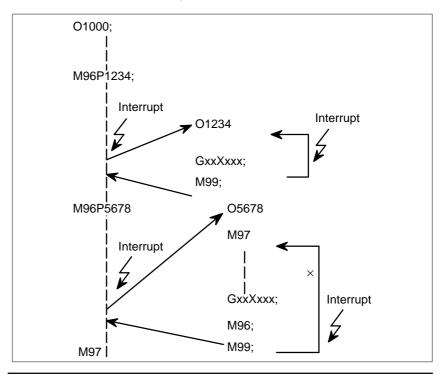
In the above example, an interrupt is executed four times when the status triggered scheme is used; when the edge– triggered scheme is used, the interrupt is executed just once.

#### Return from a custom macro interrupt

To return control from a custom macro interrupt to the interrupted program, specify M99. A sequence number in the interrupted program can also be specified using address P. If this is specified, the program is searched from the beginning for the specified sequence number. Control is returned to the first sequence number found.

When a custom macro interrupt program is being executed, no interrupts are generated. To enable another interrupt, execute M99. When M99 is specified alone, it is executed before the preceding commands terminate. Therefore, a custom macro interrupt is enabled for the last command of the interrupt program. If this is inconvenient, custom macro interrupts should be controlled by specifying M96 and M97 in the program.

When a custom macro interrupt is being executed, no other custom macro interrupts are generated; when an interrupt is generated, additional interrupts are inhibited automatically. Executing M99 makes it possible for another custom macro interrupt to occur. M99 specified alone in a block is executed before the previous block terminates. In the following example, an interrupt is enabled for the Gxx block of O1234. When the signal is input, O1234 is executed again. O5678 is controlled by M96 and M97. In this case, an interrupt is not enabled for O5678 (enabled after control is returned to O1000).



#### NOTE

When an M99 block consists only of address O, N, P, L, or M, this block is regarded as belonging to the previous block in the program. Therefore, a single–block stop does not occur for this block. In terms of programming, the following (1) and (2) are basically the same. (The difference is whether G $\bigcirc$  is executed before M99 is recognized.) (1) G $\bigcirc$  X $\bigcirc$  $\bigcirc$ ; M99;

(2) GOO XOOO M99;

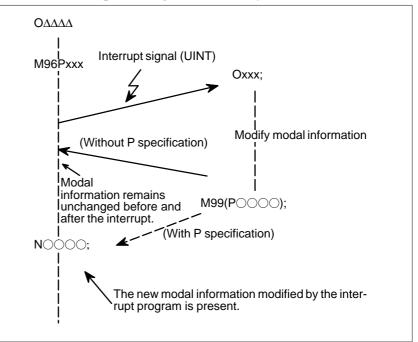
#### Custom macro interrupt and modal information

A custom macro interrupt is different from a normal program call. It is initiated by an interrupt signal (UINT) during program execution. In general, any modifications of modal information made by the interrupt program should not affect the interrupted program.

For this reason, even when modal information is modified by the interrupt program, the modal information before the interrupt is restored when control is returned to the interrupted program by M99.

When control is returned from the interrupt program to the interrupted program by M99 Pxxxx, modal information can again be controlled by the program. In this case, the new continuous information modified by the interrupt program is passed to the interrupted program. Restoration of the old modal information present before the interrupt is not desirable. This is because after control is returned, some programs may operate differently depending on the modal information present before the interrupt. In this case, the following measures are applicable:

- (1) The interrupt program provides modal information to be used after control is returned to the interrupted program.
- (2) After control is returned to the interrupted program, modal information is specified again as necessary.



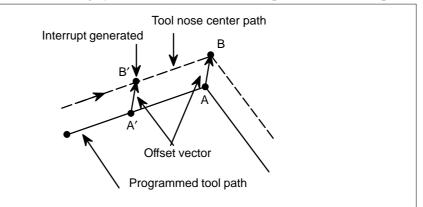
 Modal information when control is returned by M99

 Modal information when control is returned by M99 POOOO The modal information present before the interrupt becomes valid. The new modal information modified by the interrupt program is made invalid.

The new modal information modified by the interrupt program remains valid even after control is returned. The old modal information which was valid in the interrupted block can be read using custom macro system variables #4001 to #4120.

Note that when modal information is modified by the interrupt program, system variables #4001 to #4120 are not changed.

- System variables (position information values) for the interrupt program
- The coordinates of point A can be read using system variables #5001 and up until the first NC statement is encountered.
- The coordinates of point A' can be read after an NC statement with no move specifications appears.
- The machine coordinates and workpiece coordinates of point B' can be read using system variables #5021 and up and #5041 and up.



- Custom macro interrupt and custom macro modal call
- Custom macro interrupt and program restart

When the interrupt signal (UINT) is input and an interrupt program is called, the custom macro modal call is canceled (G67). However, when G66 is specified in the interrupt program, the custom macro modal call becomes valid. When control is returned from the interrupt program by M99, the modal call is restored to the state it was in before the interrupt was generated. When control is returned by M99Pxxxx;, the modal call in the interrupt program remains valid.

When the interrupt signal (UINT) is input while a return operation is being performed in the dry run mode after the search operation for program restart, the interrupt program is called after restart operation terminates for all axes. This means that interrupt type II is used regardless of the parameter setting.

 DNC operation and Interruption type custom macro

"Interruption type custom macro" cannot be done during DNC operation or executing a program with an external input–output device.

# **16** PROGRAMMABLE PARAMETER ENTRY (G10)

General

The values of parameters can be entered in a program. This function is used for setting pitch error compensation data when attachments are changed or the maximum cutting feedrate or cutting time constants are changed to meet changing machining conditions.

#### Format

|        | Format  |  |  |
|--------|---|--|--|
| G10L50 | ); Parameter entry mode setting                                     |  |  |
|        | For parameters other than the axis type                             |  |  |
| N_P_R  | N_P_R_; For axis type parameters                                    |  |  |
|        |   |  |  |
| G11;   | Parameter entry mode cancel   |  |  |
|        | Meaning of command  |  |  |
| N_:    | Parameter No. (4digits) or compensation position No.(0 to 1023) for |  |  |
|        | pitch errors compensation +10,000 (5digit)                          |  |  |
| R_:    | Parameter setting value (Leading zeros can be omitted.)             |  |  |
| P_:    | Axis No. 1 to 8 (Used for entering axis type parameters)            |  |  |

#### **Explanations**

- Parameter setting value (R\_)
- Axis No. (P\_)

Do not use a decimal point in a value set in a parameter  $(R_{-})$ . a decimal point cannot be used in a custom macro variable for R either.

Specify an axis number (P\_) from 1 to 8 (up to eight axes) for an axis type parameter. The control axes are numbered in the order in which they are displayed on the CNC display.

For example, specify P2 for the control axis which is displayed second.

#### WARNING

- 1 Do not fail to perform reference point return manually after changing the pitch error compensation data or backlash compensation data. Without this, the machine position can deviate from the correct position.
- 2 The canned-cycle mode must be cancelled before entering of parameters. When not cancelled, the drilling motion will be activated.

#### NOTE

Other NC statements cannot be specified while in parameter input mode.

#### Examples

1. Set bit 2 (SPB) of bit type parameter No. 3404

| G10L50 ;Parameter entry modeN3404 R 00000100 ;SBP settingG11 ;cancel parameter entry mode |  |
|---|--|

2. Change the values for the Z-axis (2nd axis) and C-axis (4th axis) in axis type parameter No. 1322 (the coordinates of stored stroke limit 2 in the positive direction for each axis).

| G10L50 ;        | Parameter entry mode        |
|-----------------|-----------------------------|
| N1322P2R4500 ;  | Modify Z axis               |
| N1322P4R12000 ; | Modify C axis               |
| G11 ;           | cancel parameter entry mode |

# MEMORY OPERATION BY Series 15 TAPE FORMAT

Programs in the Series 15 tape format can be registered in memory for memory operation by setting bit 1 of parameter No. 0001. Registration to memory and memory operation are possible for the functions which use the same tape format as that for the Series 15 as well as for the following functions which use a different tape format:

- Equal–lead threading
- Subprogram calling
- Canned cycle
- Multiple repetitive canned cycle
- Canned drilling cycle

#### NOTE

Registration to memory and memory operation are possible only for the functions available in this CNC.

## 17.1 ADDRESSES AND SPECIFIABLE VALUE RANGE FOR Series 15 TAPE FORMAT

Some addresses which cannot be used for the this CNC can be used in the Series 15 tape format. The specifiable value range for the Series 15 tape format is basically the same as that for the this CNC. Sections II–17.2 to II–17.5 describe the addresses with a different specifiable value range. If a value out of the specifiable value range is specified, an alarm is issued.

## 17.2 EQUAL-LEAD THREADING

#### Format

G32IP\_F\_Q\_; or G32IP\_E\_Q\_;

- IP:Combination of axis addresses
- F :Lead along the longitudinal axis
- E :Lead along the longitudinal axis
- Q :Sight of the threading start angle

#### **Explanations**

#### • Address

Although the Series 15 allows the operator to specify the number of threads per inch with address E, the Series 15 tape format does not. Addresses E and F are used in the same way for specifying the lead along the longitudinal axis. The thread lead specified with address E is therefore also assumed as a continuous–state value for address F.

## • Specifiable value range for the thread lead

| Address for thread lead |                                 | ddress for thread lead mm input |                              |
|-------------------------|---------------------------------|---------------------------------|------------------------------|
|                         | E                               | 0.0001 to 500.0000 mm           | 0.000001 to<br>9.999999 inch |
| F                       | Command with a decimal point    |                                 | 0.000001 to<br>9.999999 inch |
| ſ                       | Command without a decimal point | 0.01 to 500.00 mm               | 0.0001 to 9.9999 inch        |

## • Specifiable value range for the feedrate

| Address for feedrate    |                            | mm input                   | inch input                  |                              |
|-------------------------|----------------------------|----------------------------|-----------------------------|------------------------------|
| Feed<br>per<br>F minute | Increment<br>system (IS–B) | 1 to 240000<br>mm/min      | 0.01 to 9600.00<br>inch/min |                              |
|                         |                            | Increment<br>system (IS–C) | 1 to 100000<br>mm/min       | 0.01 to 4800.00<br>inch/min  |
|                         | Feed per rotation          |                            | 0.01 to 500.00<br>mm/rev    | 0.0001 to 9.9999<br>inch/rev |

#### WARNING

Specify the feedrate one more time when switching between feed per minute and feed per rotation.

## 17.3 SUBPROGRAM CALLING

#### Format

M98P0000L0000;

P:Subprogram number L:Repetition count

#### Explanation

| Address                               | Address L cannot be used in this CNC tape format but can be used in the Series 15 tape format.   |
|---------------------------------------|--|
| <ul> <li>Subprogram number</li> </ul> | The specifiable value range is the same as that for this CNC (1 to 9999). If a value of more than four digits is specified, the last four digits are assumed as the subprogram number. |
| <ul> <li>Repetition count</li> </ul>  | The repetition count L can be specified in the range from 1 to 9999. If no repetition count is specified, 1 is assumed.  |

# 17.4 CANNED CYCLE

Format

Outer / inner surface turning cycle (straight cutting cycle) G90X Z F ;

Outer / inner surface turning cycle (taper cutting cycle) G90X\_Z\_I\_F\_; I:Length of the taper section along the X-axis (radius) Threading cycle (straight threading cycle)

**G92X\_Z\_F\_Q\_;** F:Thread lead Q:Shift of the threading start angle

Threading cycle (taper threading cycle) G92X\_Z\_I\_F\_; I:Length of the taper section along the X-axis (radius)

End surface turning cycle (front taper cutting cycle) G94X\_Z\_F\_;

End surface turning cycle (front taper cutting cycle) G94X\_Z\_K\_F\_; K:Length of the taper section along the Z-axis

- Address
- Specifiable value range for the feedrate

Addresses I and K cannot be used for a canned cycle in this CNC tape format but can be used in the Series 15 tape format.

Same as that for equal-lead threading in section II-17.2. See section II-17.2.

# 17.5 MULTIPLE REPETITIVE CANNED TURNING CYCLE

Format

### Outer / inner surface turning cycle G71P\_Q\_U\_W\_I\_K\_D\_F\_S\_T\_;

- I : Length and direction of cutting allowance for finishing the rough machining cycle along the X-axis (ignored if specified)
- K : Length and direction of cutting allowance for finishing the rough machining cycle along the Z-axis (ignored if specified)
- D: Depth of cut

### End surface rough machining cycle G72P\_Q\_U\_W\_I\_K\_D\_F\_S\_T\_;

- I : Length and direction of cutting allowance for finishing the rough machining cycle along the X-axis (ignored if specified)
- K : Length and direction of cutting allowance for finishing the rough machining cycle along the Z-axis (ignored if specified)
- D: Depth of cut

### Closed–loop turning cycle

#### G73P\_Q\_U\_W\_I\_K\_D\_F\_S\_T\_;

- I: Length and direction of clearance along the X-axis (radius)
- K: Length and direction of clearance along the Z-axis
- D: Number of divisions

#### End surface cutting-off cycle

- G74X\_Z\_I\_K\_F\_D\_;
  - or

#### G74U\_W\_I\_K\_F\_D\_;

- I : Distance to be traveled along the X-axis
- K: Depth of cut along the Z-axis
- D: Clearance of the tool at the end of the cutting path

#### Outer / inner surface cutting-off cycle

- G75X\_Z\_I\_K\_F\_D\_;
  - or

#### G75U\_W\_I\_K\_F\_D\_;

- I : Distance to be traveled along the X-axis
- K: Depth of cut along the Z-axis
- D: Clearance of the tool at the end of the cutting path

#### Multiple repetitive threading cycle

# G76X\_Z\_I\_K\_D\_F\_A\_P\_Q\_;

- I : Difference of radiuses at threads
- K: Height of thread crest (radius)
- D: Depth of the first cut (radius)
- A: Angle of the tool tip (angle of ridges)
- P: Method of cutting

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# Addresses and specifiable value range

If the following addresses are specified in the Series 15 tape format, they are ignored.

- I and K for the outer/inner surface rough machining cycle (G71)
- I and K for the end surface rough machining cycle (G72)

For the multiple repetitive threading cycle (G76), specify P1 (constant depth of cutting with a single edge) or P2 (constant depth of zigzag thread cutting with both edges) as the cutting method (P). A value of between 0 and 120 degrees can be specified for tool tip angle A. If other values are specified, P/S alarm 062 is issued.

Address D (cutting depth and retraction distance) can be specified with a value between –99999999 and 99999999, in the minimum input increment, even when calculator–like decimal point input is specified (when bit 0 (DPI) of parameter No. 3401 is set to 1). When address D contains a decimal point, P/S alarm No. 007 is issued.

The specifiable value range for the feedrate is the same as that for equal-lead threading. See section II-17.2.

# 17.6 CANNED DRILLING CYCLE FORMATS

Format

#### Drilling cycle

### G81X\_C\_Z\_F\_L\_ ; or G82X\_C\_Z\_R\_F\_L\_ ;

R: Distance from the initial level to the R position

- P: Dwell time at the bottom of the hole
- F: Cutting feedrate
- L: Number of repetitions

#### Peck drilling cycle

G81X\_C\_Z\_R\_Q\_P\_F\_L\_;

- R: Distance from the initial level to the R position
- Q: Depth of cut in each cycle
- P: Dwell time at the bottom of the hole
- F: Cutting feedrate
- L: Number of repetitions

# High-speed peck drilling cycle G83.1X\_C\_Z\_R\_Q\_P\_F\_L\_;

- R: Distance from the initial level to the R position
- Q: Depth of cut in each cycle
- P: Dwell time at the bottom of the hole
- F: Cutting feedrate
- L: Number of repetitions

#### Tapping

### G84X\_C\_Z\_R\_P\_F\_L\_;

- R: Distance from the initial level to the R position
- P: Dwell time at the bottom of the hole
- F: Cutting feedrate
- L: Number of repetitions

### Rigid tapping

- G84.2X\_C\_Z\_R\_P\_F\_L\_S\_;
  - R: Distance from the initial level to the R position
  - P: Dwell time at the bottom of the hole
  - F: Cutting feedrate
  - L: Number of repetitions
  - S: Spindle speed

#### Boring cycle

# G85X\_C\_Z\_R\_F\_L\_; or G89X\_C\_Z\_R\_P\_F\_L\_;

- R: Distance from the initial level to the R position
- P: Dwell time at the bottom of the hole
- F: Cutting feedrate
- L: Number of repetitions

# Cancel

G80;

# Explanations

Address

For this CNC tape format, the address used to specify the number of repetitions is K. For the Series 15 tape format, it is L.

• G code

Some G codes are valid only for this CNC tape format or Series 15 tape format. Specifying an invalid G code results in P/S alarm No. 10 being generated.

| G codes valid only for the Series 15 tape format            | G81, G82, G83.1, G84.2 |
|---|------------------------|
| G codes valid only for the Series 16/18/160/180 tape format | G87, G88               |

 Positioning plane and drilling axis For this CNC tape format, the positioning plane and drilling axis are determined according to the G code for the canned cycle used.

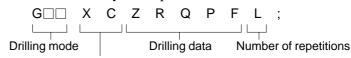
For the Series 15 tape format, the positioning plane and drilling axis are determined according to G17/G19.

The drilling axis is the basic axis (Z-axis or X-axis) that does not lie in the positioning plane.

| G code | Positioning plane | Drilling axis |
|--------|-------------------|---------------|
| G17    | XY plane          | Z–axis        |
| G19    | YZ plane          | X–axis        |

Resetting bit 1 (FXY) of parameter No. 5101 enables fixing of the drilling axis to the Z-axis.

 Details of data specifying machining Data for the canned cycle is specified as follows:



Hole position data

| Setting                 | Address          | Explanation  |
|-------------------------|------------------|--|
| Drilling<br>mode        | G                | Canned drilling cycle G code   |
| Hole posi-<br>tion data | X/U (Z/W)<br>C/H | Incremental or absolute value used to specify the hole position  |
|                         | Z/W (X/U)        | Incremental or absolute value used to specify the distance from the R position to the bottom of the hole   |
| Drilling                | R                | Incremental value used to specify the distance<br>from the initial level to the R position, or absolute<br>value used to specify the R position. Which to use<br>depends on bit 6 of parameter No. 5102 and the G<br>code system being used. |
| mode                    | Q                | Incremental value used to specify the depth of cut in each G83 or G83.1 cycle with radius programming.   |
|                         | Р                | Dwell time at the bottom of the hole. The relation-<br>ship between the dwell time and the specified val-<br>ue is the same as that for G04.   |
|                         | F                | Cutting feedrate   |
| Number of repetitions   | L                | Number of repetitions for a sequence of cutting operations. If L is not specified, it is assumed to be 1.  |

# • Specifying the R position

The R position is specified as an incremental value for the distance between the initial level to the R position. For the Series 15 tape format, the parameter and the G code system used determine whether an incremental or absolute value is to be used to specify the distance between the initial level and the R position.

If bit 6 (RAB) of parameter No. 5102 is 0, an incremental value is always used. If it is 1, the type of value used depends on the G code system used. When G code system A is used, an absolute value is used. When G code system B or C is used, an absolute value is used in G90 mode, and an incremental value is used in G91 mode.

| Series 15 tape format   |          |             | Series<br>16/18/160/180<br>tape format |             |
|---|----------|-------------|--|-------------|
| Bit 6 of parameter No. 5102 = 1 Bit 6 of parameter No. 5102 = 0 |          |             |  |             |
| G code system   |          |             |  |             |
| A   | A B, C   |             | Incremental                            | Incremental |
| Absolute  | G90      | G91         | moremental                             |             |
| Absolute  | Absolute | Incremental |  |             |

• Details of the canned cycle

The correspondence between the G codes and this CNC tape format or Series 15 tape format is listed below. This list also provides notes on dwell during a canned cycle.

- No. G (Use) This CNC command format
- 1. G81 (Drilling cycle) G83 (G87) P0 <Q not specified> No dwelling
- **2. G82** (**Drilling cycle**)**G83** (**G87**) **P** <**Q not specified**> The tool always dwells at the bottom of the hole.
- **3. G83** (**Peck drilling cycle**) **G83** (**G87**) **<Type B>** If the block contains a P command, the tool dwells at the bottom of the hole.
- 4. G83.1 (Peck drilling cycle) G83 (G87) <Type A>

If the block contains a P command, the tool dwells at the bottom of the hole.

Note) Either type A or B is selected according to bit 2 (RTR) of parameter No. 5101.

- **5. G84 (Tapping) G84 (G88)I** f the block contains a P command, the tool dwells after it reaches the bottom of the hole and after it is retracted to the R position.
- 6. G84.2 (Rigid tapping) M29 S\_ G84 (G88) If the block contains a P command, the tool dwells before the spindle starts rotating in reverse at the bottom of the hole and before it starts rotating in the normal direction at the R position.
- 7. G85 (Boring cycle) G85 (G89) P0 No dwelling
- 8. G89 (Boring cycle) G85 (G89) P\_

The tool always dwells at the bottom of the hole.

• Clearance d for G83 and G83.1

Parameter No. 5114 determines clearance d for G83 and G83.1.

• Dwell with G83 and

G83.1

For Series 15-T, G83 or G83.1 does not cause the tool to dwell. For the

Series 15 tape format, the tool dwells at the bottom of the hole only if the block contains a P address. Dwelling with G84 and In Series 15-T, G84/G84.2 causes the tool to dwell before the spindle G84.2 starts rotating in either the normal or reverse direction, according to the corresponding parameter setting. For the Series 15 tape format, when the block contains a P address, the tool dwells at the bottom of the hole and at the R position before the spindle starts rotating either in the normal or reverse direction. Rigid tapping For the Series 15 tape format, rigid tapping can be specified by using the methods listed below: Format Condition (parameter), comment G84.2 X\_Z\_R\_....S\*\*\*\*; S\*\*\*\* · Setting (F10/F11) = 1G84.2 X\_Z\_R\_ .... ; M29 S\*\*\*\* : G84 X\_Z\_R\_....; \* Common to Series 16 format M29 S\*\*\*\* G84 X\_Z\_R\_ .... ; G84 X\_Z\_R\_ .... S\*\*\*\* ; G84 is made a G code for rigid tapping. Bit 0 (G84) of parameter No. 5200 = 1 S\*\*\*\* : \* Common to Series 16 format G84 X\_Z\_R\_ .... ; • Diameter or radius Specifying 1 for bit 7 (RDI) of parameter No. 5102 causes the canned programming cycle R command diameter or radius programming mode in the Series 15 tape format to match the diameter or radius programming mode for the drilling axis. • Disabling the Series 15 Specifying bit 3 (F16) of parameter No. 5102 disables the Series 15 tape format format. This applies only to the canned drilling cycle. However, the number of repetitions must be specified by using the L address.

### CAUTION

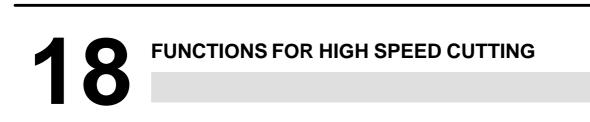
Setting bit 3 (F16) of parameter No. 5102 to 1 overrides bits 6 (RAB) and 7 (RDI) of parameter No. 5102; both settings are assumed to be 0.

# Limitations

- C-axis as the drilling axis
- Clamping the C-axis

It is impossible to use the C-axis (the third axis) as a drilling axis. So, specifying G18 (ZX plane) generates P/S alarm No. 28 (plane selection command error).

For the Series 15 tape format, it is impossible to specify an M code for clamping the C-axis.



# 18.1 HIGH SPEED CYCLE CUTTING

### Format

This function can convert the machining profile to a data group that can be distributed as pulses at high–speed by the macro compiler and macro executor. The function can also call and execute the data group as a machining cycle using the CNC command (G05 command). This function is applied to 1–path lathe control.

#### G05 P10000 L000;

P10000 is number of the machining cycle to be called first: P10001 to P10999 LOO0 is repetition count of the machining cycle

(L1 applies when this parameter is omitted.):

L1 to L999

Call and execute the data for the high speed cutting cycle specified by the macro compiler and macro executor using the above command.

Cycle data can be prepared for up to 999 cycles. Select the machining cycle by address P. More than one cycle can be called and executed in series using the cycle connection data in the header.

Specify the repetition count of the called machining cycle by address L. The repetition count in the header can be specified for each cycle.

The connection of cycles and their repetition count are explained below with an example.

Example) Assume the following:

Cycle 1 Cycle connection data 2 Repetition count 1 Cycle 2 Cycle connection data 3 Repetition count 3 Cycle 3 Cycle connection data 0 Repetition count 1 G05 P10001 L2 ; The following cycles are executed in sequence: Cycles 1, 2, 2, 2, 3, 1, 2, 2, 2, and3

# NOTE

- 1 An alarm is issued if the function is executed in the G41/G42 mode.
- 2 Single block stop, dry run/feedrate override, automatic acceleration/deceleration and handle interruption are disabled during high–speed cycle machining.

# Alarms

| Alarm<br>number | Descriptions   |
|-----------------|--|
| 115             | The contents of the header are invalid. This alarm is issued in the following cases.                               |
|                 | 1. The header corresponding to the number of the specified call machining cycle was not found.                     |
|                 | 2. A cycle connection data value is not in the valid range (0 to 999).   |
|                 | 3. The number of data items in the header is not in the valid range (1 to 32767).                                  |
|                 | 4. The first variable No. for storing data in the executable format is not in the valid range (#20000 to #85535).  |
|                 | 5. The last variable No. for storing data in the executable format exceeds the limit (#85535).                     |
|                 | 6. The first variable No. for start data in the executable format overlaps with a variable No. used in the header. |
| 178             | High–speed cycle machining was specified in the G41/G42 mode.  |
| 179             | The number of control axes specified in parameter 7510 exceeds the maximum number.                                 |

# 18.2 DISTRIBUTION PROCESSING TERMINATION MONITORING FUNCTION FOR THE HIGH–SPEED MACHINING COMMAND (G05)

During high–speed machining, the distribution processing status is monitored. When distribution processing terminates, P/S alarm No. 000 and P/S alarm No. 179 are issued upon completion of the high–speed machining command (according to the setting of ITPDL (bit 7 of parameter No. 7501)).

These P/S alarms can be canceled only by turning off the CNC power.

# **Explanations**

- High-speed machining command
- Distribution processing termination

High–speed machining using the high–speed remote buffer A function, high–speed remote buffer B function, and high–speed cycle function based on the G05 command

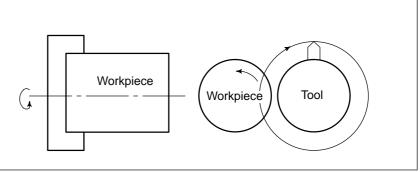
Failure to perform normal distribution processing because distribution processing required for high–speed machining exceeded the CNC processing capacity, or because distribution data sent from the host was delayed for some reason while the high–speed remote buffer A or G function was being used

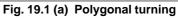
| Number | Message                            | Contents  |
|--------|------------------------------------|---|
| 000    | PLEASE TURN OFF POWER              | During high–speed machining,<br>distribution processing was ter-<br>minated.<br>Related parameters:<br>Remote buffer transfer baud rate<br>(parameter No. 133)                |
| 179    | PARAM. (NO. 7510) SETTING<br>ERROR | Number of controlled axes in<br>high–speed machining (parame-<br>ter No. 7150)<br>High–speed axis selection dur-<br>ing high–speed machining (bit 0<br>of parameter No. 7510) |



# 19.1 POLYGONAL TURNING

Polygonal turning means machining a polygonal figure by rotating the workpiece and tool at a certain ratio.





By changing conditions which are rotation ratio of workpiece and tool and number of cutters, the machining figure can be changed to a square or hexagon. The Machining time can be reduced as compared with polygonal figure machining using C and X axes of the polar coordinate. The machined figure however, is not exactly polygonal. Generally, polygonal turning is used for the heads of square and/or hexagon bolts or hexagon nuts.

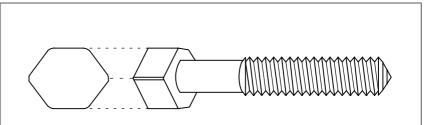


Fig. 19.1 (b) Hexagon bolt

Format

| G51.2(G251) | P_Q_;<br>P,Q: | Rotation ratio of spindle and Y axis<br>Specify range:Intefer 1 to 9 for both<br>P and Q   |
|-------------|---------------|--|
|             |               | When Q is a positive value, Y axis<br>makes positive rotation.<br>When Q is a negative value, Y axis<br>makes negative rotation. |

# Explanations

Tool rotation for polygonal turning is controlled by CNC controlled axis. This rotary axis of tool is called Y axis in the following description.

The Y axis is controlled by G51.2 command, so that the rotation speeds of the workpiece mounted on the spindle (previously specified by S–command) and the tool becomt the specified ratio.

(Example) Rotation ratio of workpiece (spindle) to Y axis is 1:2, and the Y axis makes positive rotation.

# G51.2P1Q2;

When simultaneous start is specified by G51.2, the one–rotation signal sent from the position codes set on the spindle is detected. After this detection, the Y axis rotation is controoled according to the rotation ratio (P:Q) while synchronizing with the spindle speed. Namely, the Y axis rotation is controlled so that the spindle and Y axis stand in a relation of P:Q. This relation will be maintained until the plygonal turning cancel command is executed (G50.2 or reset operation). The direction of Y axis rotation is determined by the code

Q and not affected by the direction of the lposition coder rotation.

Synchronixation of the spindle and Y axis is canceled by the following commnad:

#### G50.2(G250);

When G50.2 is specified, synchronization of the spindle and Y axis is canceled and the Y axis stops.

This synchronization is also canceledd in the following casset:

- i) Power off
- ii) Emergency stop
- iii) Servo alarm
- iv) Reset (external reset signal ERS, reset/rewind ignal RRW, and RESET key on the MDI panel)
- v) Occurrence of P/S alarm Nos. 217 to 221

# Example

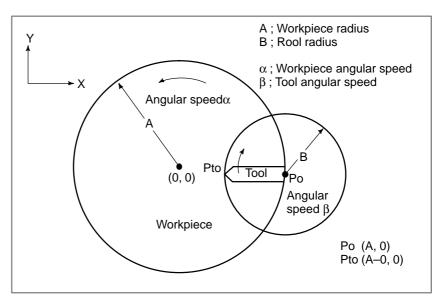
G00X100. 0Z20.0 S1000.0M03 ; Workpiece rotation speed 1000rmp
G51.2P1 Q2 ; Tool rotation start (tool rotation speed 2000rpm)
G01X80.0 F10.0 ; X axis infeed
G04X2. ;
G00X100.0 ;X axis escape
G50.2 ; Tool rotation stop
M05 ; Spindle stop Specify G50.2 and G51.2 always in a single block.

### Principle of Polygonal Turning

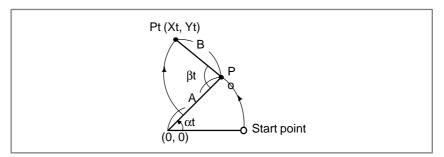
The principle of polygonal turning is explained below. In the figure below the radius of tool and workpiece are A and B, and the angular speeds of tool and workpiece are aand b. The origin of XY cartesian coordinates is assumed to be the center of the workpiece.

Simplifying the explanation, consider that the tool center exists at the position

Po (A, 0) on the workpiece periphery, and the tool nose starts from position Pto(A-B, 0).

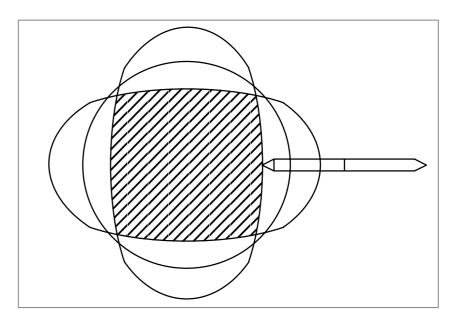


In this case, the tool nose position Pt (Xt, Yt) after time t is expressed by equation 1:

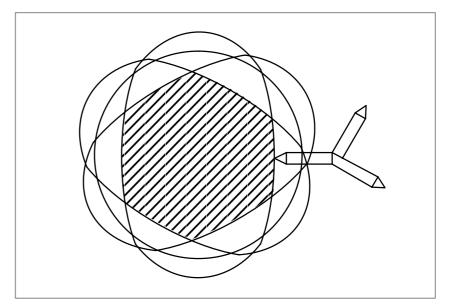


Xt=Acos  $\alpha$ t-Bcos( $\beta$ - $\alpha$ )t (Equation 1) Yt=Asin  $\alpha$ t+Bsin( $\beta$ - $\alpha$ )t Assuming that the rotation ration of workpiece to tool is 1:2, namely,  $\beta$ =2 $\alpha$ , equation 1 is modified as follows Xt=Acos  $\alpha$ t-Bcos  $\alpha$ t=(A-B)cos  $\alpha$ t (Equation 2) Xt=Asin  $\alpha$ t+Bsin  $\alpha$ t=(A+B)sin  $\alpha$ t Equation 2 indicates that the tool nose path draws an ellipse with longer diameter A+B and shorter diameter A-B. Then consider the case when one tool is set at 180° symmetrical positions,

for atotal of two. It is seen that a square can be machined with these tools as shown below.



If three tools are set at every  $120^{\circ}$ , the machining figure will be a hexagon as shown below.



# WARNING

- 1 The starting point of the threading process becomes inconsistent when performed during synchronous operation.
- Cancel the synchronizing by executing G50.2 when threading.
- 2 The following signals become either valid or invalid in relation to the Y axis in synchronous operation.

Valid signals in relation to Y axis: machine lock servo off

Invalid signals in relation to Y axis:

feed hold

interlock

ovrride

dry run

(During a dry run, however, there is no wait for a revolution signal in the G51.2 block.)

### NOTE

1 The Y axis, unlike the other controlled axes, cannot be specifiied a move command as Y—. That is, an axis move command is unnecessary for the Y axis. Because, when G51.2 (polygonal turning mode) is specified, it is only necessary to control the Y axis so that the tool rotates at a certain ratio to the spindle rotation speed.

However, only the reference point return command (G28V0;) can be specified since the Y axis rotation is stopped at the unstable position when G50.2 (polygonal turning mode cancel command) is specified. If the tool rotation start position is unstable, a problem may occur, for example, when the same figure is machined with a finishing tool after once machined with a roughing tool.

Specification of G28V0; for Y axis is equal to the orientation command for the spindle. In the other axes, unlike the manual reference point return, G28 usually makes reference point return without detecting the deceleration limit. However, with G28V0; , for the Y axis, reference point return is executed by detecting the deceleration limit, like manual reference point return.

To machine a workpiece into the same figure as the previous one, the tool and the spindle must be in the same position as the previous time when the tool starts rotating. The tool is set start rotation when the one-rotation signal of the position coder set on the spindle is detected.

- 2 The Y axis used to control tool rotation for polygonal turning uses the 4th axis. However, by setting parameters, (No. 7610) the 3rd axis may also be used. In this case, that axis must be named C axis.
- 3 Among the position display of the Y axis, the display for the machine coordinate value (MECHINE) will change from a range of 0 to the parameter setting (the amount of movement per revolution) as the Y axis moves.
  - Absolute or relative coordinate values are not renewed.
- 4 An absolute position detector cannot be set on the Y axis.
- 5 Manual continuous feed or handle feed is invalid when the Y axis is in synchronous operation.
- 6 The Y axis in synchronous operation is not included in the number of axis controlled simultaneously.

# 19.2 ROTARY AXIS ROLL-OVER

**Explanations** 

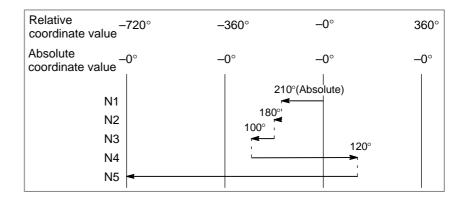
Examples

The roll–over function prevents coordinates for the rotation axis from overflowing. The roll–over function is enabled by setting bit 0 of parameter 1008 to 1.

For an incremental command, the tool moves the angle specified in the command. For an absolute command, the coordinates after the tool has moved are values set in parameter No. 1260, and rounded by the angle corresponding to one rotation. The tool moves in the direction in which the final coordinates are closest when bit 1 (ROAx) of parameter No. 1008 is set to 0. Displayed values for relative coordinates are also rounded by the angle corresponding to one rotation when bit 2 (ROAx) of parameter No. 1008 is set to 1

Assume that axis C is the rotating axis and that the amount of movement per rotation is 360.000 (parameter No. 1260 = 360000). When the following program is executed using the roll–over function of the rotating axis, the axis moves as shown below.

| C0 ;         | Sequence<br>number | Actual<br>movement<br>value | Absolute coordinate value after movement end |
|--------------|--------------------|-----------------------------|--|
| N1 C–150.0 ; | N1                 | -150                        | 210  |
| N2 C540.0 ;  | N2                 | -30                         | 180  |
| N3 C-620.0 ; | N3                 | -80                         | 100  |
| N4 H380.0 ;  | N4                 | +380                        | 120  |
| N5 H–840.0 ; | N5                 | -840                        | 0  |



# 19.3 SIMPLE SYNCHRONIZATION CONTROL

The simple synchronization control function allows synchronous and normal operations on two specified axes to be switched, according to an input signal from the machine.

For a machine with two tool posts that can be independently driven with different controlled axes, this function enables the operations described below.

This section describes the operations of a machine having two tool posts, both of which can be independently operated along the X-axis and Y-axis. If your machine uses other axes for the same purpose, substitute the corresponding axis names for X and Y.

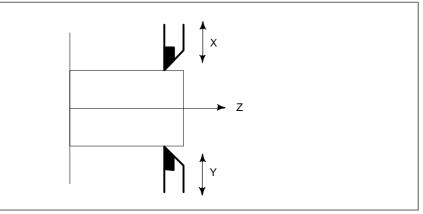


Fig. 19.3 Sample Axis Configuration of a Machine on which the Simple Synchronization Control Function is Executed

# **Explanations**

Synchronous operation

Synchronous operation is possible on a machine having two tool posts. In synchronous operation mode, movement on one axis can be synchronized with movement specified for another axis. The move command can be specified for one of the two axes, which is referred to as the master axis. The other axis, for referred synchronization with the master axis is maintained, is referred to as the slave axis. If the master axis is X and the slave axis is Y, synchronous operation on the X-axis (master axis) and Y-axis (slave axis) are performed according to Xxxxx commands issued for the master axis.

In synchronous operation mode, a move command specified for the master axis results in simultaneous operation of the servo motors of the master and slave axes.

In this mode, synchronization error compensation is not performed. That is, any positioning error between the two servo motors is not monitored, nor is the servo motor of the slave axis adjusted to minimize any error. No synchronization error alarm is output. Automatic operations can be synchronized, but manual operations cannot.

• Normal operation Normal operation is performed when different workpieces are machined on different tables. As with normal CNC control, move commands for the master and slave axes are specified with the addresses of those axes (X and Y). Move commands for the two axes can be specified in an identical block.

1 According to the Xxxxx command programmed for the master axis, movement is performed along the X-axis, as in normal mode.

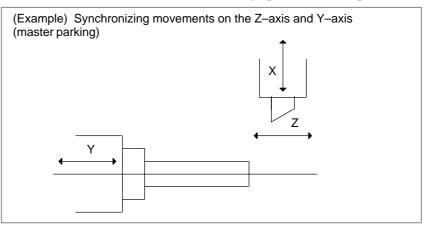
| B–63004EN/02  | PROGRAMMING   | 19. AXIS CONTROL FUNCTION  |
|---|---|--|
|   | <ul><li>movement is performed alor</li><li>3 According to the Xxxxx Yy are performed along both the</li></ul>   | ommand programmed for the slave axis,<br>ng the Y-axis, as in normal mode.<br>yyy command, simultaneous movements<br>e X-axis and Y-axis, as in normal mode.<br>operations can be controlled, as in normal   |
| <ul> <li>Switching synchronous<br/>and normal operations</li> </ul>         | For details of how to switch the to the manual supplied by the r  | synchronous and normal operations, refer nachine tool builder.   |
| • Automatic reference<br>position return                                    | the second, third, or fourth<br>synchronous operation mode, a<br>the X-axis, and an identical mo-<br>this Y-axis movement agrees v<br>the Y-axis, a lamp indicating<br>completed for the Y-axis also      | Ference position return (G28), or return to<br>reference position (G30), is issued in<br>reference position return is performed for<br>ovement is performed for the Y-axis. If<br>with a return to the reference position on<br>that reference position return has been<br>lights.<br>hat G28 and G30 be specified in normal |
| • Checking automatic reference position return                              | issued in synchronous opera<br>performed for the X-axis and Y<br>If these X-axis and Y-axis n<br>reference positions on the X-ax<br>reference position return has be<br>light. If not, an alarm is output | novements correspond to returns to the xis and Y-axis, the lamps indicating that een completed for the X-axis and Y-axis   |
| <ul> <li>Slave axis command</li> </ul>                                      | If a move command is specioperation mode, P/S alarm 213   | fied for the slave axis in synchronous is output.  |
| <ul> <li>Master and slave axes</li> </ul>                                   | The master axis is defined in pa<br>by an external signal.  | rameter 8311. The slave axis is specified  |
| Limitations   |   |  |
| <ul> <li>Coordinate system<br/>setting and tool<br/>compensation</li> </ul> |   | tool compensation causing a shift in the<br>ed in synchronous operation mode, P/S  |
| <ul> <li>External deceleration,<br/>interlock, machine lock</li> </ul>      | · ·   | de, the signal for external deceleration,<br>f the master axis only is valid. The<br>l is ignored.   |
| <ul> <li>Pitch error<br/>compensation</li> </ul>                            | Pitch error compensation and separately for the master and sl   | backlash compensation are performed ave axes.  |
| <ul> <li>Manual absolute switch</li> </ul>                                  |   | e, the manual absolute switch must be set<br>f the switch is set to off, the correct slave<br>de.  |
| <ul> <li>Manual operation</li> </ul>  | Manual operations cannot be sy  | ynchronized.   |
|   |   |  |

# 19.4 SYNCHRONIZATION CONTROL

The synchronization control function enables the synchronization of movements on two axes. If a move command is programmed for one of those two axes (master axis), the function automatically issues the same command to the other axis (slave axis), thus establishing synchronization between the two axes. The parking state can be selected to suppress movement of the slave axis, even if a move command is specified for the master axis. If the parking state is used with the synchronization control function, the operation can be controlled as follows:

- 1 Synchronizes the movement on the slave axis with that of the master axis.
- 2 Performs slave axis movement according to the move command programmed for the master axis. However, the movement specified by the command is not made for the master axis itself (master parking).
- 3 Updates the slave axis coordinates according to the distance travelled along the master axis. However, no movement is made for the slave axis (slave parking).

When method 2 above is used, the following operation can be performed:



Movement is performed for the X-axis and Y-axis according to commands issued for the X-axis and Z-axis. (The Y-axis movement is synchronized with that of the Z-axis.) If the Z-axis is set to the parking state, the coordinates on the Z-axis and Y-axis are updated.

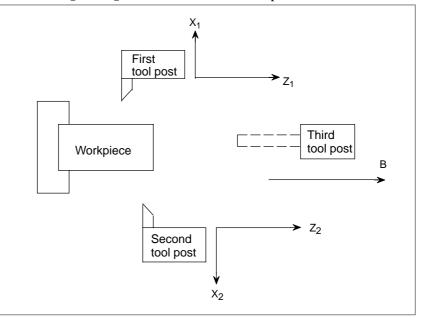
As the coordinates on the Z-axis and Y-axis are always updated, the coordinate system need not be reset when the synchronization status is changed. A move command can be executed immediately after the status is changed.

# NOTE

- 1 In the synchronization control described above, an identical move command is simultaneously output for two servo processing systems. Positional error between the two servo motors is not monitored, nor is either servo motor adjusted to minimize the error. That is, synchronization error compensation is not carried out.
- 2 The method used to specify the synchronization control function varies with the machine tool builder. For details, refer to the manual supplied by the machine tool builder.

# 19.5 B–AXIS CONTROL (G100, G101, G102, G103, G110)

This function sets an axis (B–axis) independent of the basic controlled axes  $X_1$ ,  $Z_1$ ,  $X_2$ , and  $Z_2$  and allows drilling, boring, or other machining along the B–axis, in parallel with the operations for the basic controlled axes. The  $X_2$  and  $Z_2$  axes can be used in two–path control mode.



Format

 Registering operation programs

G101–G100 : Starts registering the first program. G102–G100 : Starts registering the second program. G103–G100 : Starts registering the third program. G100 Ends registering of the programs. : Three operations (programs) on the B-axis can be registered. (In twopath control mode, three programs can be registered for each tool post.) The B-axis operation program must be specified in the blocks between G101, G102, or G103 and G100, allowing it to be discriminated from the normal NC program. The registered operation is started upon executing the corresponding M code, described below. O1234 : ÷ Normal NC program Starts registering of a B-axis G101 ;-\_\_\_\_\_ operation program. ÷ B-axis operation program G100 : Ends registering of the B-axis \_ \_ \_ \_ \_ \_ \_ \_ \_ operation program. ÷ Normal NC program M30; Note) In the block of G101, G102, G103, or G100, specify no other codes.

# • Command used to start the operation

| To start an operation, parameters 8251 to 8  | the miscellaneous functions (M**) specified in 253 are used.   |
|--|--|
| Parameter 8252:<br>M code used to<br>Parameter 8253:   | o start operation of the first program<br>o start operation of the second program<br>o start operation of the third program  |
| O1234 ;<br>:<br>M**; -<br>:<br>M30 ;   | Starts executing the registered B–axis operation. In subsequent blocks, the normal NC program and the B–axis operation program are executed in parallel. (** is specified in parameters 8251 to 8253.)   |
| Example<br>01234 ;<br>G50 X100. Z200. ;<br>G101 ;<br>G00 B10. ;<br>M03 ;<br>G04 P2500 ;<br>G81 B20. R15. F5<br>G28 ;<br>G100 ;<br>G00 X80. Z50. ;<br>G01 X45. F1000 ;<br>;<br>G00 X10. ;<br>M** ;<br>G01 Z30. F300 ; | <ul> <li>Starts registering of an operation program.</li> <li>Blocks of the B–axis</li> </ul>  |
| <ul> <li></li></ul>  | fy the B–axis operation program in blocks between<br>G102, or G103 and G100. The program is registered<br>gram memory.<br>g the B–axis operation registered with 1 to 3 above.<br>blocks, the normal NC operation and the B–axis<br>executed in parallel. An M code of the miscellaneous<br>d to start the B–axis operation. The M code, used to<br>tion, is specified in parameters 8251 to 8253. |

# • Single-motion operation

# G110 [operation command];

A single-motion operation for the B-axis can be specified and executed as shown above. Such an operation need not be registered as a special (first to third) program. Nor does it need to be by a special command, as described above.

# **Explanations**

• Specifying two-path control mode

One of the following three two-path control modes can be selected:

- 1 B-axis control is executed for either tool post 1 or 2.
- 2 B-axis control is executed separately for tool posts 1 and 2.
- 3 Identical B-axis control is executed for tool posts 1 and 2.

The mode is selected according to the value specified for parameter 8250 for each tool post.

The following 13 G codes, and the M, S, and T codes of the miscellaneous functions, can be used in a B-axis operation program:

| Code | Description  |
|------|--|
| G00  | Positioning (rapid traverse)                                   |
| G01  | Linear interpolation (cutting feed)                            |
| G04  | Dwell  |
| G28  | Reference position return, automatic coordinate system setting |
| G80  | Canned cycle, cancel   |
| G81  | Drilling cycle, spot drilling                                  |
| G82  | Drilling cycle, counterboring                                  |
| G83  | Peck drilling cycle  |
| G84  | Tapping cycle  |
| G85  | Boring cycle   |
| G86  | Boring cycle   |
| G98  | Feed per minute  |
| G99  | Feed per rotation  |
| M**  | Auxiliary function   |
| S**  | Auxiliary function   |
| T**  | Auxiliary function, tool offset                                |

#### G28 (reference position return)

Unlike the normal G28 cycle, the G28 cycle for a B-axis operation does not include intermediate point processing. For example, the following cannot be specified:

G28 B99.9;

### G80 to G86 (canned drilling cycle)

Of the canned drilling cycles supported by the FANUC Series 16 or Series 18 for machining centers, those cycles equivalent to G80 to G86 can be executed.

Data can be specified in the same way as for the FANUC Series 16 or Series 18 for machining centers, except for the following points:

- 1. The drilling position is not specified with X and Y.
- 2. The distance from point R to the bottom of the hole is specified with B.

# Codes that can be used in a B-axis operation program

- 3. All operations are executed in the initial level return mode.
- 4. The repetition count (K) cannot be specified.
- 5. In canned cycle mode, point R must be specified. (If point R is omitted, P/S alarm No. 5036 is output.)
- 6. The drilling start point (d) for the G83 (peck drilling) cycle is specified with parameter 8258.

#### G98, G99 (feed per minute, feed per rotation)

The MDF bit (bit 2 of parameter 8241) specifies an initial continuous–state G code for G110, or the G code to start registration of the operation program (G101, G102, G103).

When the MDF bit is set to 0, the initial continuous–state code is G98. When the MDF bit is set to 1, the initial continuous–state code is G99.

Example)

When MDF is set to 0 G110 B100. F1000. ; 1000 mm/min G110 G99 B100. F1 ; 1 mm/rev

### NOTE

In two-path control mode, the system uses the actual spindle speed, calculated from the feedback signal output by the position coder connected to the tool post to which the controlled axis belongs.

#### M, S, and T codes (auxiliary functions)

According to a numeric value subsequent to address M, S, or T, the binary code and strobe signal are sent to the machine. The codes and signals for addresses M, S, and T are all output to an identical interface and can be used to control power–on or power–off of the machine. For this purpose, the axis control interface of the PMC is used, which differs from that used for the miscellaneous functions for the normal NC program. The following M codes, used to control the spindle, are automatically output during the G84 (tapping) or G86 (boring) cycle:

- M03: Forward spindle rotation
- M04: Reverse spindle rotation
- M05: Spindle stop

T<sup>\*\*</sup> to T (\*\* + 9), where \*\* is the number specified in parameter 8257, are used as the codes of the auxiliary functions to adjust the tool offset.

#### Example)

T50 to T59 if parameter 8257 is set to 50

- 1. An M, S, or T code must not be specified in a block containing another move command. The M, S, and T codes must not be specified in an identical block.
- 2. Usually, normal NC operation and B-axis operation are independent of each other. Synchronization between operations can be established by coordinating the miscellaneous functions of the normal NC program and B-axis operation program.

(Normal NC operation) (Registered B-axis operation)

: : M11; G00 B111; G01 X999 : G01 B222; G28 Z777; G28; M50; M50; G00 X666; G81 B444 R111 F222; : :

Upon receiving M50 of both the normal NC program and the B-axis program, the PMC ladder outputs the completion signals (FIN) for the two miscellaneous functions. G00 X666 of the normal NC program and G81 B444 R111 F222 of the B-axis program are executed simultaneously.

### **Custom macro**

Custom macro variables (local variables, common variables, system variables #\*\*\*\*) can be used in an operation program between G101, G102, or G103 and G100.

- 1. The value of the macro variable is calculated not from the data existing upon execution of the B-axis operation, but from the data existing at registration of the operation program.
- 2. An instruction that causes a branch to a location beyond the range of G101, G102, or G103 to G100 is processed without being checked.
- 3. In the two–path control mode, tool posts 1 and 2 use different macro variables.

When a new operation program is registered, the previous operation program is automatically deleted.

If an error is detected in an operation program to be registered, the program is initialized but is not registered.

In the same way as a normal NC program, the B-axis operation program can use the following as modal data: modal G codes, F codes, and P, Q, and F codes in the canned cycle. These codes do not affect the modal information of the normal NC program. When a B-axis operation program is started (by G101, G102, or G103), the initial modal data is set for the program. It is not affected by the previous modal information.

Example)

| G01 X10. F1000 ;<br>G101 (G102, G103) ;<br>B10. ;<br>G01 B–10. F500 ;<br>G100 ;<br>X–10. ; | 1<br>2<br>3<br>4<br>5<br>6 |
|--|----------------------------|
| X-10. ;  | 6                          |

Irrespective of the modal information for normal operation (G01 specified in block), block ③ specifies G00 if the MDG bit (bit 1 of parameter 8241) is set to 0, or G01 if the MDG bit is set to 1. Block ⑤ causes movement with F1000, specified in block 1.

- Operation program
- Modal

| • Operation start command                                       | The MST bit (bit 7 of parameter 8240) specifies the method used to start<br>the B-axis operation as described below:<br>If the MST bit is set to 1, the B-axis operation is started when the M code<br>to start the operation is executed.<br>If the MST bit is set to 0, the B-axis operation is started when the M code<br>used to start the operation is executed and the PMC outputs the<br>miscellaneous function completion signal (FIN).<br>Up to five M codes for starting the programs can be stored. The programs<br>corresponding to these M codes are executed in succession. (In two-path<br>control mode, up to five codes can be stored for each tool post.)<br>Example)<br>When the first, second, and third programs are started by M40, M41,<br>and M42, respectively<br>O1234. ;<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>:<br>: |
|---|--|
|   | As M41 is specified while the program started by M40 is being executed,<br>the second program is automatically started upon termination of the first<br>program.<br>M42, M40, and M41, specified during execution of the first program, are<br>stored such that the corresponding programs are executed in the same<br>order as that in which the M codes are specified.<br>If six or more M codes for starting the programs are specified while a<br>program is being executed, P/S alarm 5038 is output.<br>In two–path control mode, the M code specified for tool post 1 starts the<br>B–axis program registered for tool post 1. The M code specified for tool<br>post 2 starts the B–axis program registered for tool post 2.  |
| <ul> <li>Specifying absolute or<br/>incremental mode</li> </ul> | The amount of travel along the B-axis can be specified in either absolute<br>or incremental mode. In absolute mode, the end point of travel along the<br>B-axis is programmed. In incremental mode, the amount of travel along<br>the B-axis is programmed directly.<br>The ABS bit (bit 6 of parameter 8240) is used to set absolute or<br>incremental mode. When the ABS bit is set to 1, absolute mode is<br>selected. When the ABS bit is set to 0, incremental mode is selected. The<br>mode is specified with this parameter when the program is registered.   |

 Specifying a tool offset The T\*\*; command shifts the end point of the specified B-axis travel, in either the positive or negative direction, by the amount specified with the B-axis offset screen. If this function is used to set the difference between the programmed tool position and actual tool position in machining, the program need not be modified to correct the tool position. The value specified with parameter 8257 is assigned to the auxiliary function to cancel the offset. The subsequent nine numbers are assigned to the tool offset functions. These auxiliary function numbers are displayed on the B-axis offset screen. For details, see "OPERATION." Single-motion operation If a G110 block is specified, a single-motion operation along the B-axis can be specified and executed. In single-motion operation mode, a single block results in a single operation. The single-motion operation is executed immediately provided if it is specified before the B-axis operation is started. If the operation is specified while a registered program is being executed, the operation is executed once that program has terminated. After the specified single-motion operation has been executed, the next block is executed. G110 G01 B100. F200 ; Block for single-motion operation along B-axis G00 X100. Z20.; : Program memory An operation program is registered in program memory as a series of different blocks of the move, dwell, auxiliary, and other functions. Program memory can hold a desired number of blocks, up to a maximum of 65535 blocks for each program. If the program memory contains no free space when an attempt is made to register a B-axis program, P/S alarm 5033 is output. Six blocks require 80 characters of program memory. A canned cycle (G81 to G86) is also registered as a series of blocks, such as travel and dwell. The entire program memory is backed up by battery. The programs registered in program memory are thus retained even after the system power is turned off. After turning the system power on, the operation can be started simply by specifying the M code for starting the program. Example) : G101; G00 B10.; ..... One block G04 P1500 ; ..... One block G81 B20. R50. F600 ; ..... Three blocks G28 ; ..... One block M15;.... One block G100; ٠ (Total 7 blocks) Reset When the NC is reset by pressing the MDI reset key or by the issue of an external reset signal, reset and rewind signal, or emergency stop, B-axis

external reset signal, reset and rewind signal, or emergency stop, B-axis control is also reset. The PMC interface signal can reset only B-axis control. For details, refer to the manual supplied by the machine tool manufacturer.

• **PMC–controlled axis** A B–axis operation can be executed only when the B–axis can be controlled by the PMC. For details, refer to the manual supplied by the machine tool builder.

# Limitations

- Single-motion operation
- 1. Only a single-motion operation can be specified with G110.

| G110 G00 B100.;              | OK                 |
|------------------------------|--------------------|
| G110 G28 ;                   | OK                 |
| G110 G81 B100. R150.0 F100 ; | P/S alarm No. 5034 |

2. A canned cycle (G81 to G86), and other operations containing multiple motions, cannot be specified with G110.

If an inhibited operation is specified, P/S alarm No. 5034 is output.

3. modal information specified with G110 does not affect the subsequent blocks. In the G110 block, the initial modal value specified at the start of the operation becomes valid, irrespective of the modal information specified the previous blocks.

### Example)

When the MDG bit (bit 1 of parameter 8241) is set to 1 and the MDF bit (bit 2 of parameter 8241) is set to 1

| G98 G00 X100. F1000 ; | (1) |
|-----------------------|-----|
| G110 B200. F2;        | (2) |
| X200. ;               | (3) |
| G01 X200.;            | (4) |

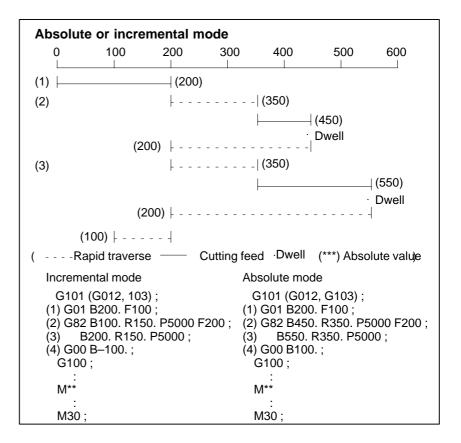
Block (2) instigates cutting feed (G01) at 2.0 mm/rev (G99).

Block (3) instigates rapid traverse (G00).

- Block (4) instigates cutting feed (G01) at 1000 mm/min (G98).
- 4. During tool-tip radius compensation, two or more G110 blocks cannot be specified in succession. If such blocks are specified in succession, P/S alarm No. 504 is output. To specify two or more G110 blocks in succession for a B-axis operation, register the blocks as a program with G101, G102, or G103 and G100.

# **Examples**

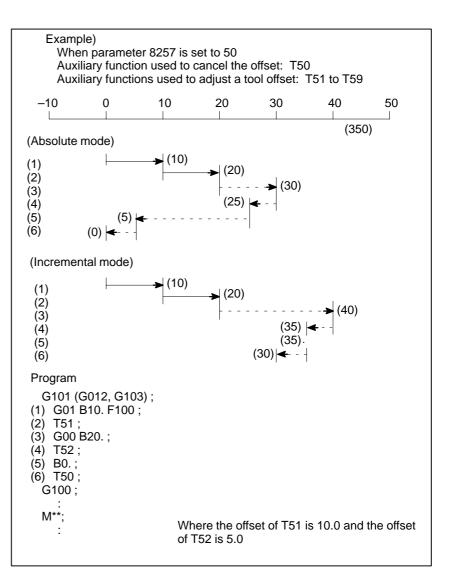
• Absolute or incremental mode



### • Tool posts 1 and 2

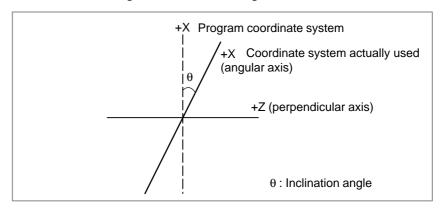
| If a single axis is used as the common B-axis of the two tool posts in<br>two-path control, tool posts 1 and 2 share the B coordinate.<br>For example, after program 1 for tool post 1 and program 2 for tool post<br>2 are executed in that order, the total travel along the B-axis appears to<br>be +100.<br><program 1=""><br/>G101 ;</program> |  |
|---|--|
| G00 B200. ; (Absolute mode)<br>G100 ;   |  |
| M30 ;   |  |
| <program 2=""><br/>G101 ;<br/>G00 B300. ; (Absolute mode)<br/>:<br/>G100 ;</program>  |  |
| :<br>M30 ;  |  |

### • Tool offset



# 19.6 ANGULAR AXIS CONTROL / ARBITRARY ANGULAR AXIS CONTROL

When the angular axis makes an angle other than  $90^{\circ}$  with the perpendicular axis, the angular axis control function controls the distance traveled along each axis according to the inclination angle. For the ordinary angular axis control function, the X-axis is always used as the angular axis and the Z-axis is always used as the perpendicular axis. For angular axis control B, however, arbitrary axes can be specified as the angular and perpendicular axes, by specifying parameters accordingly. A program, when created, assumes that the angular axis and perpendicular axis intersect at right angles. However, the actual distance traveled is controlled according to an inclination angle.



When the angular axis is the X-axis and the perpendicular axis is the Z-axis, the amount of travel along each axis is controlled according to the formulas shown below.

The distance to be traveled along the X-axis is determined by the following formula :

 $Xa = \frac{Xp}{\cos\theta}$ 

The distance traveled along the Z-axis is corrected by the inclination of the X-axis, and is determined by the following formula:

$$Za = Zp - \frac{1}{2}Xp \tan \theta$$

The speed component along the X-axis of feed rate is determined by the following formula:

$$a = \frac{Fp}{\cos\theta}$$

Xa, Za, Fa:Actual distance and speed

Xp, Zp, Fp:Programmed distance and speed

The angular and perpendicular axes to which angular axis control is to be applied must be specified beforehand, using parameters (No. 8211 and 8212).

Parameter AAC (No. 8200#0) enables or disables the inclined axis control function. If the function is enabled, the distance traveled along each axis is controlled according to an inclination angle (No. 8210).

Parameter AZR (No. 8200#2) enables angular axis manual reference point return only with a distance along the angular axis.

If perpendicular/angular axis control disable signal NOZAGC has been set to 1, the angular axis control function is enabled only for the angular axis. In such a case, the move command for the angular axis is converted to angular coordinates. The perpendicular axis is not affected by the move command for the angular axis.

• Method of use

**Explanations** 

 Absolute and relative position display

• Machine position display

An absolute and a relative position are indicated in the programmed Cartesian coordinate system. Machine position display

A machine position indication is provided in the machine coordinate system where an actual movement is taking place according to an inclination angle. However, when inch/metric conversion is performed, a position is indicated which incorporates inch/metric conversion applied to the results of inclination angle operation.

#### WARNING

- 1 After inclined axis control parameter setting, be sure to perform manual reference point return operation.
- 2 If bit 2 (AZR) of parameter No. 8200 has been set to 0, such that manual reference position return along the angular axis also causes movement along the perpendicular axis, once manual reference position return has been performed along the angular axis, also perform manual reference position return along the perpendicular axis.
- 3 Once the tool has been moved along the angular axis with perpendicular/angular axis control disable signal NOZAGC set to 1, manual reference position return must be performed.
- 4 Before attempting to manually move the tool along both the angular and perpendicular axes simultaneously, set perpendicular/angular axis control disable signal NOZAGC to 1.

# NOTE

- 1 If an inclination angle close to  $0^{\circ}$  or  $\pm 90^{\circ}$  is set, an error can occur. A range from  $\pm 20^{\circ}$  to  $\pm 60^{\circ}$  should be used.
- 2 Before a perpendicular axis reference point return check (G37) can be made, angular axis reference point return operation must be completed.
- 3 For arbitrary angular axis control, if the same axis number has been specified in both parameters No. 8211 and 8212, or if a value outside the valid data range has been specified for either parameter, the angular and perpendicular axes will be as follows:

Angular axis: First axis

Perpendicular axis: Second axis

# 19.7 TOOL WITHDRAWAL AND RETURN (G10.6)

To replace the tool damaged during machining or to check the status of machining, the tool can be withdrawn from a workpiece. The tool can then be advanced again to restart machining efficiently.

The tool withdrawal and return operation consists of the following four steps:

Retract

The tool is retracted to a predefined position using the TOOL WITHDRAW switch.

Withdrawal

The tool is moved to the tool-change position manually.

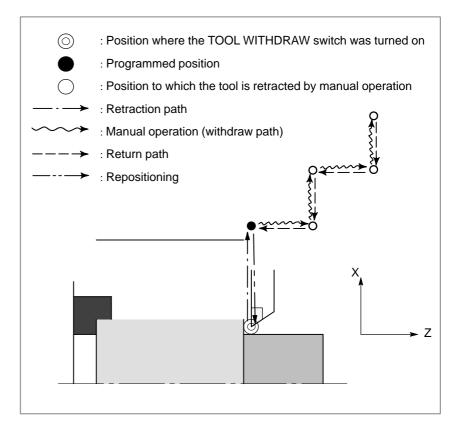
Return

The tool returns to the retract position.

Repositioning

The tool returns to the interrupted position.

For the tool withdrawal and return operations, see Section 4.8 in "Operation."



Format

# Specify a retraction axis and distance in the following format:

#### G10.6 IP\_;

IP\_: In incremental mode, retraction distance from the position where the retract signal is turned on In the absolute mode, retraction distance to an absolute position

# Explanations

| • Retraction                      | <ul> <li>When the TOOL WITHDRAW switch on the machine operator's panel is turned on during automatic operation or in the automatic operation stop or hold state, the tool is retracted the length of the programmed retraction distance. This operation is called retraction. The position at which retraction is completed is called the retraction position. Upon completion of retraction, the RETRACT POSITION LED on the machine operator's panel goes on.</li> <li>When the TOOL WITHDRAW switch is turned on during execution of a block in automatic operation, execution of the block is interrupted immediately and the tool is retracted. After retraction is completed, the system enters the automatic operation hold state.</li> <li>If the retraction distance and direction are not programmed, retraction is not performed. In this state, the tool can be withdrawn and returned. When the TOOL WITHDRAW switch is turned on in the automatic operation stop or hold state is entered again.</li> <li>When the TOOL WITHDRAW switch is turned on, the tool withdraw mode is set. When the tool withdraw mode is set, the TOOL BEING WITHDRAWN LED on the machine operator's panel goes on.</li> </ul> |
|-----------------------------------|---|
| Withdrawal                        | When the manual mode is set, the tool can be moved manually (manual continuous feed or manual handle feed) to replace the tool or measure a machined workpiece. This operation is called a withdrawal. The tool withdrawal path is automatically memorized by the CNC.  |
| • Return                          | When the mode is returned to automatic operation mode and the TOOL<br>RETURN switch on the machine operator's panel is turned off, the CNC<br>automatically moves the tool to the retraction position by tracing the<br>manually-moved tool path backwards. This operation is called a return.<br>Upon completion of a return to the retraction position, the<br>RETRACTIONS POSITION LED comes on.   |
| <ul> <li>Repositioning</li> </ul> | When the cycle start button is pressed while the tool is in the retraction<br>position, the tool moves to the position where the TOOL WITHDRAW<br>switch was turned on. This operation is called repositioning. Upon<br>completion of repositioning, the TOOL BEING WITHDRAWN LED is<br>turned off, indicating that the tool withdrawal mode has terminated.<br>Operation after completion of repositioning depends on the automatic<br>operation state when the tool withdrawal mode is set.   |
|                                   | (1) When the tool withdrawal mode is set during automatic operation, operation is resumed after completion of repositioning.  |
|                                   | <ul><li>(2) When the tool withdrawal mode is set when automatic operation is held or stopped, the original automatic operation hold or stop state is set after completion of repositioning. When the cycle start button is pressed again, automatic operation is resumed.</li></ul>   |

# Limitations

| • offset  | If the origin, presetting, or workpiece offset is changed after retraction is specified with G10.6 in absolute mode, the change is not reflected in the retraction position. After such changes are made, the retraction position must be respecified with G10.6. When the tool is damaged, automatic operation can be interrupted with a tool withdrawal and return operation in order to replace the tool. Note that if the offset value is changed after tool replacement, the change is ignored when automatic operation is resumed from the start point or other point in the interrupted block. |
|---|---|
| <ul> <li>Machine lock, mirror<br/>image, and scaling</li> </ul> | When withdrawing the tool manually in the tool withdrawal mode, never<br>use the machine lock, mirror–image, or scaling function.   |
| • Threading   | Tool withdrawal and return operation cannot be performed during threading.  |
| • Drilling canned cycle   | Tool withdrawal and return operation cannot be performed during a drilling canned cycle.  |
| Reset   | Upon reset, the retraction data specified in G10.6 is cleared. Retraction data needs to be specified again.   |
| <ul> <li>Retraction command</li> </ul>                          | The tool withdrawal and return function is enabled even when the retraction command is not specified. In this case, retraction and repositioning are not performed.   |
|   | WARNING   |

### WARNING

The retraction axis and retraction distance specified in G10.6 need to be changed in an appropriate block according to the figure being machined. Be very careful when specifying the retraction distance; an incorrect retraction distance may damage the workpiece, machine, or tool.



## 20.1 GENERAL

 Application to latheswith one spindle and two tool posts Two-path control can be used with a lathe that supports simultaneous cutting by its two independently operating tool posts.

Two-path control can be used for a lathe that machines one workpiece attached to one spindle with two tool posts simultaneously.

For example, while one tool post is performing outer surface machining, the other tool post can perform inner surface machining, thus reducing machining time dramatically.

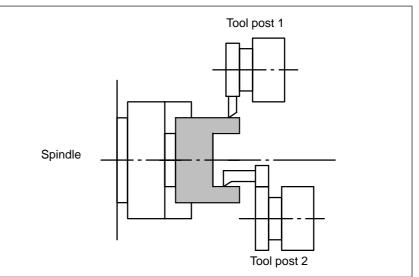


Fig. 20.1 (a) Application to lathes with one spindle and tow tool posts

 Application to lathes with two spindles and two tool posts Two-path control can be used for a lathe that machines a workpiece attached to each of two spindles with two tool posts simultaneously. In this case, each tool post operates independently of each other as if two lathes were used, thus improving productivity.

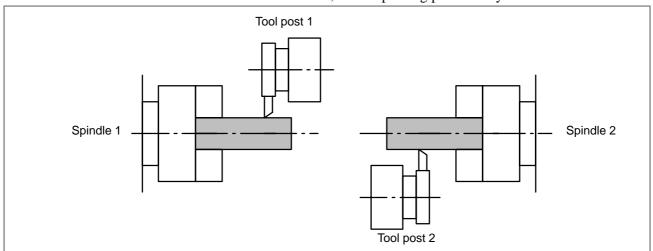


Fig. 20.1 (b) Application to lathes with two spindles and two tool posts

#### Controlling two tool posts independently at the same time

The operations of two tool posts are programmed independently of each other, and each program is stored in program memory for each tool post. When automatic operation is to be performed, each tool post is activated after selecting a program for machining with tool post 1 and a program for machining with tool post 2 from the programs stored in program memory for each tool post. Then the programs selected for the tool posts are executed independently at the same time. When tool post 1 and tool post 2 need to wait for each other during machining, the waiting function is available (Section **20.2**)

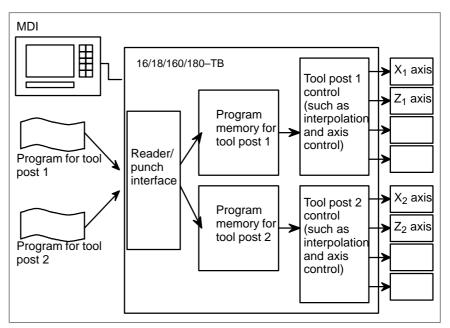


Fig. 20.1 (c) Controlling two tool posts independently at the same time

Just one MDI is provided for the two tool posts. Before operation and display on the MDI, the tool post selection signal is used to switch between the two tool posts.

#### NOTE

Simultaneous operation of the two tool posts or the operation of only a single tool post can be selected by pressing a key on the machine operator's panel. For details, refer to the manual supplied by the machine tool builder.

## 20.2 WAITING FOR TOOL POSTS

| Explanations  | other during machining. By specify<br>program for each tool post, the two to<br>a specified block. When an M code for<br>one tool post during automatic operat<br>same M code to be specified before star<br>This function is called the tool post w<br>A range of M codes used as M code | ntrol based on M codes is used to cause one tool post to wait for the<br>er during machining. By specifying an M code in a machining<br>ogram for each tool post, the two tool posts can wait for each other at<br>pecified block. When an M code for waiting is specified in a block for<br>e tool post during automatic operation, the other tool post waits for the<br>ne M code to be specified before staring the execution of the next block.<br>is function is called the tool post waiting function.<br>range of M codes used as M codes for waiting is to be set in the<br>rameters (Nos. 8110 and 8111) before hand. |  |  |  |  |
|---|---|--|--|--|--|--|
| Example   | M100 to M103 are used as M codes<br>Parameter setting: No. 8110=100 (M<br>M100<br>No. 8111=103 (M<br>M103   | Minimum M code for waiting:<br>)<br>Maximum M code for waiting:  |  |  |  |  |
| Tool post 1 program   | Tool post 2 program   |  |  |  |  |  |
| 01357 ;<br>G50 X_Z_;<br>G00 X_Z_T0101 ;<br>S1000 M03 ;<br>M100 ;<br>N1100 G01 X_Z_F_; | 02468 ;<br>G50 X_Z_;<br>G00 X_Z_T0202 ;<br>S2000 M03 ;<br>M100 ;<br>N2100 G01 X_Z_F_;<br>N2199;<br>M101 ;<br><waiting (m101)=""></waiting>  | Waiting<br>Simultaneous,<br>independent operation<br>of tool post 1 (N1100 to<br>N1199) and tool post 2<br>(N2100 to N2199)  |  |  |  |  |
| M101 ;  | N2200 S3000 ;   | Waiting  |  |  |  |  |
| M102 ;<br><waiting (m102)=""></waiting>   | G00 X_Z_T0202 ;   | Operation of tool post<br>2 (N2200 to N2299)<br>only   |  |  |  |  |
| N1300;-<br>G00 X_Z_T0505 ;<br>N1399;<br>M103 ;<br>M30 ;                               | N2299 ,<br>M102 ;<br>N2300 ;<br>G00 X_Z_T0707 ;<br>N2399 ;<br>M103 :<br>M30 ;   | Waiting<br>Simultaneous,<br>independent operation<br>of tool post 1 (N1300 to<br>N1399) and tool post 2<br>(N2300 to N2399)<br>Waiting<br>End of program   |  |  |  |  |

#### NOTE

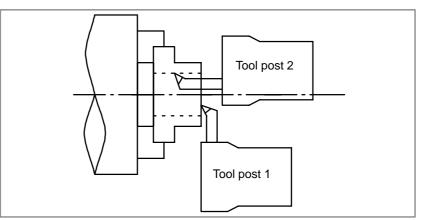
- 1 An M code for waiting must always be specified in a single block.
- 2 If one tool post is waiting because of an M code for waiting specified, and a different M code for waiting is specified with the other tool post, an P/S alarm (No. 160) is raised. In this case, both tool posts stop operation.
- 3 PMC-CNC interface Unlike other M codes, the M code for waiting is not output to the PMC.
  4 Operation of a single tool post
- If the operation of a single tool post is required, the M code for waiting need not be deleted. By using the NOWT signal to specify that waiting be ignored (G0063, #1), the M code for waiting in a machining program can be ignored. For details, refer to the manual supplied by the machine tool builder.

## 20.3 TOOL POST INTERFACE CHECK

#### 20.3.1 General

When two tool posts machine the same workpiece simultaneously, the tool posts can approach each other very closely. If the two tool posts interfere with each other due to a program error or any other setting error, a serious damage such as a tool or machine destruction can occur.

The function "tool post interference check" is available which can decelerate and stop the two tool posts before the tool posts interfere with each other due to an incorrect command.



The contours of the two tool posts are checked to determine whether or not an interference occurs.

To make a tool post interference check, data including the relationships between the two tool posts and interference forbidden areas (that is, tool shapes) needs to be set. The method of such data setting is described below.

With the tool post interference check function, whether or not the two tool posts interfere with each other is determined by checking if the interference forbidden areas (based on the interference forbidden areas of the currently selected tools) of the tool posts overlap each other after the movement of the tool posts.

#### **Explanations**

20.3.2

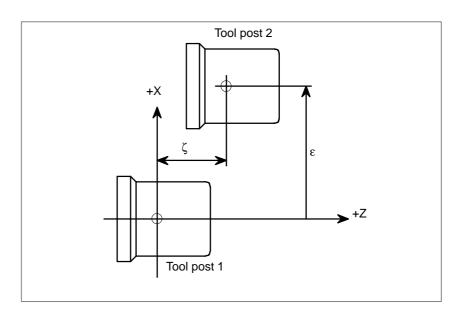
 Position setting for reference points of two tool posts

Data Setting for the

**Check Function** 

**Tool Post Interference** 

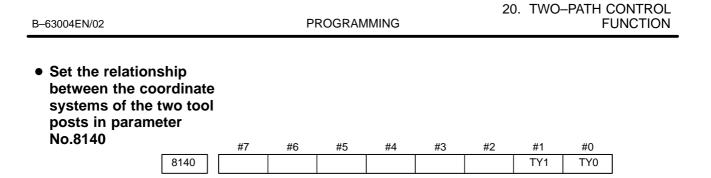
When reference point return operation is completed with all axes (X1, Z1, X2, Z2), the reference point of tool post 1 is set at the origin of the ZX plane coordinate system. At this time, the position of the reference point of tool post 2 is set in a parameter. The next item describes the reference points.



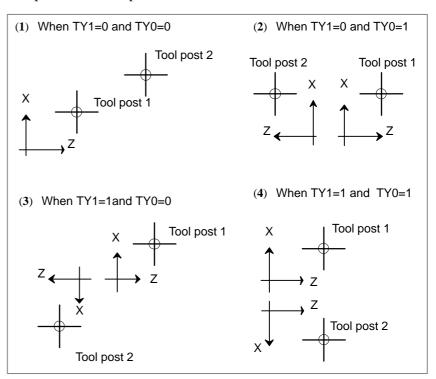
In the ZX plane coordinate system at the origin of which the reference point of tool post 1 is set, set the X coordinate ( $\epsilon$ ) of the reference point of tool post 2 in parameter No. 8151, and its Z coordinate ( $\zeta$ ) in parameter No.8152.

The unit of setting is the least command increment. For an axis subject to diameter specification, a diameter value is to be specified.

Measure ( $\epsilon$ ) and ( $\zeta$ ) when reference point return operation is completed with the four axes (X1, Z1, X2, Z2). When the relative coordinate parameters (Nos. 8151 and 8152) of the two tool posts are to be updated, reference point return operation must always be completed with the four axes beforehand. Otherwise, the internally memorized relational positions of the tool posts are not updated to new parameter values.

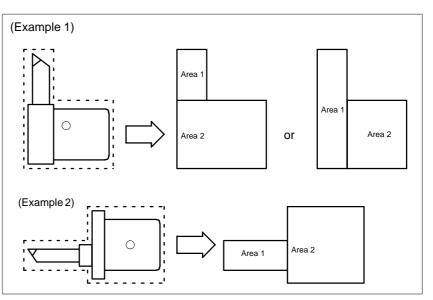


TY0, TY1:Set the relationship between the coordinate systems of the two tool posts, with tool post 1 used as the reference.

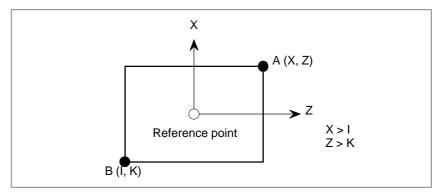


## • Setting of interference forbidden area

An interference forbidden area is set using a combination of two rectangular areas. Some examples are shown below. The dashed lines indicate interference forbidden areas.



The coordinates of the upper and lower ends (points A and B shown below) of each of two rectangles are set, with the reference point of the tool post set as the origin.



See Section **20.3.3** for information about the coordinate setting procedure.

#### 20.3.3

Setting and Display of Interference Forbidden Areas for Tool Post Interference Checking

**Explanations** 

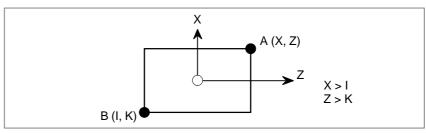
Display and set tool shape data (interference forbidden areas) according to the procedure below.

- (1) Press function | GFFSET | key.
- (2) Press the chapter selection soft key [TOOLFM].
- (3) With the tool post selection signal, select a tool post for which interference forbidden areas for tool post interference checking are to be displayed and set.
- (4) Display the screen including a tool number for which data is to be set. Method 1:Select the screen by using the page keys and cursor keys. Method 2:Enter a desired tool number, then press the soft key

#### [NO.SRH]

| TOOL FORM DATA<br>OFFSET NO. = 01 | 00001 N00001                           |
|-----------------------------------|--|
| AREA1                             | AREA 2                                 |
| X = 20.000                        | X = 40.000                             |
| Z = 70.000                        | Z = 70.000                             |
| I = -10.000                       | I = 20.000                             |
| K = -50.000                       | K = 30.000                             |
| OFFSET NO = 02                    |  |
| AREA1                             | AREA 2                                 |
| X = 80.000                        | X = -100.000                           |
| Z = 170.000                       | Z = -60.000                            |
| I = -100.000                      | I = -140.000                           |
| K = -120.000                      | K = -120.000                           |
| <b>&gt;_</b><br>MEM **** *** ***  | <b>S 0 T0000</b><br>12 : 02 : 08 HEAD1 |
| [NO.SRH ][ ][                     | ][ +INPUT ][ INPUT ]                   |

- (5) Move the cursor to a data item to be set, with the cursor move keys.(When data for point A is to be set, move the cursor to X and Z.When data for point B is to be set, move the cursor to I and K.)
- (6) With the numeric keys, enter the coordinates of point A or B. (Fraction digits can be entered.)



(7) By pressing the soft key **[INPUT]**, the entered coordinates are set. (Press the soft key **[+INPUT]** when an entered numeric value is to set after it is added to data already set.)

#### NOTE Tool number

The tool geometry data must be set for each tool number. The tool number here refers to the offset number. When both tool geometry offset and tool wear offset are used, the tool number corresponds to the wear offset number. To use two or more offset numbers for the same tool, the same data for the tool must be set two or more times in the tool geometry data.

### 20.3.4 Conditions for Making a Tool Post Interference Check

A tool post interference check is made when all conditions listed below are satisfied.

- (1) Parameter IFE (No. 8140#4) for enabling the tool post interference check function is set to 0.
- (2) After power is turned on, reference point return operation is completed with all axes (X1, Z1, X2, Z2). (When an absolute–position detector is used, the matching between a machine position and absolute–position detector position must be completed.)
- (3) Offset numbers other than 0 are specified using T codes for two tool posts.
- (4) When manual mode is used, parameter IFM (No. 8140#3) for enabling the tool post interference check function in manual mode is set to 1. When all conditions for making a tool post interference check are satisfied, the tool-post-interference-check-in-progress signal is output to the PMC.

#### WARNING

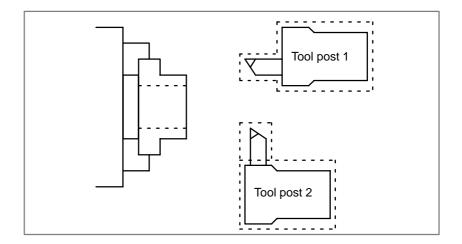
The tool post interference check function can be executed only when the number of the tool actually selected agrees with the programmed tool number.

The function cannot be executed correctly if the tool is selected by a manual operation or if no tool selection command is specified after power–on.

## 20.3.5 Execution of Tool Post Interference Checking

when all conditions described in Section **20.3.4** are satisfied, a tool post interference check is started. When a tool post interference check is made, an interference forbidden area is set for the two tool posts by using the tool shape data corresponding to the currently selected tool numbers. Then whether the areas interfere with each other is checked.

#### **Explanations**



When interface forbidden areas (tool shapes) as indicated by dashed lines are set for tool posts 1 and 2 as shown above, a check is made by determining whether the two interference forbidden areas indicated by dashed lines overlap each other after the movement of the tool posts.

If the two areas interfere with each other an P/S alarm (No. 508 or No. 509) is raised; the two tool posts are decelerated and stopped.

If an interference alarm is raised, a tool post interference alarm signal is output to the PMC.

If an interference alarm is raised by the interference of the two tool posts during automatic operation, switch to manual mode to move the tool posts out of the interference state. Then release the alarm by a reset.

The interference check function can be enabled even in manual mode by setting the parameter (No. 8140#3) to 1. This allows the tool posts interfering with each other to be moved along the axes only in such directions that clear the interference. With this capability, the two tool posts interfering with each other in automatic operation cannot be manually moved by mistake further into the interference forbidden areas after the mode is switched to manual mode to clear the interference, thus providing safety.

#### WARNING

When an alarm is raised, the CNC system and machine system stop with some delay in time.

So an actual stop position can be closer to the other tool post beyond an interference forbidden position specified using tool shape data. So, for safety, tool shape data a little larger than the actual shape should be set. The extra distance, L, required for this purpose is calculated form a rapid traverse feedrate as follows

L= (Rapid traverse feedrate)  $\times \frac{1}{7500}$ 

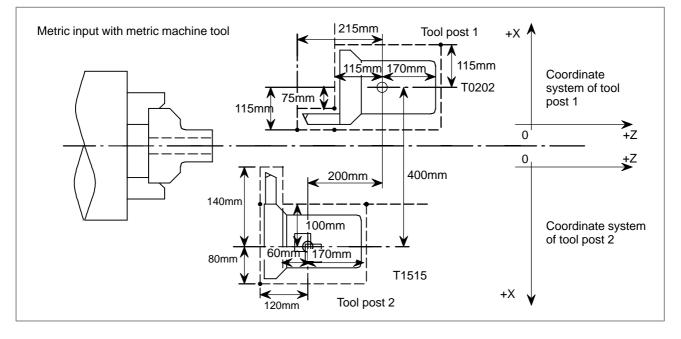
For example, when a rapid traverse feedrate of 15 m/min is used, L=2mm.

#### CAUTION

When parameters and interface forbidden areas are set to use the interference check function, be sure to check that correct interference forbidden areas are set. For this purpose, set manual mode, and cause the tool posts to interfere with each other in various directions.

## 20.3.6 Example of Making a Tool Post Interference Check

#### **Explanations**



The coordinate systems shown on the right of the figure above are the ZX plane coordinate systems of tool posts 1 and 2. For clarity, the coordinate systems are shifted; actually, the origins of the coordinate systems must match the machine zero points.

Assume the machine configuration shown above. Assume also that offset number 02 is assigned to tool post 1, and offset number 15 is assigned to tool post 2.

Suppose that the figure represents the state of reference point return operation completed with all axes (X1,Z1, X2, Z2). Then set -800 mm(diameter) and -200 mm in parameter Nos. 8151 and 8152, respectively.

The positional relationship of the two tool posts matches type (4) indicated in Section **20.3.2**. So set parameters TY0 and TY1 (No.8140#0, #1) as follows:

Parameter TY1 (No.8140#1)=1

Parameter TY0 (No.8140#0)=1

Then set tool shape data (interference forbidden area) for each tool post.

| 1001   |   |  |  |  |
|--|---|--|--|--|
| COOL FO  | RM DATA   |  | 00001  | N00001   |
| OFFSET   | NO. = 01  |  |  |  |
| ARE  | A 1   | AR   | EA 2   |  |
| X=   | 20.000  | X=   | 40.000   |  |
| $\mathbf{Z} =$   | 70.000  |  | 70.000   |  |
| ⊥=   | -10.000   | I=   | 20.000   |  |
| K=   | -50.000   | K=   | 20.000<br>30.000   |  |
| OFFSET   | NO. = 02  |  |  |  |
| ARE  | A 1   | AR   | EA 2   |  |
| X=   | 115.000   | X=   | -75.0  | 00   |
| $\mathbf{Z} =$   | 170.000   |  | -115.0   |  |
| I=   | -115.000  |  | -115.0   |  |
| K=   | -115.000<br>-115.000  | K=   | -215.0   | 00   |
|  |   |  |  |  |
| >_   |   |  | S 0 T00  | 00   |
| MEM  | * * * * * * * * * *   | 12   | :02:08   | HEAD 1   |
|  | I][ ][  |  |  |  |
|  |   |  |  |  |
|  |   |  |  |  |
|  |   |  |  |  |
|  |   |  |  |  |
| TOOL F   | ORM DATA  |  | 00001  | N00001   |
|  |   |  | 00001  | N00001   |
|  | NO. = 15  |  |  | N00001   |
| OFFSET<br>ARE  | NO. = 15<br>A 1   | AR   | EA 2   |  |
| OFFSET<br>ARE  | NO. = 15<br>A 1<br>80.000   | AR<br>X=   | EA 2<br>-100.  | 000  |
| OFFSET<br>ARE<br>X=<br>Z=  | NO. = 15<br>A 1<br>80.000<br>170.000  | AR<br>X=<br>Z=   | EA 2<br>-100.<br>-60.  | 000  |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=  | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000  | AR<br>X=<br>Z=<br>I=                                     | EA 2<br>-100.<br>-60.<br>-140.   | 000<br>000<br>000                                |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=  | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000  | AR<br>X=<br>Z=<br>I=                                     | EA 2<br>-100.<br>-60.  | 000<br>000<br>000                                |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=<br>OFFSET                                | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000  | AR<br>X=<br>Z=<br>I=<br>K=                               | EA 2<br>-100.<br>-60.<br>-140.<br>-120.  | 000<br>000<br>000<br>000                         |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE                         | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1                                     | AR<br>X=<br>Z=<br>I=<br>K=<br>AR                         | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2  | 000<br>000<br>000<br>000                         |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE                         | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000                            | AR<br>X=<br>Z=<br>I=<br>K=<br>AR<br>X=                   | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0   | 000<br>000<br>000<br>000                         |
| OFFSET<br>ARE<br>X=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=                         | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000<br>0.000<br>0.000          | AR<br>X=<br>Z=<br>I=<br>K=<br>AR                         | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0   | 000<br>000<br>000<br>000<br>000                  |
| OFFSET<br>ARE<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=<br>Z=                   | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000<br>0.000<br>0.000          | AR<br>X=<br>I=<br>K=<br>AR<br>X=<br>Z=                   | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0<br>0.0                                    | 000<br>000<br>000<br>000<br>000<br>00<br>00      |
| OFFSET<br>ARE<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=<br>Z=<br>I=             | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000                            | AR<br>X=<br>Z=<br>I=<br>K=<br>AR<br>X=<br>Z=<br>I=       | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0<br>0.0<br>0.0                             | 000<br>000<br>000<br>000<br>000<br>00<br>00      |
| OFFSET<br>ARE<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=<br>Z=<br>I=             | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000<br>0.000<br>0.000          | AR<br>X=<br>Z=<br>I=<br>K=<br>AR<br>X=<br>Z=<br>I=       | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0<br>0.0<br>0.0                             | 000<br>000<br>000<br>000<br>000<br>00<br>00      |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K= | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000<br>0.000<br>0.000<br>0.000 | AR<br>X=<br>Z=<br>I=<br>K=<br>AR<br>X=<br>Z=<br>I=<br>K= | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0 | 000<br>000<br>000<br>000<br>00<br>00<br>00<br>00 |
| OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K=<br>OFFSET<br>ARE<br>X=<br>Z=<br>I=<br>K= | NO. = 15<br>A 1<br>80.000<br>170.000<br>-100.000<br>-200.000<br>NO. = 16<br>A 1<br>0.000<br>0.000<br>0.000          | AR<br>X=<br>Z=<br>I=<br>K=<br>AR<br>X=<br>Z=<br>I=<br>K= | EA 2<br>-100.<br>-60.<br>-140.<br>-120.<br>EA 2<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0<br>0.0 | 000<br>000<br>000<br>000<br>00<br>00<br>00<br>00 |

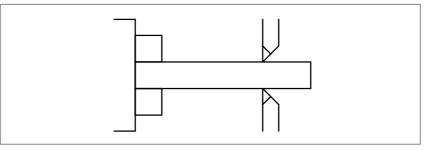
The figures below show the setting of data for tool number 02 assigned to tool post 1 and for tool number 15 assigned to tool post 2.

Set data for other tools similarly. A preparation for an interference check is completed when data has been set for all tools. Turn on power. Then, an interference check is started when a T code is specified with each tool post

after reference point return operation is completed with all of the four axes (X1, Z1, X2, Z2).

## 20.4 BALANCE CUT (G68, G69)

When a thin workpiece is to be machined as shown below, a precision machining can be achieved by machining each side of the workpiece with a tool simultaneously;this function can prevent the workpiece from warpage that can result when only one side is machined at a time. When both sides are machined at the same time, the movement of one tool must be in phase with that of the other tool. Otherwise, the workpiece can vibrate, resulting in poor machining. With this function, the movement of one tool post can be easily synchronized with that of the other tool post.



#### Fig. 20.4 Balance cut

When G68 is specified in the programs for both tool post 1 and tool post 2, the pulse distribution of tool post 1 is synchronized with that of tool post 2 to start balance cutting. Thus the two tool posts can move exactly at the same time to allow balance cutting.

| G code | Meaning                 |  |
|--------|-------------------------|--|
| G68    | Balance cut mode        |  |
| G69    | Balance cut mode cancel |  |

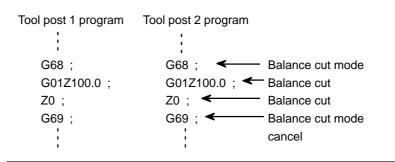
In the balance cut mode, balance cutting is performed only when a move command is specified for both tool posts. Balance cutting is performed even when different axes are specified for each tool post or an offset move command is specified. G68 or G69 must be specified in a single block. (Otherwise, a P/S alarm (No. 163) is raised. When G68 or G69 is specified with one tool post, the tool post does not move until the execution for the other tool post proceeds to G68 or G69. And if cutting is specified with one tool post in the balance cut mode, the tool post does not move until the execution of or the other tool post proceeds to a cutting command.

#### CAUTION

Balance cut only starts cutting feed on both tool posts at the same time; it does not maintain synchronization thereafter. To synchronize all the movements of both tool posts, the setting for both tool posts, such as the travel distance and feedrate, must be the same.

#### **Explanations**

#### Example



#### CAUTION

- 1 Balance cutting is not performed in dry run or machine lock state.
- 2 When rapid traverse operation is specified, balance cut processing is not performed.
- 3 A workpiece for which thread cutting has been performed in the balance cut mode cannot be subjected to thread cutting in the cancel mode. Thread cutting starts at a different position.

#### NOTE

- 1 Time delay before the pulse distribution of both tool posts is started is 2 msec or shorter.
- 2 In the balance cut mode, synchronization is established at the start of a move block, so movement can momentarily stop.
- 3 If feed hold operation is performed during balance cutting using both tool posts, balance cut processing is not performed at restart time, it is performed when the next move command is specified for both tool posts.
- 4 The cancel mode (G69) is set by a reset.
- 5 When the option "mirror image for double turrets" is selected, the balance cut function cannot be used.

| 20.5<br>MEMORY COMMON<br>TO TOOL POSTS                | A machine with two tool posts has different custom macro common<br>variables and tool compensation memory areas for tool posts 1 and 2.<br>Tool posts 1 and 2 can share the custom macro common variables and tool<br>compensation memory areas provided certain parameters are specified<br>accordingly.                                     |
|---|---|
| Explanations  |   |
| <ul> <li>Custom macro common<br/>variables</li> </ul> | Tool posts 1 and 2 can share all or part of custom macro common variables #100 to #149 and #500 to #531, provided parameters 6036 and 6037 are specified accordingly. (The data for the shared variables can be written or read from either tool post.) See Section 15.1 of Part II.  |
| <ul> <li>Tool compensation<br/>memory</li> </ul>      | Tool post 2 can reference or specify the data in the tool compensation<br>memory area of tool post 1, provided the CMF bit (bit 5 of parameter<br>8100) is specified accordingly. This can be executed only when tool posts<br>1 and 2 have identical data for tool compensation (number of groups,<br>number of columns, unit system, etc.). |

## 20.6 SPINDLE CONTROL IN TWO-PATH CONTROL

The two-path control function supports two spindle interfaces. Thus, 16–TB can control a lathe that simultaneously machines a workpiece attached to one spindle with two tool posts, or can control a lathe that simultaneously machines a workpiece attached to each of two spindles with two tool posts.

The former spindle control is referred to as 1–spindle control, and the latter is referred to as 2–spindle control.

Parameter 2SP (No. 3703#0) is used to select 1-spindle control or 2-spindle control.

#### **Explanations**

• 1-spindle control

One spindle is controlled by programmed commands for tool post 1 or tool post 2. Programmed commands(Note 1) for the spindle can be specified from either tool post. However, a spindle speed output selection signal (Note 2) determines which commands from the two tool posts are valid. The spindle is controlled according to the commands from a tool post selected by the signal.

A feedback pulse signal from the position coder attache to the spindle is applied to both tool posts. Such a feedback pulse signal is used for processing such as thread cutting and feed per rotation with each tool post.

• 2-spindle control Two spindles, spindle 1 and spindle 2 (Note 3), are controlled independently of each other according to programmed commands (Note 1) for each tool post. Usually, programmed commands for tool post 1 are used to control spindle 1, and programmed commands for tool post 2 are used to control spindle 2. Feedback pulse signals from the position coders attached to spindle 1 and spindle 2 are applied to tool post 1 and tool post 2, respectively.

PROGRAMMING

The spindle speed output selection signal (Note 2) can be used to specify which spindle must be controlled by programmed commands for which tool post. In addition, a spindle feedback input selection signal (Note 2) can be used to specify which spindle must be controlled by programmed commands for which tool post. In addition, a spindle feedback input selection signal (Note 2) can be used to specify which tool post must receive a feedback signal from which spindle. Thus, tool post 1 can control spindle 2, and tool post 2 can control spindle 1.

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#### NOTE

- 1 The programmed commands for spindles include the following.
  - S code to specify a spindle speed
  - M03 (forward spindle rotation), M04 (reverse spindle rotation)
  - Commands for constant surface speed control (G96, G97, S code to specify surface speeds, commands to specify maximum spindle speeds)
- 2 Refer to the "FANUC Series 16*i*/18*i*/160*i*/180*i*–MODEL A CONNECTION MANUAL (FUNCTION)" for detailed information about the spindle speed output selection signal and spindle feedback input selection signal. Control over these signals varies from one machine tool builder to another. So be sure to read the relevant manual prepared by the machine tool builder to be familiar with the commands for the spindles.
- 3 The spindle connected to spindle interface 1 (main CPU board) is defined as spindle 1, and the spindle connected to spindle interface 2 (optional board 2) is defined as spindle 2. For detail refer to FANUC Series 16*i*/18*i*/160*i*/180*i*-MODEL A CONNECTION MANUAL (FUNCTION).

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## 20.7 SYNCHRONIZATION CONTROL AND COMPOSITE CONTROL

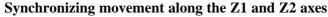
In 2-paths control, the synchronization control function and composite control function enable synchronization control in a single system or between two systems, composite control of two systems, and superposition control of two systems.

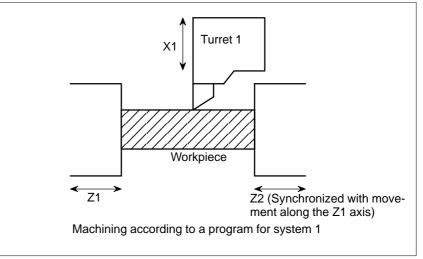
#### **Explanations**

• Synchronization control

Synchronizes movement along an axis of one system with that along an axis of the other system.

#### Example)

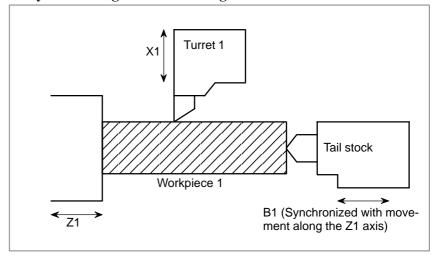




Synchronizes movement along an axis of one system with that along another axis of the same system.

#### Example)

Synchronizing movement along the Z1 and B1 axes



#### • Composite control

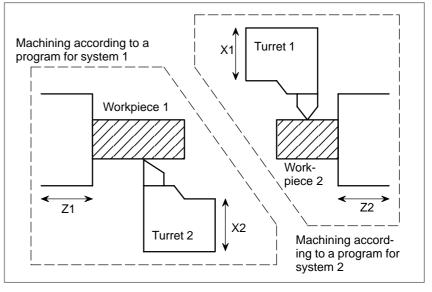
Exchanges the move commands for different axes of different systems.

#### **Example**)

#### Exchanging the commands for the X1 and X2 axes

-> Upon the execution of a command programmed for system 1, movement is performed along the X2 and Z1 axes.

Upon the execution of a command programmed for system 2, movement is performed along the X1 and Z2 axes.

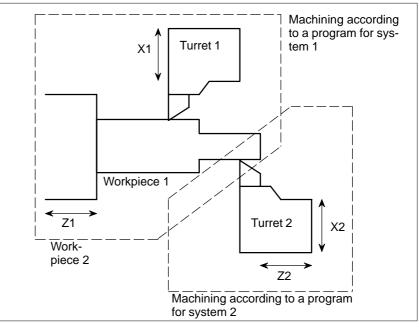


• Superposition control

Provides a move command of an axis for a different axis in another system.

#### Example)

#### Providing the Z2 axis with a move command specified for the Z1 axis



#### NOTE

The method used to specify synchronization or composite control varies with the machine tool builder. For details, refer to the manual supplied by the machine tool builder. PROGRAMMING

## 20.8 COPYING A PROGRAM BETWEEN TWO PATHS

#### **Explanations**

• Single–program copy

In a CNC supporting two-path control, specified machining programs can be copied between the two paths by setting bit 0 (PCP) of parameter No. 3206 to 1. A copy operation can be performed by specifying either a single program or a range. For information about operations, see Section 9.10 in Part III.

Copy source number: 0001 Copy destination number: Not set



Copy source number: 0001 Copy destination 0010



#### • Specified-range copy

Copy source number: 0001 to 0100 Copy destination number: Not set

| Copy source |               | Copy destination |
|-------------|---------------|------------------|
| O0001       | $\rightarrow$ | O0001            |
| O0010       | $\rightarrow$ | O0010            |
| O0100       | $\rightarrow$ | O0100            |
| O1000       |               |                  |
| O2000       |               |                  |
| O2000       |               |                  |

#### Copy source number: 0001 to 0100 Copy destination 1000

| Copy source |               | Copy destination |
|-------------|---------------|------------------|
| O0001       | $\rightarrow$ | O1001            |
| O0010       | $\rightarrow$ | O1001            |
| O0100       | $\rightarrow$ | O1002            |
| O1000       |               |                  |
| O2000       |               |                  |
| 02000       |               |                  |

# 21

## PATTERN DATA INPUT FUNCTION

This function enables users to perform programming simply by extracting numeric data (pattern data) from a drawing and specifying the numerical values from the MDI panel.

This eliminates the need for programming using an existing NC language.

With the aid of this function, a machine tool builder can prepare the program of a hole machining cycle (such as a boring cycle or tapping cycle) using the custom macro function, and can store it into the program memory.

This cycle is assigned pattern names, such as BOR1, TAP3, and DRL2.

An operator can select a pattern from the menu of pattern names displayed on the screen.

Data (pattern data) which is to be specified by the operator should be created in advance with variables in a drilling cycle.

The operator can identify these variables using names such as DEPTH, RETURN RELIEF, FEED, MATERIAL or other pattern data names. The operator assigns values (pattern data) to these names.

## 21.1 DISPLAYING THE PATTERN MENU

Pressing the  $\operatorname{MENU}$  key and  $\operatorname{MENU}$  is displayed on the following

#### pattern menu screen.

| MENU : HOLE PATTERN      | 00000 и00000   |
|--------------------------|----------------|
| 1. TAPPING               |                |
| 2. DRILLING              |                |
| 3. BORING                |                |
| 4. POCKET                |                |
| 5. BOLT HOLE             |                |
| 6. LINE ANGLE            |                |
| 7. GRID                  |                |
| 8. PECK                  |                |
| 9. TEST PATRN            |                |
| 10. BACK                 |                |
|                          |                |
| >                        |                |
| MDI **** *** *** 16:     | 05:59          |
| [ MACRO ] [ MENU ] [ OPR | ] [ ] [(OPRT)] |
|                          | )              |

#### HOLE PATTERN :

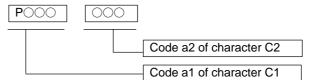
This is the menu title. An arbitrary character string consisting of up to 12 characters can be specified.

#### **BOLT HOLE** :

This is the pattern name. An arbitrary character string consisting of up to 10 characters can be specified, including katakana.

The machine tool builder should specify the character strings for the menu title and pattern name using the custom macro, and load the character strings into program memory as a subprogram of program No. 9500.

- Macro commands specifying the menu title



- q : Assume  $a_3$  and  $a_4$  to be the codes of characters  $C_3$  and  $C_4. \$  Then,  $q{=}a_310^3{+}a_4$
- r : Assume  $a_5$  and  $a_6$  to be the codes of characters  $C_5$  and  $C_6$ . Then,  $r=a_510^3+a_6$
- i : Assume  $a_7$  and  $a_8$  to be the codes of characters  $C_7$  and  $C_8$ . Then,  $i=a_710^3+a_8$
- j : Assume  $a_9$  and  $a_{10}$  to be the codes of characters  $C_9$  and  $C_{10}. \$  Then,  $j{=}a_9\,10^3{+}a_{10}$
- k : Assume  $a_{11}$  and  $a_{12}$  to be the codes of characters  $C_{11}$  and  $C_{12}. \$  Then,  $k{=}a_{11}10^3{+}a_{12}$

Example)

If the title of the menu is "HOLE PATTERN" then the macro instruction is as follows:

 $\begin{array}{c} \text{G65 H90 P072079} \\ \hline \text{HO} \\ \hline \text{LE} \\ \hline \text{LE} \\ \hline \text{P} \end{array} \end{array}$ 

 $\frac{I065084}{AT} \frac{J084069}{TE} \frac{K082078}{RN};$ 

For codes corresponding to these characters, refer to the table in II–21.3.

| <ul> <li>Macro instruction<br/>describing the pattern<br/>name</li> </ul> | Pattern name: $C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9 C_{10}$<br>$C_1, C_2, C_{10}$ : Characters in the pattern name (10 characters)<br>Macro instruction<br>G65 H91 P <sub>n</sub> Q <sub>q</sub> R <sub>r</sub> I <sub>i</sub> J <sub>j</sub> K <sub>k</sub> ;<br>H91: Specifies the menu title<br>n : Specifies the menu No. of the pattern name<br>$n_{=1} to 10$<br>$\overline{q}$ : Assume $a_1$ and $a_2$ to be the codes of characters $C_1$ and $C_2$ . Then,<br>$q=a_{1\times}10^3+a_2$<br>r : Assume $a_3$ and $a_4$ to be the codes of characters $C_3$ and $C_4$ . Then,<br>$r=a_{3\times}10^3+a_4$<br>i : Assume $a_5$ and $a_6$ to be the codes of characters $C_5$ and $C_6$ . Then, |
|---|---|
|   | <ul> <li>i=a<sub>5×</sub>10<sup>3</sup>+a<sub>6</sub></li> <li>j : Assume a<sub>7</sub> and a<sub>8</sub> to be the codes of characters C<sub>7</sub> and C<sub>8</sub>. Then, j=a<sub>7×</sub>10<sup>3</sup>+a<sub>8</sub></li> <li>k : Assume a<sub>9</sub> and a<sub>10</sub> to be the codes of characters C<sub>9</sub> and C<sub>10</sub>. Then, k=a<sub>9×</sub>10<sup>3</sup>+a<sub>10</sub></li> </ul>   |
|   | Example)<br>If the pattern name of menu No. 1 is "BOLT HOLE" then the macro<br>instruction is as follows.<br>G65 H91 P1 Q066079 R076084 I032072 J079076 K069032 ;<br>BO LT U H OL EU  |
| <ul> <li>Pattern No. selection</li> </ul>                                 | To select a pattern from the pattern menu screen, enter the corresponding pattern No. The following is an example.<br>1 INPUT<br>The selected pattern No. is assigned to system variable #5900. The   |

rule selected pattern No. is assigned to system variable #5900. The custom macro of the selected pattern can be started by starting a fixed program (external program No. search) with an external signal then referring to the system variable #5900 in the program.

#### NOTE

If each characters of P, Q, R, I, J, and K are not specified in a macro instruction, two spaces are assigned to each omitted character.

#### Example

Custom macros for the menu title and hole pattern names.

| MENU : HOLE PATTERN          | 00000 и00000 |
|------------------------------|--------------|
| 1. TAPPING                   |              |
| 2. DRILLING                  |              |
| 3. BORING                    |              |
| 4. POCKET                    |              |
| 5. BOLT HOLE                 |              |
| 6. LINE ANGLE                |              |
| 7. GRID                      |              |
| 8. PECK                      |              |
| 9. TEST PATRN                |              |
| 10. BACK                     |              |
| >                            |              |
| MDI **** *** 16:05:59        |              |
| [ MACRO ] [ MENU ] [ OPR ] [ | ] [ (OPRT) ] |

#### O9500;

| N1G65 H90 P072 079 Q076 069 R032 080 I 065 084 J 084 069 K082 078 ; | HOLE PATTERN |
|---|--------------|
| N2G65 H91 P1 Q066 079 R076 084 I 032 072 J 079 076 K069 032 ;       | 1.BOLT HOLE  |
| N3G65 H91 P2 Q071 082 R073 068 ;                                    | 2.GRID       |
| N4G65 H91 P3 Q076 073 R078 069 I 032 065 J 078071 K076069 ;         | 3.LINE ANGLE |
| N5G65 H91 P4 Q084 065 R080 080 I 073 078 J 071 032 ;                | 4.TAPPING    |
| N6G65 H91 P5 Q068 082 R073 076 I 076 073 J 078 071 ;                | 5.DRILLING   |
| N7G65 H91 P6 Q066079 R082073 I 078 071 ;                            | 6.BORING     |
| N8G65 H91 P7 Q080 079 R067 075 I 069 084 ;                          | 7.POCKET     |
| N9G65 H91 P8 Q080069 R067075 ;                                      | 8.PECK       |
| N10G65 H91 P9 Q084 069 R083 084 I032 080 J065 084 K082 078 ;        | 9.TEST PATRN |
| N11G65 H91 P10 Q066 065 R067 0750 ;                                 | 10.BACK      |
| N12M99 ;  |              |

## 21.2 PATTERN DATA DISPLAY

When a pattern menu is selected, the necessary pattern data is displayed.

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| LT HOLE    |   |  |   | 0  | 000  | 01 N00000   |
|------------|---|--|---|--|--|---|
| :          | DZ  | ATA  | CON   | MENT   |  |   |
|            | 0.  | .000   |   |  |  |   |
| DARD X     | Ο.  | .000   | *BC   | LT HC  | LE   |   |
| DARD Y     | Ο.  | .000   | CIR   | CLE*   |  |   |
| US         | Ο.  | .000   | SEI   | PATT   | ER   | N   |
| NGL        | Ο.  | .000   | DAT   | 'A TO  | VA   | R.  |
| S NO       | Ο.  | .000   | NO.   | 500-5  | 505  | •   |
|            | Ο.  | .000   |   |  |  |   |
|            | Ο.  | .000   |   |  |  |   |
|            |   |  |   |  |  |   |
| SITION (RE | <b>ELA</b>  | TIVE)  | )   |  |  |   |
| .000       | Y   | Ο.   | 000   |  |  |   |
| .000       |   |  |   |  |  |   |
|            |   |  |   |  |  |   |
| *** ***    |   | 16:0   | 5:5   | 9  |  |   |
| [ MENU ]   | Г   | OPR  | 1   | г  | 1  | [(OPRT)]  |
|            | DARD X<br>DARD Y<br>US<br>NGL<br>S NO<br>SITION (RI<br>.000<br>.000 | D2           0 | DATA<br>O.000<br>DARD X 0.000<br>DARD Y 0.000<br>US 0.000<br>NGL 0.000<br>S NO 0.000<br>0.000<br>SITION (RELATIVE)<br>.000 Y 0.<br>.000 | DATA         COM           0.000         0.000           DARD X         0.000         *BC           DARD Y         0.000         CIR           US         0.000         SET           NGL         0.000         DATA           S NO         0.000         NO.           0.000         0.000         SITION (RELATIVE)           .000         Y         0.000           .000         Y         0.000           .000         Y         0.000 | DATA       COMMENT         0.000       *BOLT HC         DARD X       0.000       *BOLT HC         DARD Y       0.000       CIRCLE*         US       0.000       SET PATT         NGL       0.000       DATA TO         S NO       0.000       NO.500-5         0.000       0.000         SITION (RELATIVE)       0.000         .000       Y       0.000         *** ***       16:05:59 | DATA         COMMENT           0.000         *BOLT HOLE           DARD X         0.000         *BOLT HOLE           DARD Y         0.000         CIRCLE*           US         0.000         SET PATTER           NGL         0.000         DATA TO VA           S NO         0.000         NO.500-505           0.000         0.000           SITION (RELATIVE)         0.000           .000         Y         0.000           *** ***         16:05:59 |

#### **BOLT HOLE** :

This is the pattern data title. A character string consisting of up to 12 characters can be set.

#### TOOL :

This is the variable name. A character string consisting of up to 10 characters can be set.

#### **\*BOLT HOLE CIRCLE\*** :

This is a comment statement. A character string can be displayed consisting of up to 8 lines, 12 characters per line.

(It is permissible to use katakana in a character string or line.)

The machine tool builder should program the character strings of pattern data title, pattern name, and variable name using the custom macro, and load them into the program memory as a subprogram whose No. is 9500 plus the pattern No. (O9501 to O9510).

| <ul> <li>Macro instruction</li> </ul> | Menu title : $C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9 C_{10} C_{11} C_{12}$   |
|---------------------------------------|---|
| specifying the pattern                | $C_1, C_{2,}, C_{12}$ : Characters in the menu title (12 characters)  |
| data title                            | Macro instruction   |
| (the menu title)                      | G65 H92 $P_n Q_q R_r I_i J_j K_k$   |
| , ,                                   | H92 : Specifies the pattern name  |
|                                       | p : Assume $a_1$ and $a_2$ to be the codes of characters $C_1$ and $C_2$ . Then,<br>$p=a_{1\times}10^3+a_2$                                   |
|                                       | See 17.3 for character codes.   |
|                                       | $q$ : Assume $a_3$ and $a_4$ to be the codes of characters $C_3$ and $C_4.$ Then, $q{=}a_{3\star}10^3{+}a_4$                                  |
|                                       | $r$ : Assume $a_5$ and $a_6$ to be the codes of characters $C_5$ and $C_6.$ Then, $r{=}a_{5\star}10^3{+}a_6$                                  |
|                                       | $i$ : Assume $a_7$ and $a_8$ to be the codes of characters $C_7$ and $C_8$ . Then, $i{=}a_{7\star}10^3{+}a_8$                                 |
|                                       | $j$ : Assume $a_9$ and $a_{10}$ to be the codes of characters $C_9$ and $C_{10}$ . Then, $j{=}a_{9\times}10^3{+}a_{10}$                       |
|                                       | $k$ : Assume $a_{11}$ and $a_{12}$ to be the codes of characters $C_{11}$ and $C_{12}.$ Then, $k{=}a_{11\times}10^3{}_+a_{12}$                |
|                                       | Example)  |
|                                       | Assume that the pattern data title is "BOLT HOLE." The macro  |
|                                       | instruction is given as follows:  |
|                                       | $G65 H92 P \underline{066079}_{BO} Q \underline{076084}_{LT} R \underline{032072}_{\Box} I \underline{079076}_{OL} J \underline{069032}_{E};$ |
| <ul> <li>Macro instruction</li> </ul> | Variable name : $C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9 C_{10}$  |
| specifying the variable               | $C_{1,} C_{2,-}, C_{10}$ : Characters in the variable name (10 characters)  |
| name                                  | Macro instruction   |
|                                       | $G65 H93 P_n Q_q R_r I_i J_j K_k;$  |
|                                       | H93 : Specifies the variable name   |
|                                       | n : Specifies the menu No. of the variable name $n=1$ to 10   |
|                                       | n=1 to 10 $q$ : Assume $a_1$ and $a_2$ to be the codes of characters $C_1$ and $C_2$ . Then,  |
|                                       | $q=a_{1\times}10^3+a_2$   |
|                                       | r : Assume $a_3$ and $a_4$ to be the codes of characters $C_3$ and $C_4$ . Then,<br>r= $a_{3\times}10^3+a_4$                                  |
|                                       | i : Assume $a_5$ and $a_6$ to be the codes of characters $C_5$ and $C_6$ . Then,<br>i= $a_{5\times}10^3+a_6$                                  |
|                                       | j : Assume $a_7$ and $a_8$ to be the codes of characters $C_7$ and $C_8$ . Then,<br>j= $a_{7\times}10^3+a_8$                                  |
|                                       | k : Assume $a_9$ and $a_{10}$ to be the codes of characters $C_9$ and $C_{10}$ . Then,<br>k= $a_{9*}10^3a+a_{10}$                             |
|                                       | Example)  |
|                                       | Assume that the variable name of the variable No. 503 is "RADIUS."<br>The macro instruction is given as follows:                              |
|                                       | G65 H93 P503 Q082065 R068073 I085083 ;  |
|                                       | $\frac{1}{RA} \frac{1}{DI} \frac{1}{US}$  |
|                                       | NOTE  |
|                                       | Variable names can be assigned to 32 common variables   |

Variable names can be assigned to 32 common variables #500 to #531, which are not cleared when the power is turned off.

| <ul> <li>Macro instruction to describe a comment</li> </ul> | <ul> <li>One comment line: C<sub>1</sub> C<sub>2</sub> C<sub>3</sub> C<sub>4</sub> C<sub>5</sub> C<sub>6</sub> C<sub>7</sub> C<sub>8</sub> C<sub>9</sub> C<sub>10</sub> C<sub>11</sub> C<sub>12</sub></li> <li>C<sub>1</sub>, C<sub>2</sub>,, C<sub>12</sub>: Character string in one comment line (12 characters)</li> <li>Macro instruction</li> <li>G65 H94 P<sub>n</sub> Q<sub>q</sub> R<sub>r</sub> I<sub>i</sub> J<sub>j</sub> K<sub>k</sub>;</li> <li>H94: Specifies the comment</li> <li>p: Assume a<sub>1</sub> and a<sub>2</sub> to be the codes of characters C<sub>1</sub> and C<sub>2</sub>. Then, p=a<sub>1×</sub>10<sup>3</sup>+a<sub>2</sub></li> <li>See 17.7 for character codes.</li> <li>q: Assume a<sub>3</sub> and a<sub>4</sub> to be the codes of characters C<sub>3</sub> and C<sub>4</sub>. Then, q=a<sub>3×</sub>10<sup>3</sup>+a<sub>4</sub></li> <li>r: Assume a<sub>5</sub> and a<sub>6</sub> to be the codes of characters C<sub>5</sub> and C<sub>6</sub>. Then, r=a<sub>5×</sub>10<sup>3</sup>+a<sub>6</sub></li> <li>i: Assume a<sub>7</sub> and a<sub>8</sub> to be the codes of characters C<sub>7</sub> and C<sub>8</sub>. Then, i=a<sub>7×</sub>10<sup>3</sup>+a<sub>8</sub></li> <li>j: Assume a<sub>9</sub> and a<sub>10</sub> to be the codes of characters C<sub>9</sub> and C<sub>10</sub>. Then, k=a<sub>11×</sub>10<sup>3</sup>+a<sub>12</sub></li> <li>A comment can be displayed in up to eight lines. The comment consists of the first line to the eighth line in the programmed sequence of G65 H94</li> </ul> |
|---|--|
|   | of the first line to the eighth line in the programmed sequence of G65 H94 for each line.  |

Example)

Assume that the comment is "BOLT HOLE." The macro instruction is given as follows:

#### **Examples**

Macro instruction to describe a parameter title , the variable name, and a comment.

| /        |                |                      |
|----------|----------------|----------------------|
| VAR.     | : BOLT HOLE    | 00001 N00000         |
| NO.      | NAME           | DATA COMMENT         |
| 500      | TOOL           | 0.000                |
| 501      | STANDARD X     | 0.000 *BOLT HOLE     |
| 502      | STANDARD Y     | 0.000 CIRCLE*        |
| 503      | RADIUS         | 0.000 SET PATTERN    |
| 504      | S. ANGL        | 0.000 DATA TO VAR.   |
| 505      | HOLES NO       | 0.000 NO.500-505.    |
| 506      |                | 0.000                |
| 507      |                | 0.000                |
| ACTU     | AL POSITION (R | ELATIVE)             |
| х        | 0.000          | Y 0.000              |
| Z        | 0.000          |                      |
| >        |                |                      |
| MDI *    | *** *** ***    | 16:05:59             |
| MAC      | RO][MENU]      | [ OPR ] [ ] [(OPRT)] |
| <u> </u> |                |                      |

#### O9501;

N1G65 H92 P066 079 Q076 084 R032 072 I 079 076 J069 032 ; VAR : BOLT HOLE N2G65 H93 P500 Q084 079 R079076; #500 TOOL N3G65 H93 P501 Q075 073 R074 085 I078 032 J088 032 ; #501 KIJUN X N4G65 H93 P502 Q075 073 R074 085 I 078 032 J089 032 ; #502 KIJUN Y N5G65 H93 P503 Q082 065 R068 073 I 085 083 ; #503 RADIUS N6G65 H93 P504 Q083 046 R032 065 I 078 071 J 076 032 ; #504 S.ANGL N7G65 H93 P505 Q072 079 R076 069 I 083 032 J078 079 K046 032 ; #505 HOLES NO N8G65 H94 ; Comment N9G65 H94 P042 066 Q079 076 R084 032 I072 079 J076 069 ; \*BOLT HOLE N10G65 H94 R032 067 I073 082 J067 076 K069 042 ; CIRCLE\* N11G65 H94 P083 069 Q084 032 080 065 I084 084 J069 082 K078 032 ; SET PATTERN N12G65 H94 P068 065 Q084 065 R032 084 1079 032 J086 065 K082046 ; DATA NO VAR. N13G65 H94 P078 079 Q046 053 R048 048 I045 053 J048 053 K046 032 ; No.500-505 N14M99;

## 21.3 CHARACTERS AND CODES TO BE USED FOR THE PATTERN DATA INPUT FUNCTION

| Char-<br>acter | Code | Comment | Char-<br>acter | Code | Comment                |
|----------------|------|---------|----------------|------|------------------------|
| A              | 065  |         | 6              | 054  |                        |
| В              | 066  |         | 7              | 055  |                        |
| С              | 067  |         | 8              | 056  |                        |
| D              | 068  |         | 9              | 057  |                        |
| E              | 069  |         |                | 032  | Space                  |
| F              | 070  |         | !              | 033  | Exclama-<br>tion mark  |
| G              | 071  |         | "              | 034  | Quotation<br>mark      |
| Н              | 072  |         | #              | 035  | Hash sign              |
| I              | 073  |         | \$             | 036  | Dollar sign            |
| J              | 074  |         | %              | 037  | Percent                |
| К              | 075  |         | &              | 038  | Ampersand              |
| L              | 076  |         | ,              | 039  | Apostrophe             |
| М              | 077  |         | (              | 040  | Left<br>parenthesis    |
| N              | 078  |         | )              | 041  | Right parenthesis      |
| 0              | 079  |         | *              | 042  | Asterisk               |
| Р              | 080  |         | +              | 043  | Plus sign              |
| Q              | 081  |         | ,              | 044  | Comma                  |
| R              | 082  |         | -              | 045  | Minus sign             |
| S              | 083  |         |                | 046  | Period                 |
| Т              | 084  |         | /              | 047  | Slash                  |
| U              | 085  |         | :              | 058  | Colon                  |
| V              | 086  |         | ;              | 059  | Semicolon              |
| W              | 087  |         | <              | 060  | Left angle<br>bracket  |
| Х              | 088  |         | =              | 061  | Equal sign             |
| Y              | 089  |         | >              | 062  | Right angle bracket    |
| Z              | 090  |         | ?              | 063  | Question<br>mark       |
| 0              | 048  |         | @              | 064  | HAt"mark               |
| 1              | 049  |         | ]              | 091  | Left square<br>bracket |
| 2              | 050  |         | ^              | 092  |                        |
| 3              | 051  |         | ¥              | 093  | Yen sign               |
| 4              | 052  |         | ]              | 094  | Right squar<br>bracket |
| 5              | 053  |         | _              | 095  | Underscore             |

## Table.21.3 (a) Characters and codes to be used for the pattern data input function

#### NOTE

Right and left parentheses cannot be used.

Table 21.3 (b) Numbers of subprograms employed in the pattern data input function

| Subprogram No. | Function  |
|----------------|---|
| O9500          | Specifies character strings displayed on the pattern data menu.                 |
| O9501          | Specifies a character string of the pattern data corresponding to pattern No.1  |
| O9502          | Specifies a character string of the pattern data corresponding to pattern No.2  |
| O9503          | Specifies a character string of the pattern data corresponding to pattern No.3  |
| O9504          | Specifies a character string of the pattern data corresponding to pattern No.4  |
| O9505          | Specifies a character string of the pattern data corresponding to pattern No.5  |
| O9506          | Specifies a character string of the pattern data corresponding to pattern No.6  |
| O9507          | Specifies a character string of the pattern data corresponding to pattern No.7  |
| O9508          | Specifies a character string of the pattern data corresponding to pattern No.8  |
| O9509          | Specifies a character string of the pattern data corresponding to pattern No.9  |
| O9510          | Specifies a character string of the pattern data corresponding to pattern No.10 |

| Table. 21.3 (c) | Macro instructions used in the pattern data input function |
|-----------------|--|
|-----------------|--|

| G code | H code | Function                          |
|--------|--------|-----------------------------------|
| G65    | H90    | Specifies the menu title.         |
| G65    | H91    | Specifies the pattern name.       |
| G65    | H92    | Specifies the pattern data title. |
| G65    | G93    | Specifies the variable name.      |
| G65    | H94    | Specifies the comment.            |

| T-1-1- 04 0 (-1) | Next and shall be a sum based in the mattern shate in |              |
|------------------|---|--------------|
| Table, 21.3 (d)  | System variables employed in the pattern data in      | put function |

| System variable | Function                      |
|-----------------|-------------------------------|
| #5900           | Pattern No. selected by user. |

## **III. OPERATION**

## GENERAL

## 1.1 MANUAL OPERATION

**Explanations** 

 Manual reference position return (See Section III–3.1)

The CNC machine tool has a position used to determine the machine position.

This position is called the reference position, where the tool is replaced or the coordinate are set. Ordinarily, after the power is turned on, the tool is moved to the reference position.

Manual reference position return is to move the tool to the reference position using switches and pushbuttons located on the operator's panel.

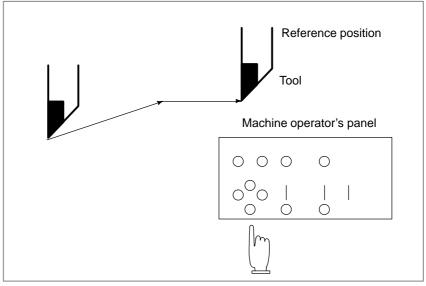


Fig. 1.1 (a) Manual reference position return

The tool can be moved to the reference position also with program commands.

This operation is called automatic reference position return (See Section II–6).

## Machine operator's panel Manual pulse generator Tool Workpiece

## • The tool movement by manual operation

Using machine operator's panel switches, push buttons, or the manual handle, the tool can be moved along each axis.

Fig. 1.1 (b) The tool movement by manual operation

The tool can be moved in the following ways:

- (i) Jog feed (See Section III–3.2) The tool moves continuously while a push button remains pressed.
- (ii) Incremental feed (See Section III–3.3) The tool moves by the predetermined distance each time a button is pressed.
- (iii) Manual handle feed (See Section III–3.4)By rotating the manual handle, the tool moves by the distance corresponding to the degree of handle rotation.

## 1.2 TOOL MOVEMENT BY PROGRAMMING – AUTOMATIC OPERATION

Automatic operation is to operate the machine according to the created program. It includes memory, MDI, and DNC operations. (See Section III–4).

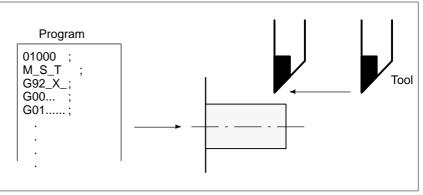
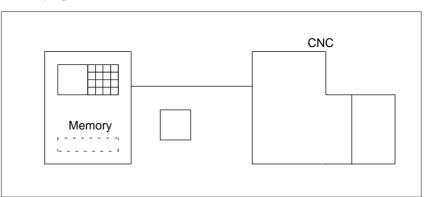


Fig. 1.2 (a) Tool Movement by Programming

### **Explanations**

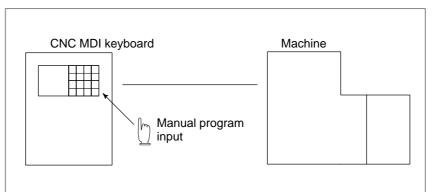
• Memory operation

After the program is once registered in memory of CNC, the machine can be run according to the program instructions. This operation is called memory operation.



### Fig. 1.2 (b) Memory Operation

After the program is entered, as an command group, from the MDI keyboard, the machine can be run according to the program. This operation is called MDI operation.



#### Fig. 1.2 (c) MDI operation

The machine can be operated by reading a program directly from an external input/output device, without having to register the program in CNC memory. This is called DNC operation.

### DNC operation

MDI operation

## 1.3 AUTOMATIC OPERATION

### **Explanations**

• Program selection

Select the program used for the workpiece. Ordinarily, one program is prepared for one workpiece. If two or more programs are in memory, select the program to be used, by searching the program number (Section III–9.3).

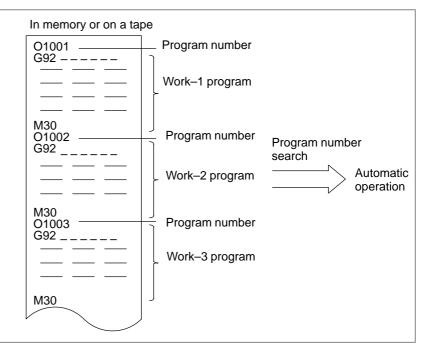


Fig. 1.3 (a) Program Selection for Automatic Operation

 Start and stop (See Section III–4) Pressing the cycle start push button causes automatic operation to start. By pressing the feed hold or reset push button, automatic operation pauses or stops. By specifying the program stop or program termination command in the program, the running will stop during automatic operation. When one process machining is completed, automatic operation stops.

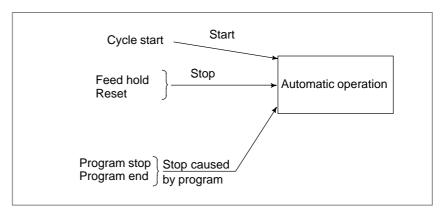


Fig. 1.3 (b) Start and Stop for Automatic Operation

• Handle interruption (See Section III-4.6)

While automatic operation is being executed, tool movement can overlap automatic operation by rotating the manual handle.

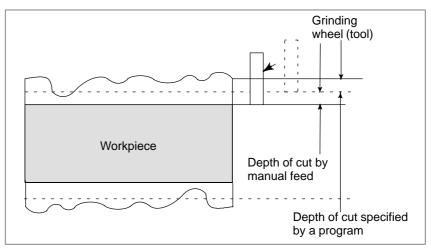


Fig. 1.3 (c) Handle Interruption for Automatic Operation

## 1.4 TESTING A PROGRAM

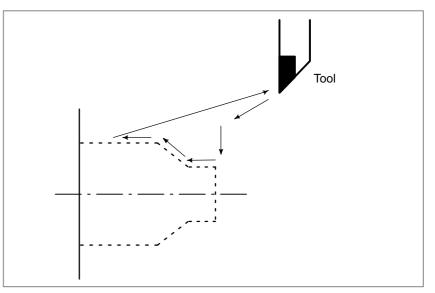
Before machining is started, the automatic running check can be executed. It checks whether the created program can operate the machine as desired. This check can be accomplished by running the machine actually or viewing the position display change (without running the machine) (See Section III–5).

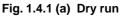
### 1.4.1 Check by Running the Machine

### **Explanations**

• Dry run (See Section III-5.4)

Remove the workpiece, check only movement of the tool. Select the tool movement rate using the dial on the operator's panel.





• Feedrate override (See Section III–5.2)

Check the program by changing the rate specified in the program.

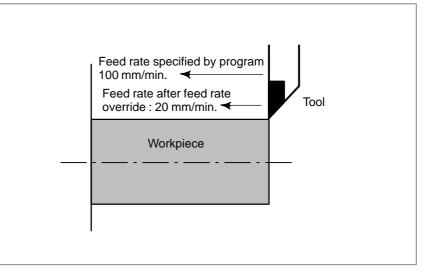


Fig. 1.4.1 (b) Feedrate Override

• Single block (See When the Section III–5.5) When the operation

When the cycle start push button is pressed, the tool executes one operation then stops. By pressing the cycle start again, the tool executes the next operation then stops. The program is checked in this manner.

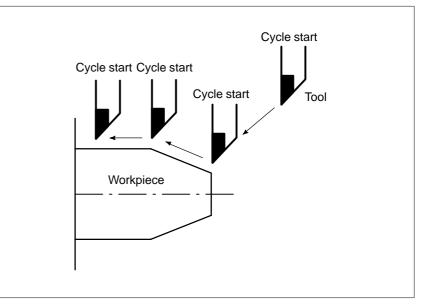


Fig. 1.4.1 (c) Single Block

### 1.4.2

How to View the Position Display Change without Running the Machine

### **Explanations**

• Machine lock (See Sections III–5.1)

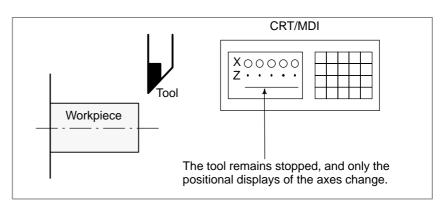


Fig. 1.4.2 Machine Lock

 Auxiliary function lock (See Section III–5.1) When automatic running is placed into the auxiliary function lock mode during the machine lock mode, all auxiliary functions (spindle rotation, tool replacement, coolant on/off, etc.) are disabled.

## 1.5 EDITING A PART PROGRAM

After a created program is once registered in memory, it can be corrected or modified from the MDI panel (See Section III–9).

This operation can be executed using the part program storage/edit function.

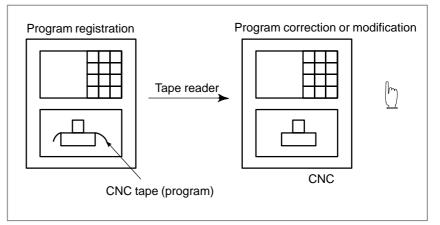


Fig. 1.5 Part Program Editing

## 1.6 DISPLAYING AND SETTING DATA

The operator can display or change a value stored in CNC internal memory by key operation on the MDI screen (See III–11).

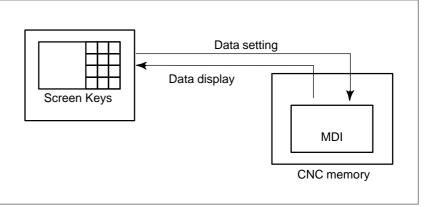


Fig. 1.6 (a) Displaying and Setting Data

### **Explanations**

• Offset value

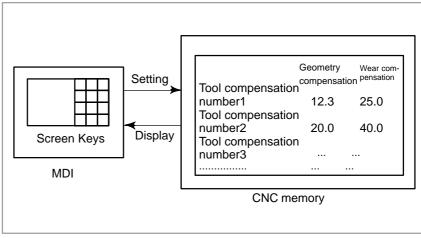


Fig. 1.6 (b) Displaying and Setting Offset Values

The tool has the tool dimension (length, diameter). When a workpiece is machined, the tool movement value depends on the tool dimensions.

By setting tool dimension data in CNC memory beforehand, automatically generates tool routes that permit any tool to cut the workpiece specified by the program. Tool dimension data is called the offset value (See Section III–11.4.1).

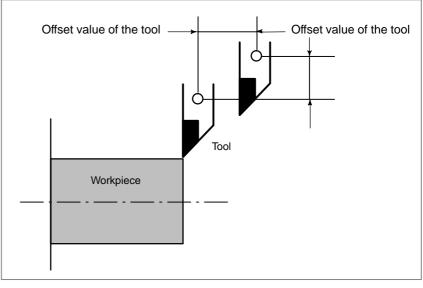


Fig. 1.6 (c) Offset Value

Apart from parameters, there is data that is set by the operator in operation. This data causes machine characteristics to change. For example, the following data can be set:

·Inch/Metric switching

·I/O devices selection

·Mirror image cutting on/off

The above data is called setting data (See Section III-11.4.3).

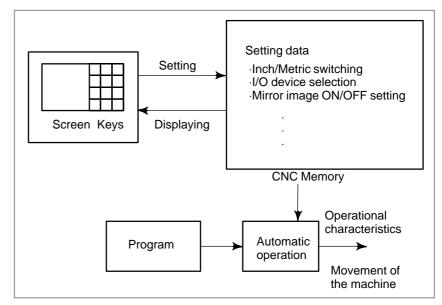


Fig. 1.6 (d) Displaying and Setting Operator's setting data

• Displaying and setting operator's setting data

 Displaying and setting parameters The CNC functions have versatility in order to take action in characteristics of various machines.

For example, CNC can specify the following:

·Rapid traverse rate of each axis

Whether increment system is based on metric system or inch system.

·How to set command multiply/detect multiply (CMR/DMR)

Data to make the above specification is called parameters (See Section III–11.5.1).

Parameters differ depending on machine tool.

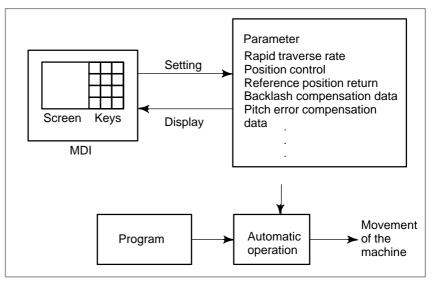


Fig. 1.6 (e) Displaying and setting parameters

• Data protection key

A key called the data protection key can be defined. It is used to prevent part programs, offset values, parameters, and setting data from being registered, modified, or deleted erroneously (See Section III–11).

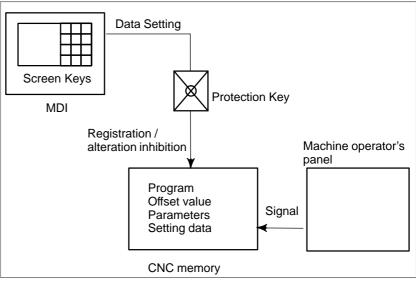
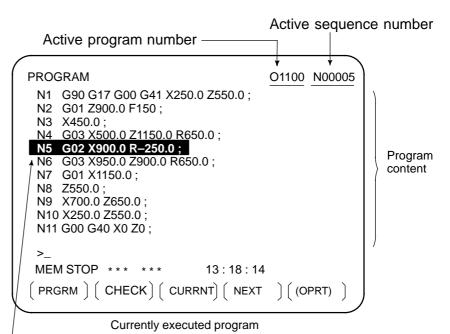


Fig. 1.6 (f) Data Protection Key

## 1.7 DISPLAY

### 1.7.1 Program Display

The contents of the currently active program are displayed. In addition, the programs scheduled next and the program list are displayed. (See Section III–11.2.1)



The cursor indicates the currently executed location

| PROGRAM   | O1100 N00003                                   |
|---|--|
| SYSTEM EDITION B1A1 – 03<br>PROGRAM NO. USED ' 10<br>MEMORY AREA USED ' 960 | FREE <sup>,</sup> 53<br>FREE <sup>,</sup> 5280 |
| PROGRAM LIBRARY LIST  | 00040 00050                                    |
| O0001 O0002 O0010 O0020<br>O0100 O0200 O1000 O1100                          | 00040 00050                                    |
|   |  |
|   |  |
| >_  |  |
|   | 3 : 18 : 14                                    |
|   |  |
| <b>\</b>  |  |

### 1.7.2 The current position of the tool is displayed with the coordinate values. The distance from the current position to the target position can also be **Current Position** displayed. (See Section III-11.1 to 11.1.3) Display Х 7 х ► Z Workpiece coordinate system ACTUAL POSITION(ABSOLUTE) O1000 N00010 123.456 456.789 Χ Ζ PART COUNT 5 RUN TIME 0H15M CYCLE TIME 0H 0M38S S 0 T0000 ACT.F 3000 MM/M

MEM STRT MTN \*\*\*

[ ABS ][ REL ][ ALL ][ HNDL][

## 1.7.3 Alarm Display

When a trouble occurs during operation, error code and alarm message are displayed on CRT screen. See APPENDIX G for the list of error codes and their meanings. (See Section III–7.1)

09:06:35

] [(OPRT)]

| ALARM I                | MESSAGE  | O1000 | N00003 |  |
|------------------------|--|-------|--------|--|
| 010                    | IMPROPER G-CODE                                      |       |        |  |
|                        |  |       |        |  |
|                        |  |       |        |  |
|                        |  |       |        |  |
| >_<br>MEM S<br>( ALARM | TOP **** *** ▲LM 19:55::<br>】 ) ( MSG ) ( HISTRY ) ( | 22    | )      |  |

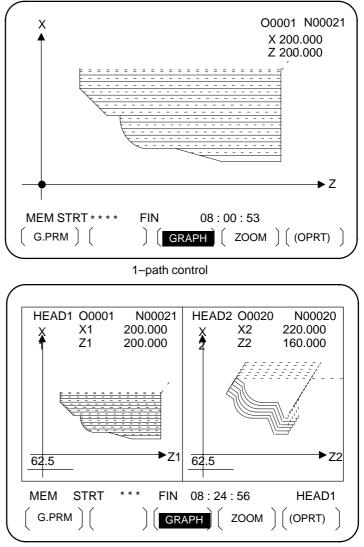
## 1.7.4 Parts Count Display, Run Time Display

When this option is selected, two types of run time and number of parts are displayed on the screen. (See Section 111–11.4.9)

| ACTUAL POSITION(ABSOLUTE) | O1000 N00010 |
|---------------------------|--------------|
| X 123                     | .456         |
| Z 456                     |              |
|                           |              |
|                           |              |
| DAI                       | RT COUNT 5   |
| RUN TIME 0H15M CYCLE T    | IME 0H 0M38S |
| ACT.F 3000 MM/M           | S 0 T0000    |
| MEM STRT MTN *** 09:06:35 |              |
| [ABS][REL][ALL][HNDL][    | [ ] [(OPRT)] |

# 1.7.5The gGraphic Display (Seemanual<br/>positionSection III-12)The g

The graphic can be used to draw a tool path for automatic operation and manual operation, thereby indicating the progress of cutting and the position of the tool. (See Section III–12)



2-path control

## 1.8 DATA OUTPUT

Programs, offset values, parameters, etc. input in CNC memory can be output to paper tape, cassette, or a floppy disk for saving. After once output to a medium, the data can be input into CNC memory.

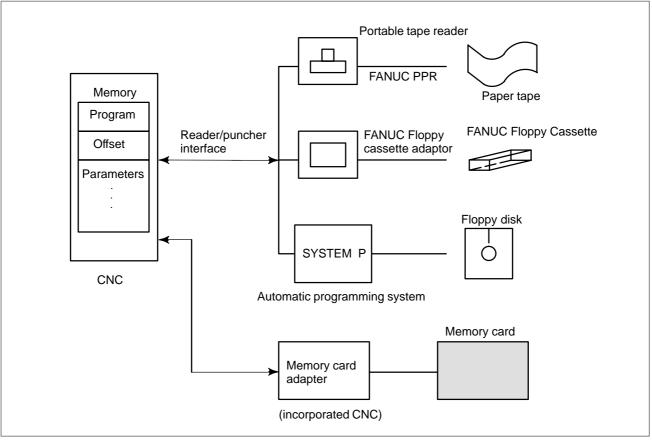


Fig. 1.8 Data Output

The available operational devices include the setting and display unit attached to the CNC, the machine operator's panel, and external input/output devices such as a Handy File and etc.

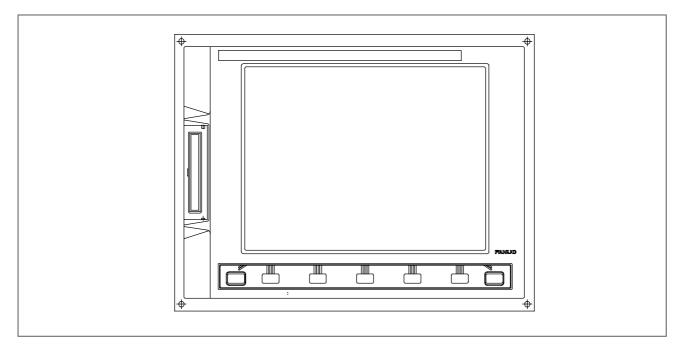
## 2.1 SETTING AND DISPLAY UNITS

The setting and display units are shown in Subsections 2.1.1 to 2.1.5 of Part III.

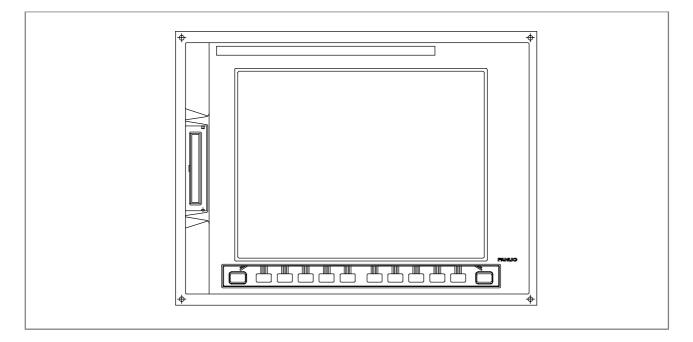
CNC control unit with 7.2"/8.4" LCD: III–2.1.1 CNC control unit with 9.5"/10.4" LCD: III–2.1.2 Stand–Alone type small MDI unit: III–2.1.3 Stand–Alone type standard MDI unit: III–2.1.4 Stand–Alone type 61 full key MDI unit: III–2.1.5 OPERATION

B-63004EN/02

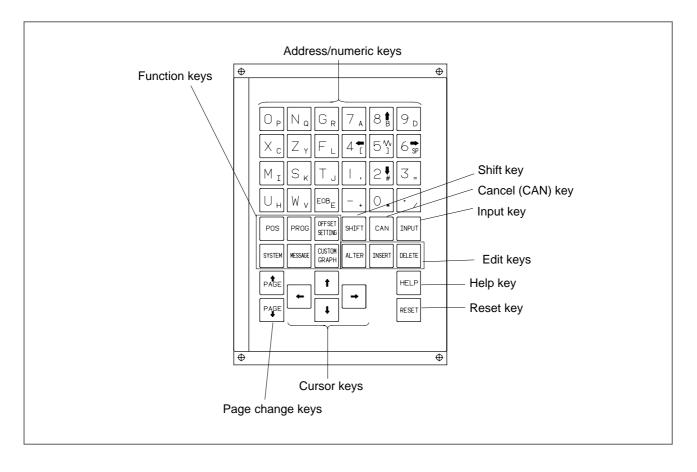
## 2.1.1 CNC Control Unit with 7.2"/8.4" LCD



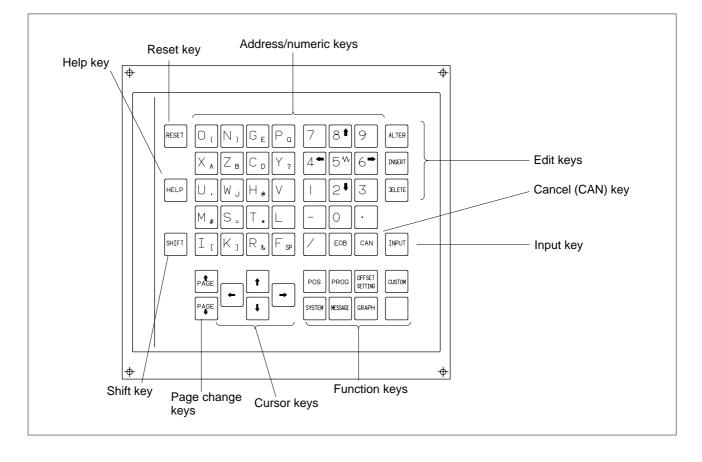
## 2.1.2 CNC Control Unit with 9.5"/10.4" LCD



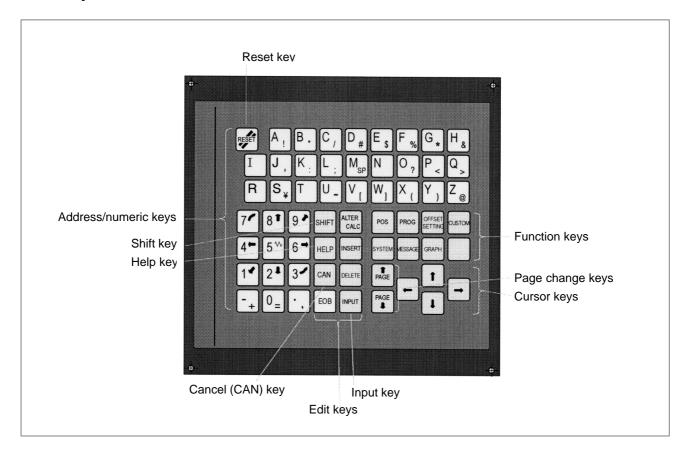
### 2.1.3 Stand–Alone Type Small MDI Unit



### 2.1.4 Stand–Alone Type Standard MDI Unit



### 2.1.5 Stand–Alone Type 61 Full Key MDI Unit



## 2.2 EXPLANATION OF THE KEYBOARD

| Number | Name                     | Explanation  |
|--------|--------------------------|--|
| 1      | RESET key                | Press this key to reset the CNC, to cancel an alarm, etc.  |
| 2      | HELP key                 | Press this key to display how to operate the machine tool, such as MDI key operation, or the details of an alarm which occurred in the CNC (Help function). In case of 160 <i>i</i> /180 <i>i</i> /160 <i>i</i> s/180 <i>i</i> s, this key is assigned to "ESC" key of the personal computer.  |
| 3      | Soft keys                | The soft keys have various functions, according to the Applications. The soft key functions are displayed at the bottom of the CRT screen.   |
| 4      | Address and numeric keys | Press these keys to input alphabetic, numeric, and other characters.   |
| 5      | SHIFT key                | Some keys have two characters on their keytop. Pressing the <shift> key switches the characters. Special character <math>\hat{E}</math> is displayed on the screen when a character indicated at the bottom right corner on the keytop can be entered.</shift>   |
| 6      | INPUT key                | When an address or a numerical key is pressed, the data is input to the buffer, and it is displayed on the CRT screen. To copy the data in the key input buffer to the offset register, etc., press the <input/> key. This key is equivalent to the [IN-PUT] key of the soft keys, and either can be pressed to produce the same result. |
| 7      | Cancel key               | Press this key to delete the last character or symbol input to the key input buffer.<br>When the key input buffer displays<br>>N001X100Z_<br>and the cancel CAN key is pressed, Z is canceled and<br>>N001X100_<br>is displayed.   |
| 8      | Program edit keys        | Press these keys when editing the program.         ALTER       : Alteration       (In case of 160i/180i/160is/180is, this key is assigned to "Tab" key of the personal computer.)         INSERT       : Insertion         DELETE       : Deletion   |
| 9      | Function keys            | Press theses keys to switch display screens for each function.<br>See sec. 2.3 for details of the function keys.   |

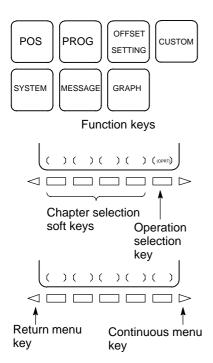
### Table 2.2 Explanation of the MDI keyboard

| Number | Name  | Explanation   |  |
|--------|---|---|--|
| 10     | Cursor move keys  | There are four different cursor move keys.  |  |
|        |   | This key is used to move the cursor to the right or in the forward direction. The cursor is moved in short units in the forward direction.  |  |
|        |   | : This key is used to move the cursor to the left or in the reverse direction. The cursor is moved in short units in the reverse direction. |  |
|        |   | : This key is used to move the cursor in a downward or forward direction. The cursor is moved in large units in the forward direction.      |  |
|        |   | : This key is used to move the cursor in an upward or reverse direction.<br>The cursor is moved in large units in the reverse direction.    |  |
| 11     | Page change keys         Two kinds of page change keys are described below. |   |  |
|        | PAGE  | : This key is used to changeover the page on the screen in the forward direction.   |  |
|        | PAGE  | : This key is used to changeover the page on the screen in the reverse direction.   |  |

### Table 2.2 Explanation of the MDI keyboard

## 2.3 FUNCTION KEYS AND SOFT KEYS

### 2.3.1 General Screen Operations



The function keys are used to select the type of screen (function) to be displayed. When a soft key (section select soft key) is pressed immediately after a function key, the screen (section) corresponding to the selected function can be selected.

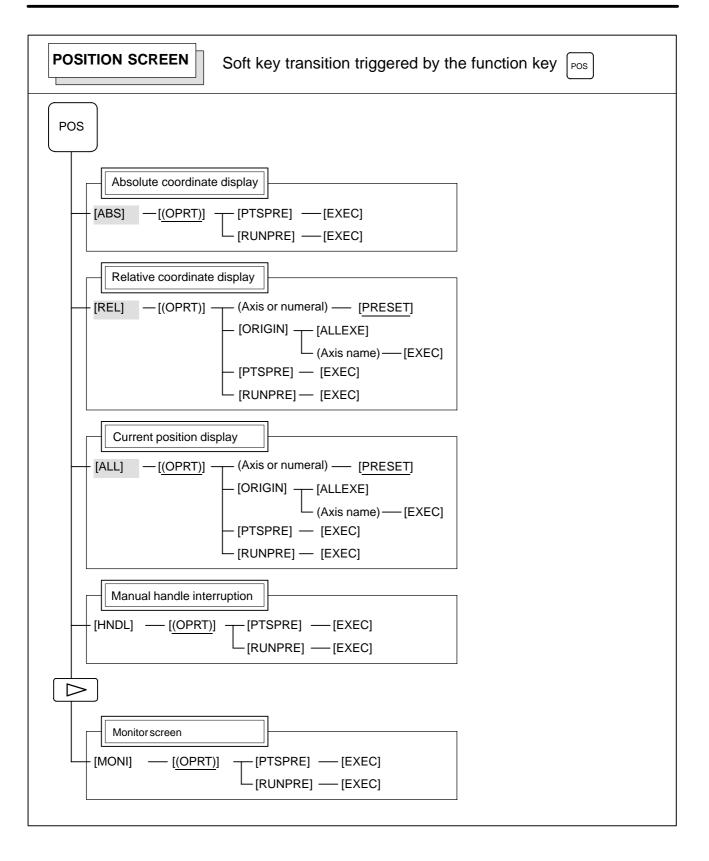
- **1** Press a function key on the MDI panel. The chapter selection soft keys that belong to the selected function appear.
- 2 Press one of the chapter selection soft keys. The screen for the selected chapter appears. If the soft key for a target chapter is not displayed, press the continuous menu key (next-menu key). In some cases, additional chapters can be selected within a chapter.
- **3** When the target chapter screen is displayed, press the operation selection key to display data to be manipulated.
- **4** To redisplay the chapter selection soft keys, press the return menu key.

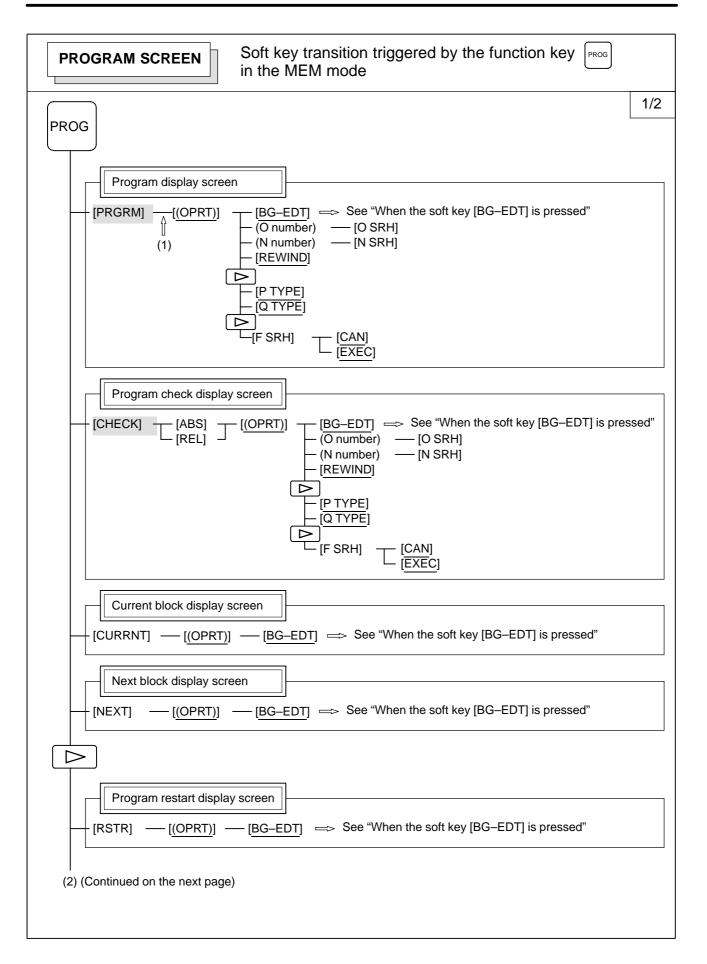
The general screen display procedure is explained above. However, the actual display procedure varies from one screen to another. For details, see the description of individual operations.

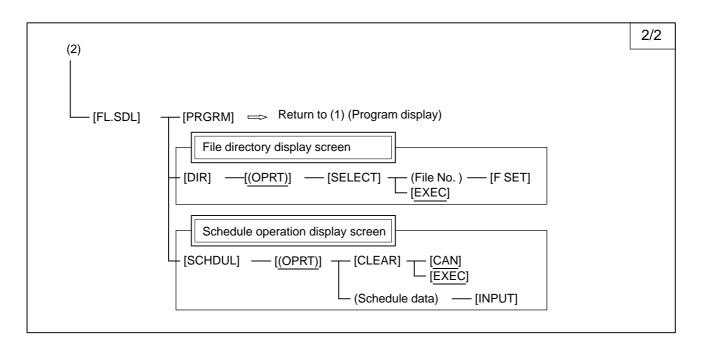
| 2.3.2<br>Function Keys | Function keys are provided to select the type of screen to be displayed.<br>The following function keys are provided on the MDI panel:   |
|------------------------|--|
| POS                    | Press this key to display the <b>position screen</b> .   |
| PROG                   | Press this key to display the <b>program screen</b> .  |
| OFFSET<br>SETTING      | Press this key to display the <b>offset/setting screen</b> .   |
| SYSTEM                 | Press this key to display the <b>system screen</b> .   |
| MESSAGE                | Press this key to display the <b>message screen</b> .  |
| GRAPH                  | Press this key to display the graphics screen.   |
| CUSTOM                 | Press this key to display the <b>custom screen (conversational macro screen)</b> .<br>In case of 160 <i>i</i> /180 <i>i</i> /160 <i>i</i> s/180 <i>i</i> s, this key is assigned to "Ctrl" key of the personal computer. |
|                        | In case of 160 <i>i</i> /180 <i>i</i> /160 <i>i</i> s/180 <i>i</i> s, this key is assigned to "Alt" key of the personal computer.  |

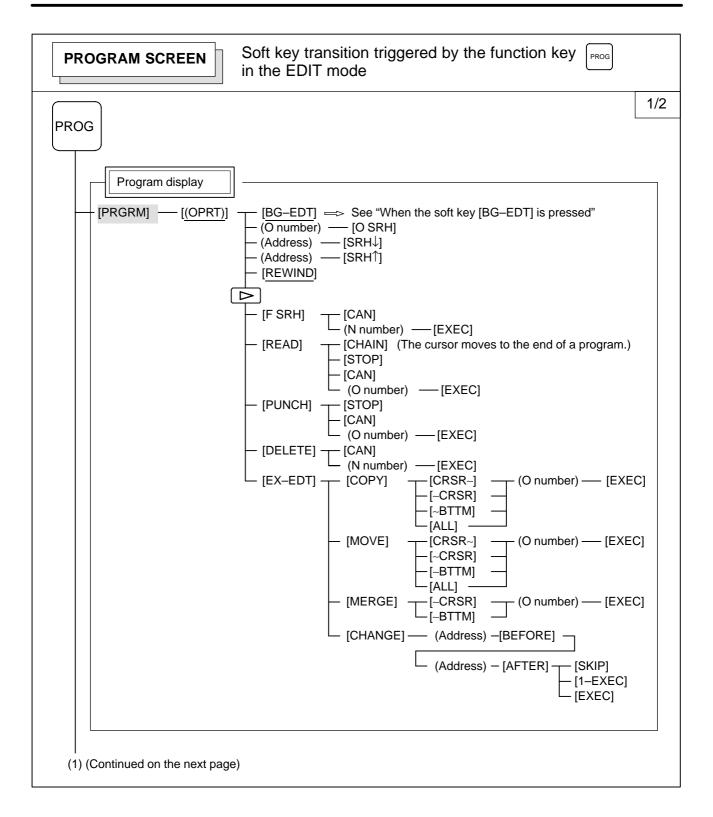
| 2.3.3<br>Soft Keys | To display a more detailed screen, press a function key followed by a soft<br>key. Soft keys are also used for actual operations.<br>The following illustrates how soft key displays are changed by pressing<br>each function key. |   |
|--------------------|--|---|
|                    | The symbols in t   | the following figures mean as shown below :                             |
|                    | :  | Indicates screens   |
|                    | :  | Indicates a screen that can be displayed by pressing a function key(*1) |
|                    | []:  | Indicates a soft key(*2)  |
|                    | () :   | Indicates input from the MDI panel.                                     |
|                    | [_] :  | Indicates a soft key displayed in green (or highlighted).               |
|                    | · · ·  | Indicates the continuous menu key (rightmost soft key)(*3).             |
|                    | L  |   |

- \*1 Press function keys to switch between screens that are used frequently.
- \*2 Some soft keys are not displayed depending on the option configuration.
- \*3 In some cases, the continuous menu key will not appear when a 12 soft key display unit is used.

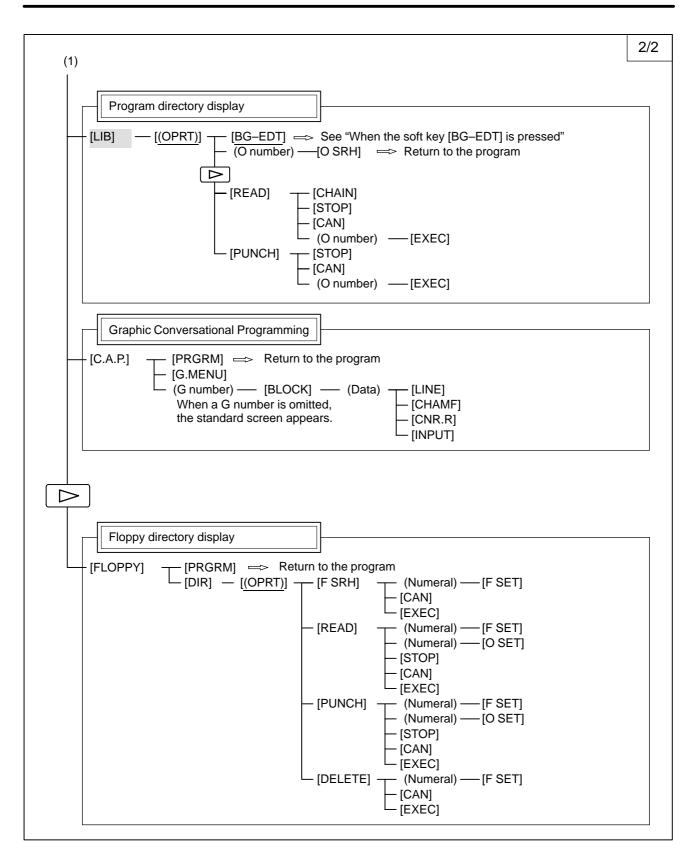








OPERATION



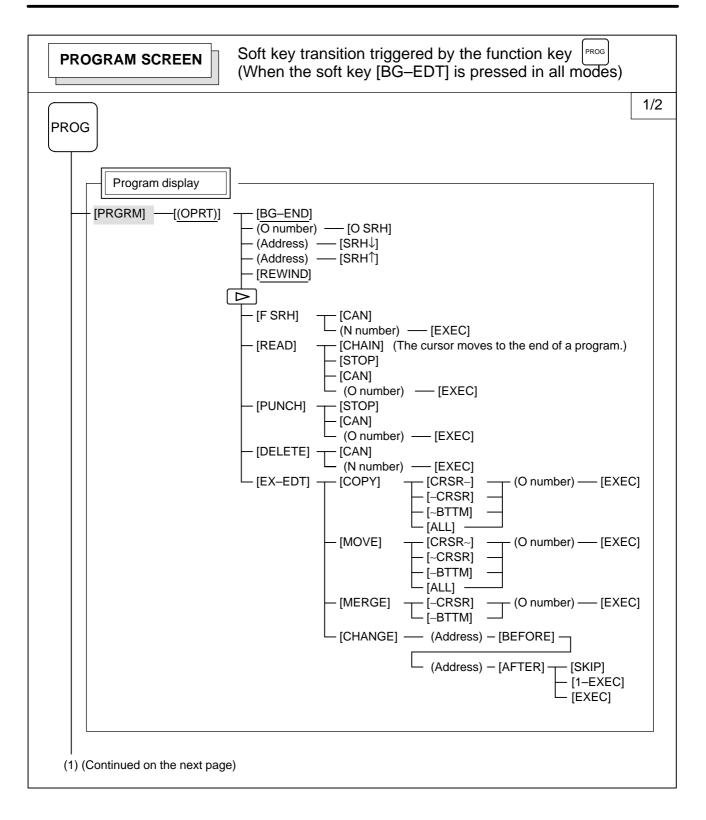
OPERATION

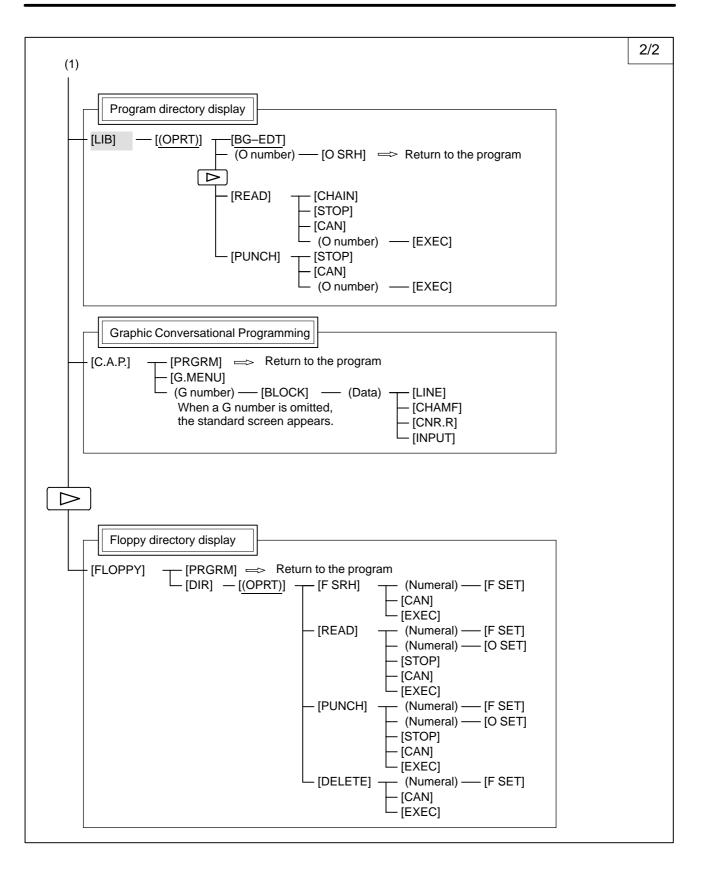
B-63004EN/02

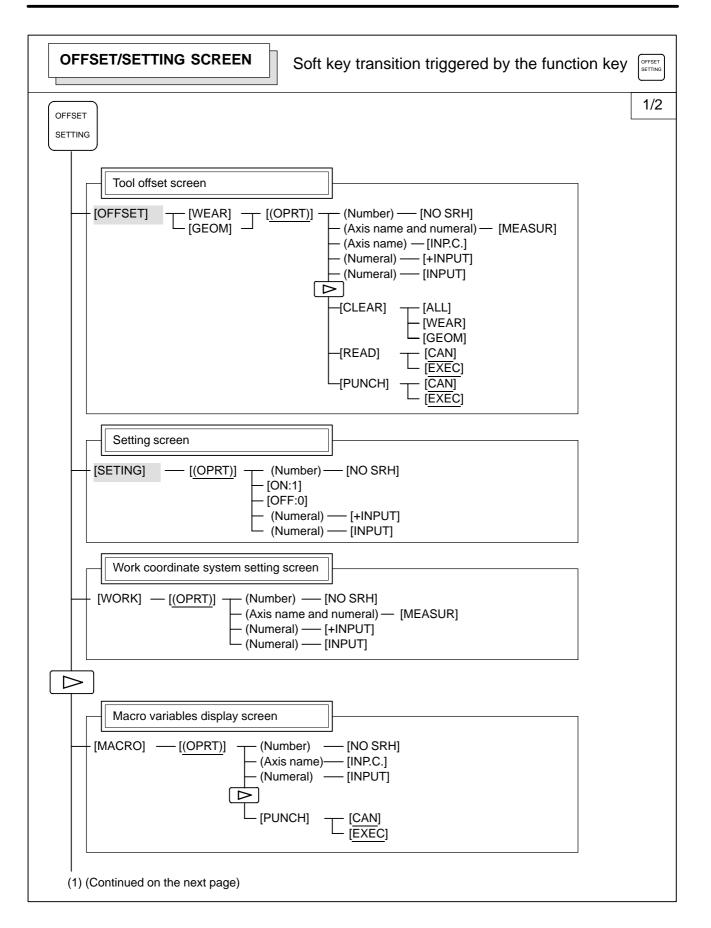
| PROGRAM SCREEN         Soft key transition triggered by the function key in the MDI mode  |
|---|
| PROG  |
| [PRGRM] — [(OPRT)] — [BG–EDT] ⇒ See "When the soft key [BG–EDT] is pressed"   |
| Program input screen         [MDI]       [BG-EDT]         [MDI]       [BG-EDT]         [Address)       [SRH↓]         (Address)       [SRH↓]         [REWIND] |
| Current block display screen         [CURRNT]       [(OPRT)]         [CURRNT]       [(OPRT)]  |
| [Next block display screen]<br>[NEXT] — [(OPRT)] — [BG–EDT] $\implies$ See "When the soft key [BG–EDT] is pressed"  |
| Program restart display screen  |
| [RSTR] — [(OPRT)] — [BG-EDT] $\implies$ See "When the soft key [BG-EDT] is pressed"   |
|   |

| <b>PROGRAM SCREEN</b> Soft key transition triggered by the function key in the HNDL, JOG, or REF mode  |
|--|
| PROG         Program display $[PRGRM] - [(OPRT)] - [BG-EDT] \implies$ See "When the soft key [BG-EDT] is pressed"         Current block display screen $[CURRNT] - [(OPRT)] - [BG-EDT] \implies$ See "When the soft key [BG-EDT] is pressed"         Next block display screen |
| [NEXT] — [(OPRT)] — [BG–EDT] $\implies$ See "When the soft key [BG–EDT] is pressed"  |
| Program restart display screen         [RSTR]       — [(OPRT)]         [BG-EDT]       ⇒ See "When the soft key [BG-EDT] is pressed"  |

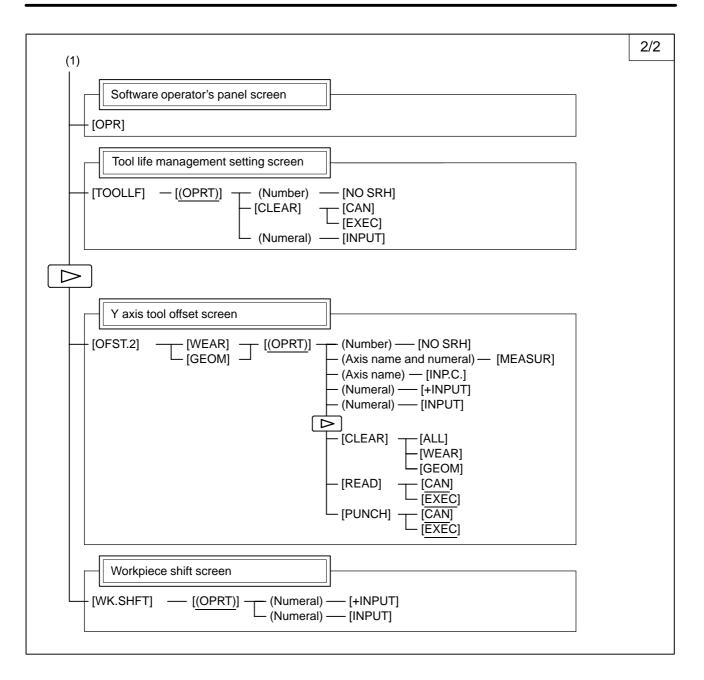
| PROG         Program display         [PRGRM]       [ <u>(OPRT)]</u> [BG-EDT]       ⇒ See "When the soft key [BG-EDT] is pressed"         (O number)       [O SRH]         (Address)       [SRH↓]         (Address)       [SRH↓]         [REWIND]       [REWIND]        | PROGRAM SCREEN | Soft key transition triggered by the function key $$P_{PROG}$$ in the TJOG or THDL mode  |
|--|----------------|--|
| $[PRGRM] \longrightarrow [(OPRT)] \longrightarrow [BG-EDT] \implies See "When the soft key [BG-EDT] is pressed" (O number) \longrightarrow [O SRH] \implies Return to the program (Address) \longrightarrow [SRH\downarrow] (Address) \longrightarrow [SRH1] (REWIND]$ | PROG           |  |
| Program directory display  |                | <ul> <li>— (O number) — [O SRH] ⇒ Return to the program</li> <li>— (Address) — [SRH↓]</li> <li>— (Address) — [SRH↑]</li> </ul> |
| $[LIB] - [(OPRT)] - [BG-EDT] \implies See "When the soft key [BG-EDT] is pressed"(O number) - [O SRH] \implies Return to the program$  |                |  |

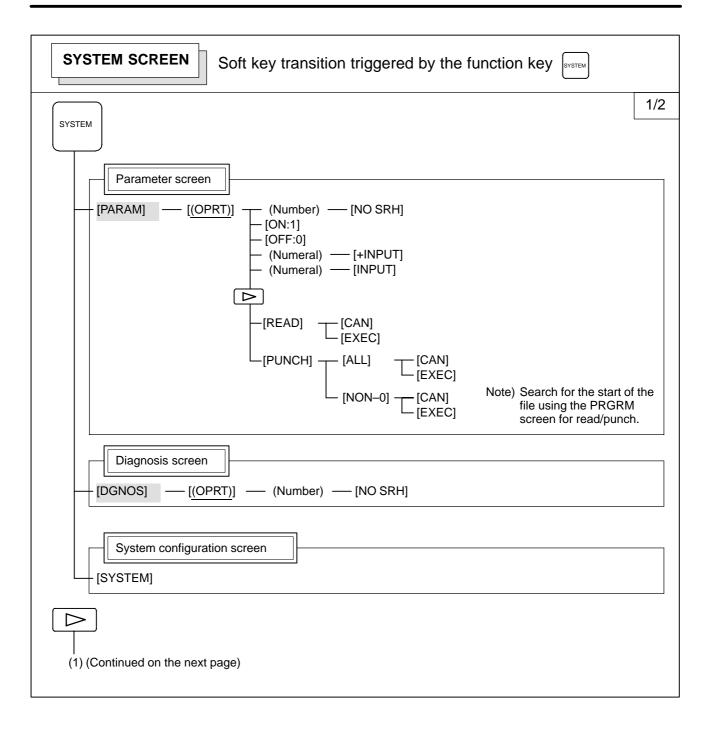


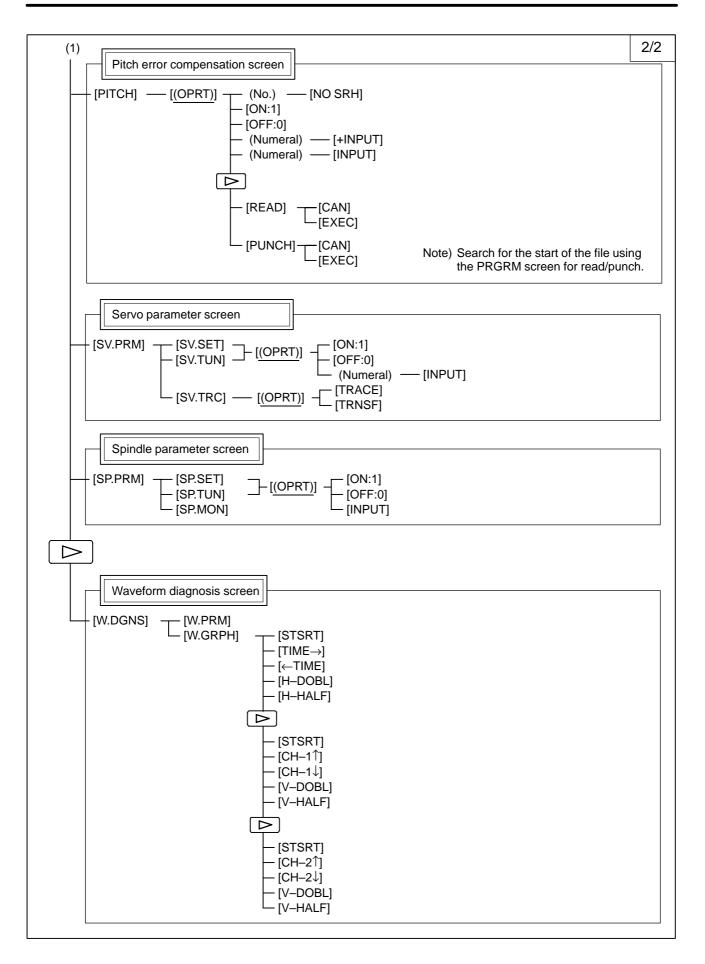




**OPERATION** 

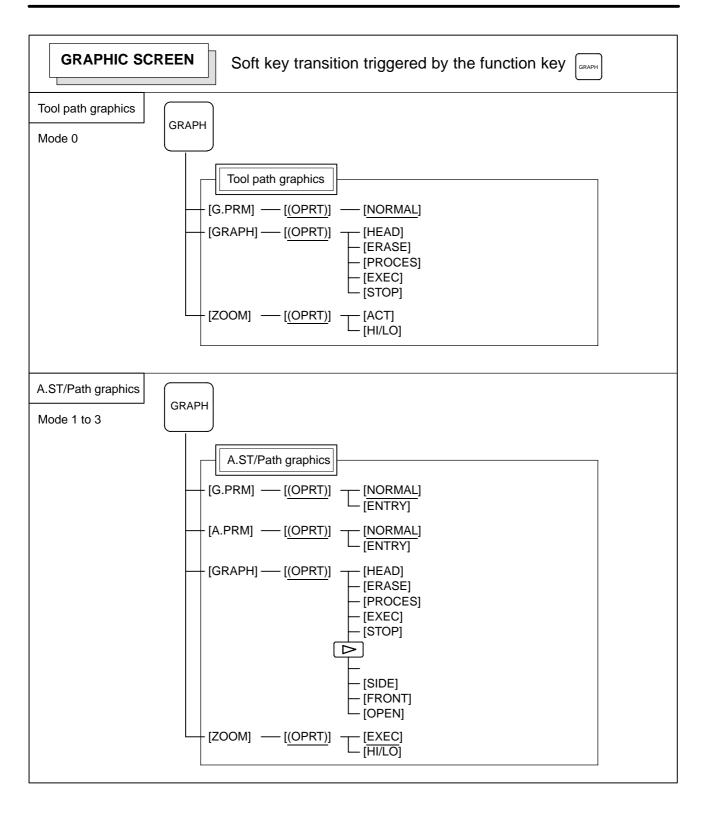






| MESSAGE SCREEN Soft key transition triggered by the function key   |
|--|
| MESSAGE<br>Alarm display screen<br>[ALARM]<br>Message display screen<br>[MSG]<br>Alarm history screen<br>[HISTRY] — [(OPRT)] — [CLEAR] |
| HELP SCREEN     Soft key transition triggered by the function key  |
| HELP<br>Alarm detail screen<br>[ALAM] — [(OPRT)] — [SELECT]  |
| Operation method screen         [OPR]       [(OPRT)]         Parameter table screen  |
| [PARA]   |

OPERATION



### 2.3.4 Key Input and Input Buffer

When an address and a numerical key are pressed, the character corresponding to that key is input once into the key input buffer. The contents of the key input buffer is displayed at the bottom of the screen. In order to indicate that it is key input data, a ">" symbol is displayed immediately in front of it. A "\_" is displayed at the end of the key input data indicating the input position of the next character.

| Key input buffer display | >N0 | 01X100Z | _     |         |     |   |  |
|--------------------------|-----|---------|-------|---------|-----|---|--|
|                          | EDI | Г       | ALM 1 | 2:35:45 |     |   |  |
|                          | ]   | ] [     | ] [   | ] [     | ] [ | 1 |  |

#### Fig. 2.3.4 Key input buffer display

To input the lower character of the keys that have two characters inscribed

on them, first press the SHIFT key and then the key in question.

When the SHIFT key is pressed, "\_" indicating the next character input position changes to " $\land$ ". Now lowercase characters can be entered (shift state).

When a character is input in shift status the shift status is canceled.

Furthermore, if the [SHIFT] key is pressed in shift status, the shift status is canceled.

It is possible to input up to 32 characters at a time in the key input buffer.

Press the CAN key to cancel a character or symbol input in the key input buffer.

#### (Example)

When the key input buffer displays >N001X100Z\_ and the cancel CAN key is pressed, Z is canceled and >N001X100\_

is displayed.

# 2.3.5 Warning Messages

After a character or number has been input from the MDI panel, a data check is executed when were the word of the soft key is pressed. In the case of incorrect input data or the wrong operation a flashing warning message will be displayed on the status display line.



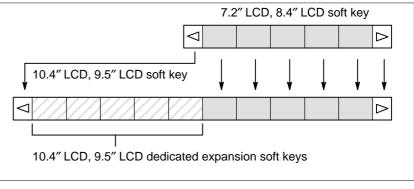
Fig. 2.3.5 Warning message display

#### Table 2.3.5 Warning Messages

| Warning message      | Content  |
|----------------------|--|
| FORMAT ERROR         | The format is incorrect.   |
| WRITE PROTECT        | Key input is invalid because of data protection key or the parameter is not write enabled. |
| DATA IS OUT OF RANGE | The input value exceeds the permitted range.   |
| TOO MANY DIGITS      | The input value exceeds the permitted number of digits.                                    |
| WRONG MODE           | Parameter input is not possible in any mode other than MDI mode.                           |
| EDIT REJECTED        | It is not possible to edit in the current CNC status.                                      |

# 2.3.6 Soft Key Configuration

There are 12 soft keys in the 10.4" LCD/MDI or 9.5" LCD/MDI panel. As illustrated below, the 5 soft keys on the right and those on the right and left edges operate in the same way as the 7.2" LCD/8.4" LCD, whereas the 5 keys on the left hand side are expansion keys dedicated to the 10.4" LCD, 9.5" LCD.



#### Fig. 2.3.6 LCD soft key configuration

Whenever a position display appears in the left half of the screen after a function key other than  $\bigcirc$  is pressed, the soft keys on the left half of the soft key display area are displayed as follows:

| REL ALL HNDL | ABS |
|--------------|-----|
|--------------|-----|

The soft key corresponding to the position display is indicated in reverse video.

# 2.4 EXTERNAL I/O DEVICES

External input/output devices such as FANUC Handy File etc. are available. This section outlines each device. For details on the devices, refer to the manuals listed below.

#### Table 2.4 External I/O device

| Device name      | Usage  | Max.<br>storage<br>capacity | Reference<br>manual |
|------------------|--|-----------------------------|---------------------|
| FANUC Handy File | Easy-to-use, multi function<br>input/output device. It is de-<br>signed for FA equipment and<br>uses floppy disks. | 3600m                       | B–61834E            |

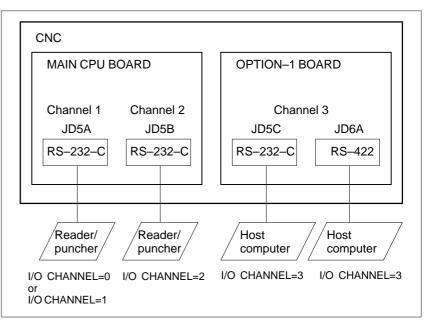
The following data can be input/output to or from external input/output devices:

- 1. Programs
- 2. Offset data
- 3. Parameters
- 4. Custom macro common variables
- 5. Pitch error compensation data

For how data is input and output, see Chapter III-8.

#### Parameter

Before an external input/output device can be used, parameters must be set as follows.

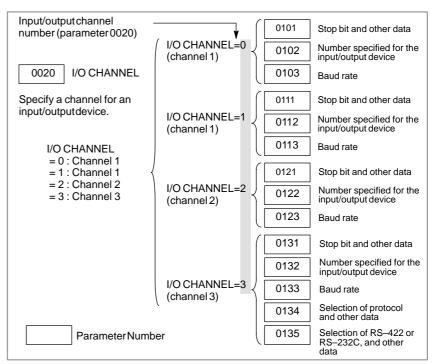


This CNC has three channels of reader/punch interfaces. The input/output device to be used is specified by setting the channel connected to that device in setting parameter I/O CHANNEL.

The specified data, such as a baud rate and the number of stop bits, of an input/output device connected to a specific channel must be set in parameters for that channel in advance.

For channel 1, two combinations of parameters to specify the input/output device data are provided.

The following shows the interrelation between the reader/punch interface parameters for the channels.



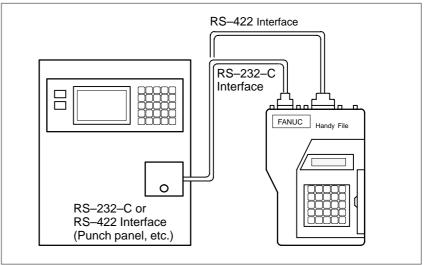
— 460 —

# 2.4.1 FANUC Handy File

The Handy File is an easy-to-use, multi function floppy disk input/output device designed for FA equipment. By operating the Handy File directly or remotely from a unit connected to the Handy File, programs can be transferred and edited.

The Handy File uses 3.5–inch floppy disks, which do not have the problems of paper tape (i.e., noisy during input/output, easily broken, and bulky).

One or more programs (up to 1.44M bytes, which is equivalent to the memory capacity of 3600–m paper tape) can be stored on one floppy disk.



# 2.5 POWER ON/OFF

# 2.5.1 Turning on the Power

| Procedure of turning on the power |   |
|-----------------------------------|---|
| 1                                 | Check that the appearance of the CNC machine tool is normal.<br>(For example, check that front door and rear door are closed.)  |
| 2                                 | Turn on the power according to the manual issued by the machin tool builder.  |
| 3                                 | After the power is turned on, check that the position screen is displayed. An alarm screen is displayed if an alarm occurs upo power–on. If the screen shown in Section III–2.5.2 is displayed, system failure may have occurred. |
|                                   | ACTUAL POSITION(ABSOLUTE) 01000 N00010  |
|                                   | X 123.456<br>Z 0.000  |
|                                   | PART COUNT 5<br>RUN TIME 0H15M CYCLE TIME 0H 0M38S<br>ACT.F 3000 MM/M S 0 T0000   |
|                                   | MEM **** *** 09:06:35<br>[ ABS ] [ REL ] [ ALL ] [ HNDL ] [ OPRT ]  |

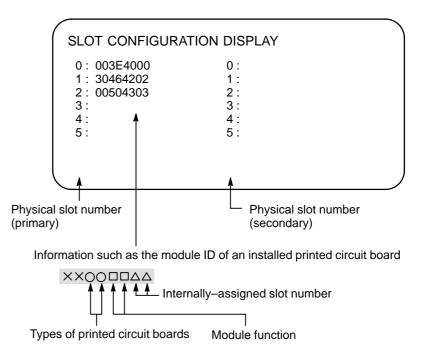
4 Check that the fan motor is rotating.

#### WARNING

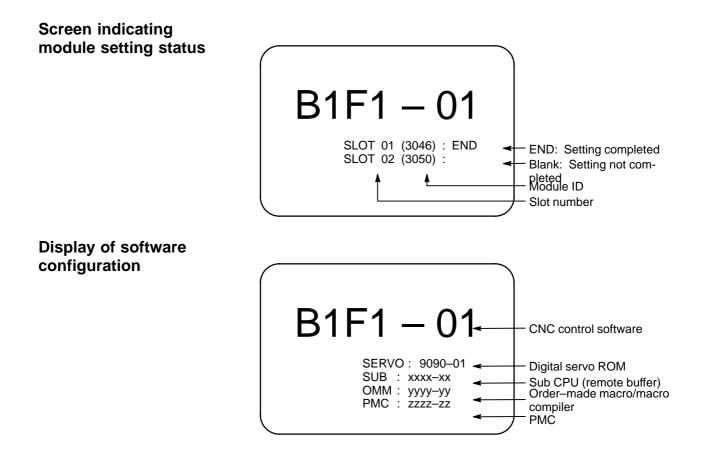
Until the positional or alarm screen is displayed at the power on, do not touch them. Some keys are used for the maintenance or special operation purpose. When they are pressed, unexpected operation may be caused.

# 2.5.2 If a hardware failure or installation error occurs, the system displays one of the following three types of screens then stops. Information such as the type of printed circuit board installed in each slot is indicated. This information and the LED states are useful for failure recovery.

#### Slot status display



For more information about the types of printed circuit boards and module functions, refer to the maintenance manual (B–63005EN).



## 2.5.3 Power Disconnection

| Procedure for Poser Disconnection |   |  |
|-----------------------------------|---|--|
| 1                                 | Check that the LED indicating the cycle start is off on the operator's panel.   |  |
| 2                                 | Check that all movable parts of the CNC machine tool is stopping.   |  |
| 3                                 | If an external input/output device such as the Handy File is connected to the CNC, turn off the external input/output device. |  |
| 4                                 | Continue to press the POWER OFF pushbutton for about 5 seconds.   |  |
| 5                                 | Refer to the machine tool builder's manual for turning off the power to the machine.  |  |
|                                   |   |  |

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3

# MANUAL OPERATION

MANUAL OPERATION are six kinds as follows :

- 3.1 Manual reference position return
- 3.2 Jog feed
- 3.3 Incremental feed
- 3.4 Manual handle feed
- 3.5 Manual absolute on and off
- 3.6 Manual linear / circular interpolation

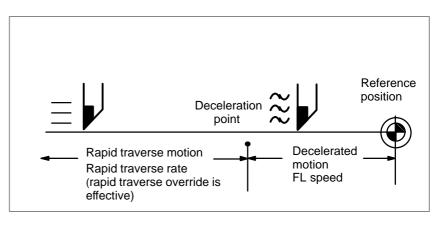
# 3.1 MANUAL REFERENCE POSITION RETURN

The tool is returned to the reference position as follows :

The tool is moved in the direction specified in parameter ZMI (bit 5 of No. 1006) for each axis with the reference position return switch on the machine operator's panel. The tool moves to the deceleration point at the rapid traverse rate, then moves to the reference position at the FL speed. The rapid traverse rate and FL speed are specified in parameters (No. 1420,1421, and 1425).

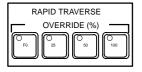
Four step rapid traverse override is effective during rapid traverse.

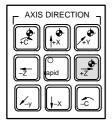
When the tool has returned to the reference position, the reference position return completion LED goes on. The tool generally moves along only a single axis, but can move along three axes simultaneously when specified so in parameter JAX(bit 0 of No.1002).



#### **Procedure for Manual Reference Position Return**

| MODE                   |
|------------------------|
|                        |
| EDIT MEMORY REMOTE MDI |
|                        |
|                        |
| HANDLE JOG ZERO TEACH  |
|                        |

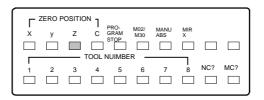




- **1** Press the reference position return switch, one of the mode selection switches.
- 2 To decrease the feedrate, press a rapid traverse override switch.
- **3** Press the feed axis and direction selection switch corresponding to the axis and direction for reference position return. Continue pressing the switch until the tool returns to the reference position. The tool can be moved along three axes simultaneously when specified so in an appropriate parameter setting. The tool moves to the deceleration point at the rapid traverse rate, then moves to the reference position at the FL speed set in a parameter.

When the tool has returned to the reference position, the reference position return completion LED goes on.

4 Perform the same operations for other axes, if necessary. The above is an example. Refer to the appropriate manual provided by the machine tool builder for the actual operations.



#### **Explanation**

Automatically setting the coordinate system
 Bit 0 (ZPR) of parameter No. 1201 is used for automatically setting the coordinate system. When ZPR is set, the coordinate system is automatically determined when manual reference position return is performed.
 When α and γ are set in parameter 1250, the workpiece coordinate system is determined so that the reference point on the tool holder or the position of the tip of the reference tool is X = α. Z = γ when reference position

of the tip of the reference tool is  $X = \alpha$ ,  $Z = \gamma$  when reference position return is performed. This has the same effect as specifying the following command for reference position return:

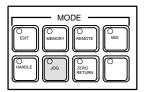
#### **G92X**α**Z**γ;

However, when options of the workpiece coordinate system is selected, it is not able to use.

#### **Restrictions**

- Moving the tool again Once the REFERENCE POSITION RETURN COMPLETION LED lights at the completion of reference position return, the tool does not move unless the REFERENCE POSITION RETURN switch is turned off.
- Reference position return completion LED The REFERENCE POSITION RETURN COMPLETION LED is extinguished by either of the following operations: - Moving from the reference position.
  - Entering an emergency stop state.
- The distance to return to reference position For the distance (Not in the deceleration condition) to return the tool to the reference position, refer to the manual issued by the machine tool builder.

# 3.2 JOG FEED



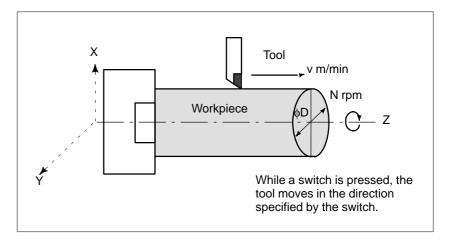
In the JOG mode, pressing a feed axis and direction selection switch on the machine operator's panel continuously moves the tool along the selected axis in the selected direction.

The manual continuous feedrate is specified in a parameter (No.1423)

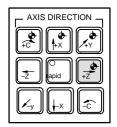
The manual continuous feedrate can be adjusted with the manual continuous feedrate override dial.

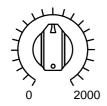
Pressing the rapid traverse switch moves the tool at the rapid traverse feedrate (No.1424) regardless of the position of the JOG feedrate override dial. This function is called the manual rapid traverse.

Manual operation is allowed for one axis at a time. 3 axes can be selected at a time by parameter JAX (No.1002#0).

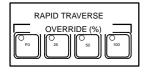


#### **Procedure for JOG Feed**





JOG FEED RATE OVERRIDE



- **1** Press the manual continuous switch, one of the mode selection switches.
- 2 Press the feed axis and direction selection switch corresponding to the axis and direction the tool is to be moved. While the switch is pressed, the tool moves at the feedrate specified in a parameter (No. 1423). The tool stops when the switch is released.
- **3** The manual continuous feedrate can be adjusted with the manual continuous feedrate override dial.
- 4 Pressing the rapid traverse switch while pressing a feed axis and direction selection switch moves the tool at the rapid traverse rate while the rapid traverse switch is pressed. Rapid traverse override by the rapid traverse override switches is effective during rapid traverse.

The above is an example. Refer to the appropriate manual provided by the machine tool builder for the actual operations.

feed

#### Explanations

• Manual per revolution

To enable manual per revolution feed, set bit 4 (JRV) of parameter No. 1402 to 1.

During manual per revolution feed, the tool is jogged at the following feedrate:

Feed distance per rotation of the spindle (mm/rev) (specified with parameter No. 1423) x JOG feedrate override x actual spindle speed (rev/min).

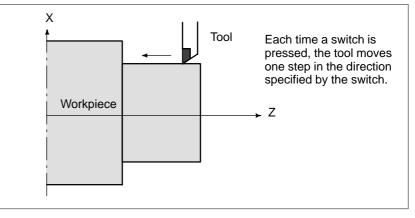
#### Restrictions

- Acceleration/deceleration for rapid traverse Feedrate, time constant and method of automatic acceleration/ deceleration for manual rapid traverse are the same as G00 in programmed command.
- Change of modes Changing the mode to the JOG feed mode while pressing a feed axis and direction selection switch does not enable JOG feed. To enable JOG feed, enter the JOG feed mode first, then press a feed axis and direction selection switch.
- Rapid traverse prior to reference position return is not performed after power-on, pushing RAPID TRAVERSE button does not actuate the rapid traverse but the remains at the manual continuous feedrate. This function can be disabled by setting parameter RPD (No.1401#01).

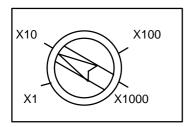
# 3.3 INCREMENTAL FEED

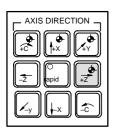
In the incremental (INC) mode, pressing a feed axis and direction selection switch on the machine operator's panel moves the tool one step along the selected axis in the selected direction. The minimum distance the tool is moved is the least input increment. Each step can be 10, 100, or 1000 times the least input increment.

This mode is effective when a manual pulse generator is not connected.



#### **Procedure for Incremental Feed**





#### Explanation

• Travel distance specified with a diameter

- **1** Press the INC switch, one of the mode selection switches.
- **2** Select the distance to be moved for each step with the magnification dial.
- **3** Press the feed axis and direction selection switch corresponding to the axis and direction the tool is to be moved. Each time a switch is pressed, the tool moves one step. The feedrate is the same as the jog feedrate.
- **4** Pressing the rapid traverse switch while pressing a feed axis and direction selection switch moves the tool at the rapid traverse rate. Rapid traverse override by the rapid traverse override switch is effective during rapid traverse.

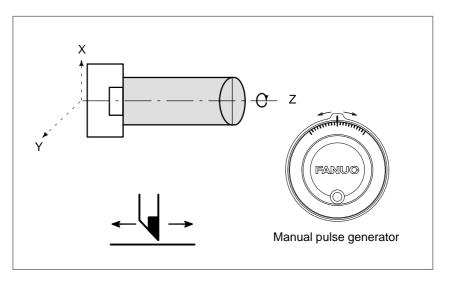
The above is an example. Refer to the appropriate manual provided by the machine tool builder for the actual operations.

The distance the tool travels along the X-axis can be specified with a diameter.

# 3.4 MANUAL HANDLE FEED

In the handle mode, the tool can be minutely moved by rotating the manual pulse generator on the machine operator's panel. Select the axis along which the tool is to be moved with the handle feed axis selection switches.

The minimum distance the tool is moved when the manual pulse generator is rotated by one graduation is equal to the least input increment. Or the distance the tool is moved when the manual pulse generator is rotated by one graduation can be magnified by 10 times or by one of the two magnifications specified by parameters (No. 7113 and 7114).



#### **Procedure for Manual Handle Feed**

|        | — мо        | DE             |       |
|--------|-------------|----------------|-------|
| EDIT   | O<br>MEMORY | O<br>REMOTE    | MDI   |
|        |             |                |       |
| HANDLE | JOG         | ZERO<br>RETURN | TEACH |



Manual pulse generator

- 1 Press the HANDLE switch, one of the mode selection switches.
- 2 Select the axis along which the tool is to be moved by pressing a handle feed axis selection switch.
- **3** Select the magnification for the distance the tool is to be moved by pressing a handle feed magnification switch. The minimum distance the tool is moved when the manual pulse generator is rotated by one graduation is equal to the least input increment.
- 4 Move the tool along the selected axis by rotating the handle. Rotating the handle 360 degrees moves the tool the distance equivalent to 100 graduations.

The above is an example. Refer to the appropriate manual provided by the machine tool builder for the actual operations.

#### Explanation

- Availability of manual pulse generator in Jog mode (JHD)
- Availability of manual pulse generator in TEACH IN JOG mode (THD)
- A command to the MPG exceeding rapid traverse rate (HPF)

Parameter JHD (bit 0 of No. 7100) enables or disables the manual pulse generator in the JOG mode.

When the parameter JHD( bit 0 of No. 7100) is set 1,both manual handle feed and incremental feed are enabled.

Parameter THD (bit 1 of No. 7100) enables or disables the manual pulse generator in the TEACH IN JOG mode.

Parameter HPF (bit 4 of No. 7100) or (No. 7117) specifies as follows:

- Parameter HPF (bit 4 of No. 7100)
- Set value 0: The feedrate is clamped at the rapid traverse rate and generated pulses exceeding the rapid traverse rate are ignored. (The distance the tool is moved may not match the graduations on the manual pulse generator.)
- Set value 1 : The feedrate is clamped at the rapid traverse rate and generated pulses exceeding the rapid traverse rate are not ignored but accumulated in the CNC. (No longer rotating the handle does not immediately stop the tool. The tool is moved by the pulses accumulated in the CNC before it stops.)
- Parameter HPF (No. 7177) (It is available when parameter HPF is 0.)
- Set value 0: The feedrate is clamped at the rapid traverse rate and generated pulses exceeding the rapid traverse rate are ignored. (The distance the tool is moved may not match the graduations on the manual pulse generator.)
- Other than 0: The feedrate is clamped at the rapid traverse rate and generated pulses exceeding the rapid traverse rate are not ignored but accumulated in the CNC until the limit specified in parameter No. 7117 is reached. (No longer rotating the handle does not immediately stop the tool. The tool is moved by the pulses accumulated in the CNC before it stops.)
- Movement direction of an axis to the rotation of MPG (HNGx)

# Parameter HNGx (bit 0 of No. 7102) switches the direction of MPG in which the tool moves along an axis, corresponding to the direction in which the handle of the manual pulse generator is rotated.

- Restrictions
- Number of MPGs

Up to three manual pulse generators can be connected, one for each axis. The three manual pulse generators can be simultaneously operated.

#### WARNING

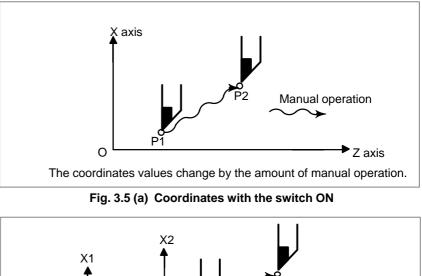
Rotating the handle quickly with a large magnification such as x100 moves the tool too fast. The feedrate is clamped at the rapid traverse feedrate.

#### NOTE

Rotate the manual pulse generator at a rate of five rotations per second or lower. If the manual pulse generator is rotated at a rate higher than five rotations per second, the tool may not stop immediately after the handle is no longer rotated or the distance the tool moves may not match the graduations on the manual pulse generator.

# 3.5 MANUAL ABSOLUTE ON AND OFF

Whether the distance the tool is moved by manual operation is added to the coordinates can be selected by turning the manual absolute switch on or off on the machine operator's panel. When the switch is turned on, the distance the tool is moved by manual operation is added to the coordinates. When the switch is turned off, the distance the tool is moved by manual operation is not added to the coordinates.



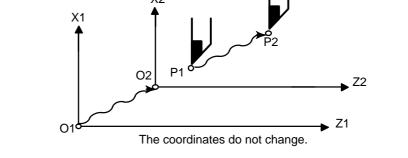
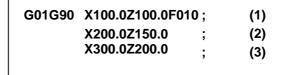


Fig. 3.5 (b) Coordinates with the switch OFF

#### Explanation

The following describes the relation between manual operation and coordinates when the manual absolute switch is turned on or off, using a program example.

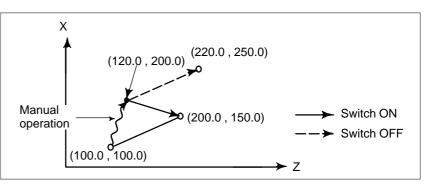


The subsequent figures use the following notation:

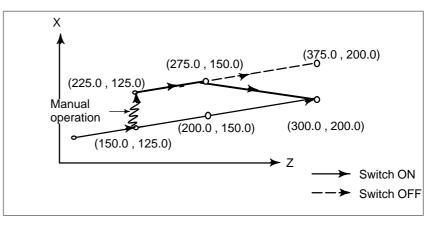
→ Movement of the tool when the switch is on → Movement of the tool when the switch is off

The coordinates after manual operation include the distance the tool is moved by the manual operation. When the switch is off, therefore, subtract the distance the tool is moved by the manual operation.

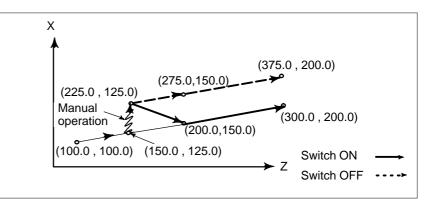
Coordinates when block (2) has been executed after manual operation (X-axis +20.0, Z-axis +100.0) at the end of movement of block (1).



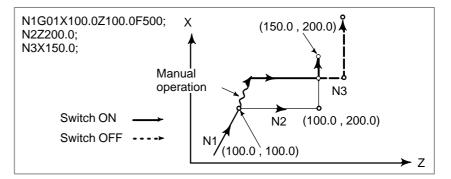
 Manual operation after a feed hold Coordinates when the feed hold button is pressed while block (2) is being executed, manual operation (X-axis + 75.0) is performed, and the cycle start button is pressed and released



 Manual operation after the end of block  When reset after a manual operation following a feed hold Coordinates when the feed hold button is pressed while block (2) is being executed, manual operation (Y-axis+75.0) is performed, the control unit is reset with the RESET button, and block (2) is read again



 When a movement command in the next block is only one axis When there is only one axis in the following command, only the commanded axis returns.

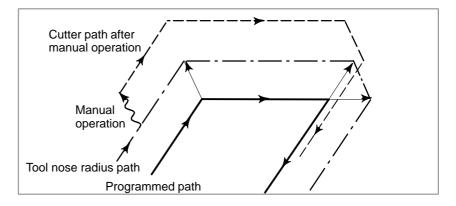


- When the next move block is an incremental
- Manual operation during tool nose radius compensation

When the following commands are incremental commands, operation is the same as when the switch is OFF.

#### When the switch is OFF

After manual operation is performed with the switch OFF during tool nose radius compensation, automatic operation is restarted then the tool moves parallel to the movement that would have been performed if manual movement had not been performed. The amount of separation equals to the amount that was performed manually.

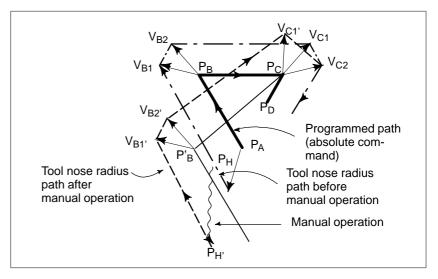


#### When the switch is ON during tool nose radius compensation

Operation of the machine upon return to automatic operation after manual intervention with the switch is ON during execution with an absolute command program in the tool nose radius compensation mode will be described. The vector created from the remaining part of the current block and the beginning of the next block is shifted in parallel. A new vector is created based on the next block, the block following the next block and the amount of manual movement. This also applies when manual operation is performed during cornering.

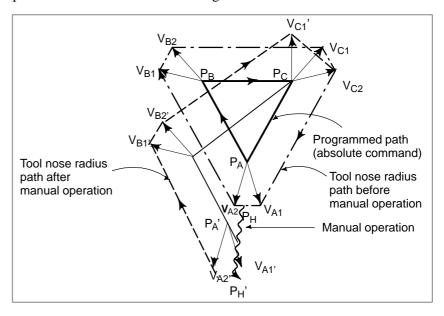
#### Manual operation performed in other than cornering

Assume that the feed hold was applied at point  $P_H$  while moving from  $P_A$  to  $P_B$  of programmed path  $P_A$ ,  $P_B$ , and  $P_C$  and that the tool was manually moved to  $P_{H'}$ . The block end point  $P_B$  moves to the point  $P_{B'}$  by the amount of manual movement, and vectors  $V_{B1}$  and  $V_{B2}$  at  $P_B$  also move to  $V_{B1'}$  and  $V_{B2'}$ . Vectors  $V_{C1}$  and  $V_{C2}$  between the next two blocks  $P_B - P_C$  and  $P_C - P_D$  are discarded and new vectors  $V_{C1'}$  and  $V_{C2'}$  ( $V_{C2'} = V_{C2}$  in this example) are produced from the relation between  $P_{B'} - P_C$  and  $P_C - P_D$ . However, since  $V_{B2'}$  is not a newly calculated vector, correct offset is not performed at block  $P_{B'} - P_C$ . Offset is correctly performed after  $P_C$ .



#### Manual operation during cornering

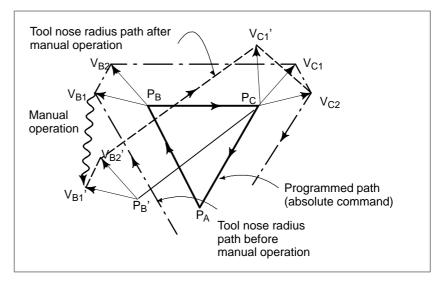
This is an example when manual operation is performed during cornering.  $V_{A2'}$ ,  $V_{B1'}$ , and  $V_{B2'}$  are vectors moved in parallel with  $V_{A2}$ ,  $V_{B1}$  and  $V_{B2}$  by the amount of manual movement. The new vectors are calculated from  $V_{C1}$  and  $V_{C2}$ . Then correct tool nose radius compensation is performed for the blocks following Pc.



#### Manual operation after single block stop

Manual operation was performed when execution of a block was terminated by single block stop.

Vectors  $V_{B1}$  and  $V_{B2}$  are shifted by the amount of manual operation. Sub-sequent processing is the same as case a described above. An MDI operation can also be interveneted as well as manual operation. The movement is the same as that by manual operation.

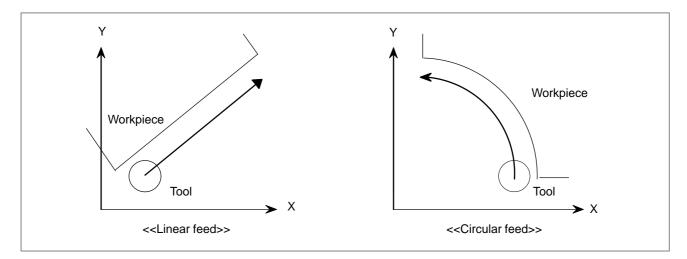


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# 3.6 MANUAL LINEAR/CIRCULAR INTERPOLATION

In manual handle feed or jog feed, the following types of feed operations are enabled in addition to the conventional feed operation along a specified single axis (X-axis, Y-axis, Z-axis, and so forth) based on simultaneous 1-axis control:

- Feed along a tilted straight line in the XY plane (linear feed) based on simultaneous 2–axis control
- Feed along a circle in the XY plane (circular feed) based on simultaneous 2–axis control



#### NOTE

The X-axis and Y-axis must be the first controlled axis and second controlled axis, respectively.

#### Procedure for Manual Linear/Circular Interpolation

#### Procedure

1 To perform manual handle feed, select manual handle feed mode. To perform jog feed, select jog feed mode.

2 To perform manual handle feed, select a feed axis (for simultaneous 1-axis feed along the X-axis, Y-axis, or Z-axis, or for simultaneous linear or circular 2-axis feed along a specified straight line or circle in the XY plane) subject to manual handle feed operation. Use the handle feed axis select switch for this selection. To perform jog feed, select a feed axis and direction with the feed axis direction select switch. While a feed axis and its direction are

specified, the tool moves in the specified axis direction are straight line or circle at the jog feedrate specified in parameter No. 1423.

**3** For manual handle feed

The tool is moved along a specified axis by turning the respective manual handle. The feedrate depends on the speed at which the manual handle is turned. A distance to be traveled by the tool when the manual handle is turned by one pulse can be selected using the manual handle feed travel distance magnification switch. For jog feed

The feedrate can be overridden using the manual feedrate override dial.

The procedure above is just an example. For actual operations, refer to the relevant manual provided by the machine tool builder.

#### **Explanations**

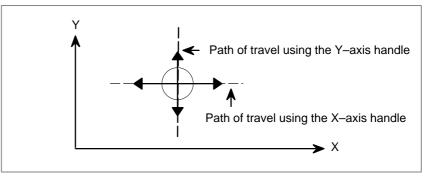
• Definition of a straight line/circle

For feed along an axis, no straight line/circle definition is required. For linear feed or circular feed, a straight line or circle must be defined beforehand. (For circular feed, for example, data such as a radius and the center of a circle must be set.) For details, refer to the relevant manual provided by the machine tool builder.

# • Manual handle feed In manual handle feed, the tool can be moved along a specified axis (X-axis, Y-axis, Z-axis, ..., or the 8th axis), or can be moved along a tilted straight line (linear feed) or a circle (circular feed).

(1) Feed along a specified axis (simultaneous 1-axis control)

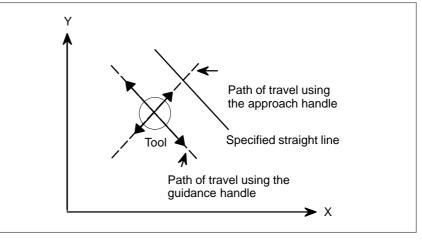
By turning a manual handle, the tool can be moved along the desired axis (such as X-axis, Y-axis, and Z-axis) on a simultaneous 1-axis control basis. (This mode of feed is the conventional type of manual handle feed.)



Feed along a specified axis

#### (2) Linear feed (simultaneous 2-axis control)

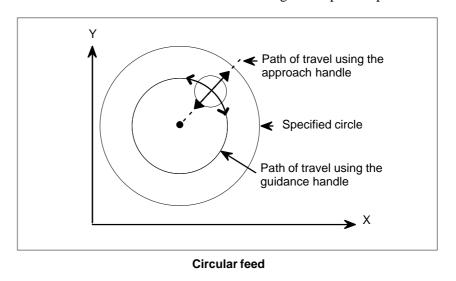
By turning a manual handle, the tool can be moved along the straight line parallel to a specified straight line on a simultaneous 2–axis control basis. This manual handle is referred to as the guidance handle. Moreover, by turning another manual handle, the tool can be moved at right angles to a specified straight line on a simultaneous 2–axis control basis. This manual handle is referred to as the approach handle. When the guidance handle or approach handle is turned clockwise or counterclockwise, the tool travels forward or backward along the respective path.



Linear feed

(3) Circular feed (simultaneous 2-axis control)

By turning a manual handle, the tool can be moved from the current position along the concentric circle that has the same center as a specified circle on a simultaneous 2–axis control basis. This manual handle is referred to as the guidance handle. Moreover, by turning another manual handle, the tool can be moved along the normal to a specified circle on a simultaneous 2–axis control basis. This manual handle is referred to as the approach handle. When the guidance handle or approach handle is turned clockwise or counterclockwise, the tool travels forward or backward along the respective path.



| • Feedrate for manual  | Feedrate   |
|--|--|
| handle feed  | The feedrate depends on the speed at which a manual handle is turned.<br>A distance to be traveled by the tool (along a tangent in the case of linear<br>or circular feed) when a manual handle is turned by one pulse can be<br>selected using the manual handle feed travel distance magnification<br>switch.  |
| • Manual handle selection  | The FS16/18 has three manual pulse generator interfaces to allow up to three manual handles to be connected. For information about how to use the manual handles connected to the interfaces (whether to use each manual handle as a handle for feed along an axis, as a guidance handle, or as an approach handle), refer to the relevant manual provided by the machine tool builder.  |
| <ul> <li>Direction of movement<br/>using manual handles</li> </ul> | The user can specify the direction of the tool moved along a straight line<br>or circle (for example, whether to make a clockwise or counterclockwise<br>movement along a circle) when the guidance handle or approach handle<br>is turned clockwise or counterclockwise. For details, refer to the relevant<br>manual provided by the machine tool builder.   |
| <ul> <li>Jog feed (JOG)</li> </ul>                                 | <ul> <li>In jog feed, the tool can be moved along a specified axis (X-axis, Y-axis, Z-axis,, or the 8th axis), or can be moved along a tilted straight line (linear feed) or a circle (circular feed).</li> <li>(1) Feed along a specified axis (simultaneous 1-axis control) While a feed axis and its direction are specified with the feed axis direction select switch, the tool moves in the specified axis direction at the feedrate specified in parameter No. 1423. The feedrate can be overridden using the manual feedrate override dial.</li> <li>(2) Linear feed (simultaneous 2-axis control)</li> </ul>  |
|  | <ul> <li>By defining a straight line beforehand, the tool can be moved as follows:</li> <li>While a feed axis and its direction are selected using the feed axis direction select switch, the tool moves along a straight line parallel to the specified straight line on a simultaneous 2-axis control basis.</li> <li>While a feed axis and its direction are selected using the feed axis direction select switch, the tool moves at right angles to the specified straight line on a simultaneous 2-axis control basis.</li> <li>The feedrate in the tangential direction is specified in parameter No. 1410. The feedrate can be overridden using the manual feedrate override dial.</li> </ul> |
|  | <ul> <li>(3) Circular feed (simultaneous 2–axis control)<br/>By defining a circle beforehand, the tool can be moved as follows:</li> <li>While a feed axis and its direction are selected using the feed axis direction select switch, the tool moves from the current position along the concentric circle that has the same center as the specified circle.</li> <li>While a feed axis and its direction are selected using the feed axis direction select switch, the tool moves along the normal to the specified circle.</li> <li>The feedrate in the tangential direction is specified in parameter No. 1410. The feedrate can be overridden using the manual feedrate</li> </ul>              |

override dial.

| B-63004EN/02   | OPERATION | 3. MANUAL OPERATION   |
|--|-----------|---|
| <ul> <li>Manual handle feed in<br/>JOG mode</li> </ul> |           | eed can be enabled using bit 0 (JHD)<br>se, however, manual handle feed is<br>loved along any axis by jog feed. |
| Limitations  |           |   |
| <ul> <li>Mirror image</li> </ul>                       | 6         | when performing manual operation.<br>he mirror image switch is off, and   |

| 3.7<br>MANUAL NUMERIC<br>COMMAND | The manual numeric command function allows data programmed<br>through the MDI to be executed in jog mode. Whenever the system is<br>ready for jog feed, a manual numeric command can be executed. The<br>following eight functions are supported: |  |  |
|----------------------------------|---|--|--|
|                                  | (1) Positioning (G00)   |  |  |
|                                  | (2) Linear interpolation (G01)  |  |  |
|                                  | (3) Automatic reference position return (G28)   |  |  |
|                                  | (4) 2nd/3rd/4th reference position return (G30)   |  |  |
|                                  | (5) M codes (miscellaneous functions)   |  |  |
|                                  | (6) S codes (spindle functions)   |  |  |
|                                  | (7) B codes (second auxiliary functions)  |  |  |
|                                  |   |  |  |
|                                  | By setting the following parameters, the commands for axial motion and the M, S, T, and B functions can be disabled:  |  |  |
|                                  | (1) Positioning (G00)   |  |  |
|                                  | (2) Linear interpolation (G01):   |  |  |
|                                  | (3) Automatic reference position<br>return (G28): Bit 0 (JAXx) of<br>parameter No. 7010   |  |  |
|                                  | (4) 2nd/3rd/4th reference position<br>return (G30):   |  |  |
|                                  | (5) M codes (miscellaneous functions):  |  |  |
|                                  | Bit 0 (JMF) of parameter No. 7002   |  |  |
|                                  | (6) S codes (spindle functions):  |  |  |
|                                  | Bit 1 (JSF) of parameter No. 7002   |  |  |
|                                  | (7) B codes (second auxiliary functions):   |  |  |
|                                  | Bit 3 (JBF) of parameter No. 7002   |  |  |
|                                  |   |  |  |

#### Procedure

Manual numeric command

#### Procedure

| MODE |        |            |  |  |  |
|------|--------|------------|--|--|--|
|      |        |            |  |  |  |
|      |        | O<br>TEACH |  |  |  |
|      | RETORN | L          |  |  |  |

- 1 Press the jog switch (one of the mode selection switches).
- 2 Press function key  $\left| \mathsf{PROG} \right|$ .
- **3** Press soft key **[JOG]** on the screen. The following manual numeric command screen is displayed.

| PROGRAM (JOG)  |                               |   | O0010 N00020                         |   |  |
|--|-------------------------------|---|--------------------------------------|---|--|
| GOO P<br>X<br>Z<br>U<br>V<br>W<br>M<br>S<br>T<br>B<br>>_ | (ABS<br>X<br>Z<br>U<br>V<br>W | SOLUTE)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 | (DIST/<br>X<br>Y<br>Z<br>U<br>V<br>W | ANCE TO GO)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 |  |
| JOG ****   | * * *                         | * * *   | 00                                   | : 00 : 00   |  |
|  | JOG                           |   | NEXT                                 | ) ( (OPRT) )  |  |

Example 1: When the maximum number of controlled axes is six

Example 2: When the maximum number of controlled axes is 7 or 8

| PROGRAM (JOG)   |  |  | O0010   | O0010 N00020  |  |
|---|--|--|---|---|--|
| G00 P<br>X<br>Z<br>U<br>V<br>W<br>A<br>C<br>T<br>S<br>B<br>>_ | (ABSC<br>X<br>Y<br>U<br>V<br>W<br>A<br>C | DLUTE)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 | (DIST<br>X<br>Y<br>Z<br>U<br>V<br>W<br>A<br>C | ANCE TO GO)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 |  |
| JOG ****  | *** *** *** 00:00:00                     |  |   |   |  |
|   | JOG )                                    |  | NEXT  | $\left( (OPRT) \right)$   |  |

4 Enter the required commands by using address keys and numeric keys on the MDI panel, then press soft key **[INPUT]** or the **INPUT** key to set the entered data.

| PROGRAM (JO  | PROGRAM (JOG)                         |  | O0010 N00020                          |   |
|--|---------------------------------------|--|---------------------------------------|---|
| G00 P<br>X 10.000<br>Y<br>Z<br>U<br>V<br>W<br>M<br>S<br>T<br>B<br>>Z120.5_ | (ABSOLI<br>X<br>Y<br>Z<br>U<br>V<br>W | UTE)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 | (DISTAN<br>X<br>Y<br>Z<br>U<br>V<br>W | CE TO GO)<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000<br>0.000 |
| JOG **** **  | ** ***                                |  | 00 : 00                               | 00 : OO   |
|  | )(                                    | CLEAR  | )                                     |   |

The following data can be set:

- 1. G00: Positioning
- 2. G01: Linear interpolation
- 3. G28: Automatic reference position return
- 4. G30: 2nd/3rd/4th reference position return
- 5. M codes: Miscellaneous functions
- 6. S codes: Spindle functions
- 7. B codes: Second auxiliary functions

The set data is maintained even when the screen or mode is changed.

#### NOTE

When an alarm state exists, data cannot be set.

**5** Press the cycle start switch on the machine operator's panel to start command execution. The status is indicated as "MSTR." (When the 9" screen is being used, the actual feedrate "ACT.F" and spindle speed "SACT" appear on the key input line.) The automatic operation signal, STL, can be turned on by setting bit 2 (JST) of parameter No. 7001.



### NOTE

If the cycle start switch is pressed while an alarm state exists, a "START IMPOSSIBLE" warning is generated, and the entered data cannot be executed.

**6** Upon the completion of execution, the "MSTR" status indication is cleared from the screen, and automatic operation signal STL is turned off. The set data is cleared entirely. G codes are set to G00 or G01 according to the setting of bit 0 (G01) of parameter No. 3402.

## **Explanations**

Positioning

An amount of travel is given as a numeric value, preceded by an address such as X, Y, or Z. This is always regarded as being an incremental command, regardless of whether G90 or G91 is specified.

The tool moves along each axis independently at the rapid traverse rate. Linear interpolation type positioning (where the tool path is linear) can also be performed by setting bit 1 (LRP) of parameter No. 1401.

|   | Manual rapid traverse selection switch  |   |  |
|---|---|---|--|
|   | Off   | On  |  |
| Feedrate (parame-<br>ter)                                 | Jog feedrate for each axis (No. 1423)   | Rapid traverse rate for each axis (No. 1420)  |  |
| Automatic accel-<br>eration/decelera-<br>tion (parameter) | Exponential acceleration/<br>deceleration in jog feed for<br>each axis (No. 1624) | Linear acceleration/decel-<br>eration in rapid traverse for<br>each axis (No. 1620) |  |
| Override  | Manual feed override  | Rapid traverse override   |  |

### NOTE

When the manual rapid traverse selection switch is set to the OFF position, the jog feedrate for each axis is clamped such that a parameter-set feedrate, determined by bit 1 (LRP) of parameter No. 1401 as shown below, is not exceeded.
LRP = 0: Manual rapid traverse rate for each axis (parameter No. 1424)
LRP = 1: Rapid traverse rate for each axis (parameter No. 1420)

• Linear interpolation (G01)

An amount of travel is given as a numeric value, preceded by an address such as X, Y, or Z. This is always regarded as being an incremental command, regardless of whether G90 or G91 is specified. Axial movements are always performed in incremental mode even during polar coordinate interpolation. In addition, movement is always performed in feed per minute mode regardless of the specification of G94 or G95.

| Feedrate (parameter)                                | Dry run feedrate (No. 1410)   |
|---|---|
| Automatic acceleration/<br>deceleration (parameter) | Exponential acceleration/<br>deceleration in cutting feed for each<br>axis (No. 1622) |
| Override  | Manual feed override  |

### NOTE

Since the feedrate is always set to the dry run feedrate, regardless of the setting of the dry run switch, the feedrate cannot be specified using F. The feedrate is clamped such that the maximum cutting feedrate, set in parameter No. 1422, is not exceeded.

#### • Automatic reference position return (G28) The tool returns directly to the reference position without passing through any intermediate points, regardless of the specified amount of travel. For axes for which no move command is specified, however, a return

operation is not performed.

| Feedrate (parameter)                                | Rapid traverse rate (No. 1420)  |
|---|---|
| Automatic acceleration/<br>deceleration (parameter) | Linear acceleration/deceleration in rapid traverse for each axis (No. 1620) |
| Override  | Rapid traverse override   |

### 2nd, 3rd, or 4th reference position return (G30)

The tool returns directly to the 2nd, 3rd, or 4th reference position without passing through any intermediate points, regardless of the specified amount of travel. To select a reference position, specify P2, P3, or P4 in address P. If address P is omitted, a return to the second reference position is performed.

| Feedrate (parameter)                                | Rapid traverse rate (No. 1420)  |
|---|---|
| Automatic acceleration/<br>deceleration (parameter) | Linear acceleration/deceleration in rapid traverse for each axis (No. 1620) |
| Override  | Rapid traverse override   |

### NOTE

The function for 3rd/4th reference position return is optional.

- When the option is not selected Return to the 2nd reference position is performed, regardless of the specification of address P.
- When the option is selected If neither P2, P3, nor P4 is specified in address P, a "START IMPOSSIBLE" warning is generated, and the entered data cannot be executed.

 M codes (miscellaneous functions) After address M, specify a numeric value of no more than the number of digits specified by parameter No. 3030. When M98 or M99 is specified, it is executed but not output to the PMC.

### NOTE

Neither subprogram calls nor custom macro calls can be performed using M codes.

#### S codes (spindle functions)

After address S, specify a numeric value of no more than the number of digits specified by parameter No. 3031.

### NOTE

Subprogram calls cannot be performed using S codes.

 B codes (second auxiliary functions)

• Data input

After address B, specify a numeric value of no more than the number of digits specified by parameter No. 3033.

### NOTE

- 1 B codes can be renamed "U," "V," "W," "A," or "C" by setting parameter No. 3460. If the new name is the same as an axis name address, "B" is used. When "B" is used, and axis name "B" exists, "B" is used as the axis address. In this case, no second auxiliary function can be specified.
- 2 Subprogram calls cannot be performed using B codes.
- (1) When addresses and numeric values of a command are typed, then soft key **[INPUT]** is pressed, the entered data is set. In this case, the input unit is either the least input increment or calculator-type input format, according to the setting of bit 0 (DPI) of parameter No. 3401.

The [NPUT] key on the MDI panel can be used instead of soft key **[INPUT]**.

- (2) Commands can be typed successively.
- (3) Key entry is disabled during execution.

If soft key **[INPUT]** or the **INPUT** key on the MDI panel is pressed during execution, an "EXECUTION/MODE SWITCHING IN PROGRESS" warning is output.

(4) If input data contains an error, the following warnings may appear:

| Warning         | Description   |
|-----------------|---|
| FORMAT ERROR    | <ul> <li>A G code other than G00, G01, and G28 has been entered.</li> <li>An address other than those displayed on the manual numeric command screen has been entered.</li> </ul>                 |
| TOO MANY DIGITS | A value that exceeds the following limitations has<br>been entered.<br>– Address G: 2 digits<br>– Address P: 1 digit<br>– Axis address: 8 digits<br>– M, S, B: The parameter–set number of digits |

#### NOTE

Even when the memory protection key is set, key input can nevertheless be performed.

Erasing data

(1) When soft key **[CLEAR]** is pressed, followed by soft key **[EXEC]**, all the set data is cleared. In this case, however, the G codes are set to G00 or G01, depending on the setting of bit 0 (G01) of parameter No. 3402.

Data can also be cleared by pressing the |RESET| key on the MDI panel.

(2) If soft key **[CLEAR]** is pressed during execution, an "EXECUTION/MODE SWITCHING IN PROGRESS" warning is output.

| 3.MANUAL OPERATION                                     | OPERATION   | B-63004EN/02  |
|--|---|---|
| <ul> <li>Halting execution</li> </ul>                  | If one of the following occurs during execution, exec<br>the data is cleared in the same way as when soft key <b>[</b><br>The remaining distance to be traveled is canceled.<br>(1) When a feed hold is applied   |   |
|  | <ul><li>(2) When the mode is changed to other than jog feed</li><li>(3) When an alarm is generated</li></ul>  | mode  |
|  | (4) When a reset or emergency stop is applied   |   |
|  | The M, S, and B functions remain effective even upo<br>the above events, with the exception of (4).   | on the occurrence of  |
| <ul> <li>Modal information</li> </ul>                  | Modal G codes and addresses used in automatic operation are not affected by the execution of comma the manual numeric command function.   | -   |
| <ul> <li>Jog feed</li> </ul>                           | When the tool is moved along an axis using a feed selection switch on the manual numeric command sc amount of travel is always shown as "0".  |   |
| Limitations  |   |   |
| <ul> <li>Constant surface speed<br/>control</li> </ul> | S codes cannot be specified in constant surface spee  | d control mode.   |
| • T codes  | T codes cannot be specified.  |   |
| • M, S, and B functions                                | While automatic operation is halted, manual numeric<br>executed. In the following cases, however, a "STA<br>warning is output, and command execution is disabl  | RT IMPOSSIBLE"  |
|  | (1) When an M, S, or B function is already being a numeric command containing an M, S, or B t executed.   |   |
|  | (2) When an M, S, or B function is already being<br>function alone is specified or a block specifying<br>contains another function (such as a move c<br>function) which has already been completed,<br>command cannot be executed.  | g that function also<br>ommand or dwell                           |
| ● Jog feed   | When a manual numeric command is specified whi<br>moved along an axis by using a feed axis and direction<br>the axial movement is interrupted, and the manual movement.<br>Therefore, the tool cannot be moved along<br>feed axis and direction selection switch during exe<br>numeric command. | on selection switch,<br>umeric command is<br>g an axis by using a |
| • Mirror image   | A mirror image cannot be produced for the direction movement.   | of a specified axial  |
| REF mode   | The manual numeric command screen appears ever<br>changed to REF mode. If, however, an attempt is mad<br>data, a "WRONG MODE" warning is output and the   | le to set and execute   |

• Functions not supporting manual numeric commands Manual numeric commands cannot be specified for an axis being used for spindle positioning, polygon turning, or synchronization/composite control. Attempting to execute a manual numeric command for such an axis will result in a "START IMPOSSIBLE" warning being output. 4

# **AUTOMATIC OPERATION**

Programmed operation of a CNC machine tool is referred to as automatic operation.

This chapter explains the following types of automatic operation:

• MEMORY OPERATION

Operation by executing a program registered in CNC memory

MDI OPERATION

Operation by executing a program entered from the MDI panel

DNC operation

Operation while reading a program from external input/output device

• PROGRAM RESTART

Restarting a program for automatic operation from an intermediate point

SCHEDULING FUNCTION

Scheduled operation by executing programs (files) registered in an external input/output device (Handy File, Floppy Cassette, or FA Card)

SUBPROGRAM CALL FUNCTION

Function for calling and executing subprograms (files) registered in an external input/output device (Handy File, Floppy Cassette, or FA Card) during memory operation

MANUAL HANDLE INTERRUPTION

Function for performing manual feed during movement executed by automatic operation

• MIRROR IMAGE

Function for enabling mirror-image movement along an axis during automatic operation

• MANUAL INTERVENTION AND RETURN

Function restarting automatic operation by returning the tool the position where manual intervention was started during automatic operation.

## 4.1 MEMORY OPERATION

Programs are registered in memory in advance. When one of these programs is selected and the cycle start switch on the machine operator's panel is pressed, automatic operation starts, and the cycle start LED goes on.

When the feed hold switch on the machine operator's panel is pressed during automatic operation, automatic operation is stopped temporarily. When the cycle start switch is pressed again, automatic operation is restarted.

When the  $\mathbb{RESET}$  key on the MDI panel is pressed, automatic operation

terminates and the reset state is entered.

For the two-path control, the programs for the two tool posts can be executed simultaneously so the two tool posts can operate independently at the same time.

The following procedure is given as an example. For actual operation, refer to the manual supplied by the machine tool builder.

### **Procedure for Memory Operation**

- 1 Press the **MEMORY** mode selection switch.
- 2 Select a program from the registered programs. To do this, follow the steps below.
  - 2–1 Press PROG to display the program screen.
  - 2–2 Press address O .
  - 2–3 Enter a program number using the numeric keys.
  - **2–4** Press the **[O SRH]** soft key.

For the two-path control, select the program for the tool post to be operated. When operating the two tool posts at the same time, select a program for each tool post.

- **3** For the two–path control, select the tool post to be operated with the tool post selection switch on the machine operator's panel.
- **4** Press the cycle start switch on the machine operator's panel. Automatic operation starts, and the cycle start LED goes on. When automatic operation terminates, the cycle start LED goes off.
- **5** To stop or cancel memory operation midway through, follow the steps below.
  - **a.** Stopping memory operation Press the feed hold switch on the machine operator's panel. The feed hold LED goes on and the cycle start LED goes off. The machine responds as follows:
    - (i) When the machine was moving, feed operation decelerates and stops.
    - (ii) When dwell was being performed, dwell is stopped.
    - (iii) When M, S, or T was being executed, the operation is stopped after M, S, or T is finished.

| Evalencian                                     | <ul> <li>When the cycle start switch on the machine operator's panel is pressed while the feed hold LED is on, machine operation restarts.</li> <li><b>b.</b> Terminating memory operation Press the RESET key on the MDI panel. Automatic operation is terminated and the reset state is entered. When a reset is applied during movement, movement decelerates then stops.</li></ul>   |
|--|--|
| Explanation                                    |  |
| Memory operation                               | <ul> <li>After memory operation is started, the following are executed:</li> <li>(1) A one-block command is read from the specified program.</li> <li>(2) The block command is decoded.</li> <li>(3) The command execution is started.</li> <li>(4) The command in the next block is read.</li> <li>(5) Buffering is executed. That is, the command is decoded to allow immediate execution.</li> <li>(6) Immediately after the preceding block is executed, execution of the next block can be started. This is because buffering has been executed.</li> <li>(7) Hereafter, memory operation can be executed by repeating the steps (4) to (6).</li> </ul> |
| Stopping and terminating memory operation      | <ul> <li>Memory operation can be stopped using one of two methods: Specify a stop command, or press a key on the machine operator's panel.</li> <li>The stop commands include M00 (program stop), M01 (optional stop), and M02 and M30 (program end).</li> <li>There are two keys to stop memory operation: The feed hold key and reset key.</li> </ul>  |
| ● Program stop (M00)                           | Memory operation is stopped after a block containing M00 is executed.<br>When the program is stopped, all existing modal information remains<br>unchanged as in single block operation. The memory operation can be<br>restarted by pressing the cycle start button. Operation may vary<br>depending on the machine tool builder. Refer to the manual supplied by<br>the machine tool builder.   |
| <ul> <li>Optional stop (M01)</li> </ul>        | Similarly to M00, memory operation is stopped after a block containing M01 is executed. This code is only effective when the Optional Stop switch on the machine operator's panel is set to ON. Operation may vary depending on the machine tool builder. Refer to the manual supplied by the machine tool builder.  |
| <ul> <li>Program end<br/>(M02, M30)</li> </ul> | When M02 or M30 (specified at the end of the main program) is read,<br>memory operation is terminated and the reset state is entered.<br>In some machines, M30 returns control to the top of the program. For<br>details, refer to the manual supplied by the machine tool builder.  |
| <ul> <li>Feed hold</li> </ul>                  | When Feed Hold button on the operator's panel is pressed during memory operation, the tool decelerates to a stop at a time.  |

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|--|---|---|
| • Reset  | reset state by using RESET key on the   | d and the system can be made to the<br>MDI or external reset signal. When<br>tem during a tool moving status, the   |
| <ul> <li>Optional block skip</li> </ul>                              | When the optional block skip switc<br>turned on, blocks containing a slash  | h on the machine operator's panel is (/) are ignored.   |
| <ul> <li>Cycle start for the two–path control</li> </ul>             | post. This allows the operator to a<br>them at the same time in memory operated we<br>select the tool post to be operated we<br>the machine operator's panel and<br>activate the selected tool post. (The p | tart switch is provided for each tool<br>ctivate a single tool posts to operate<br>eration or MDI operation. In general,<br>with the tool post selection switch on<br>then press the cycle start button to<br>procedure may vary with the machine<br>te manual issued by the machine tool |
| Calling a subprogram<br>stored in an external<br>input/output device |   | input/output device such as a Floppy<br>ted during memory operation. For  |

## 4.2 MDI OPERATION

In the **MDI** mode, a program consisting of up to 10 lines can be created in the same format as normal programs and executed from the MDI panel. MDI operation is used for simple test operations.

The following procedure is given as an example. For actual operation, refer to the manual supplied by the machine tool builder.

### **Procedure for MDI Operation**

- 1 Press the **MDI** mode selection switch. For the two-path control, select the tool post for which a program is to
  - be created with the tool post selection switch. Create a separate program for each tool post.
- 2 Press the PROG function key on the MDI panel to select the program screen. The following screen appears:

| PROGRAM (MDI)  | 0010 | 00002  |
|--|------|--------|
| O0000;   |      |        |
| G00 G90 G94 G40 G80 G50 G54<br>G17 G22 G21 G49 G98 G67 G64<br>B H M<br>T D<br>F S      |      |        |
| >_   |      |        |
| MDI         ****         ***         20:40           ( PRGRM ) ( MDI ) ( CURRNT) ( NEX |      | (OPRT) |

Program number O0000 is entered automatically.

- **3** Prepare a program to be executed by an operation similar to normal program editing. M99 specified in the last block can return control to the beginning of the program after operation ends. Word insertion, modification, deletion, word search, address search, and program search are available for programs created in the MDI mode. For program editing, see Chapter III–9.
- **4** To entirely erase a program created in MDI mode, use one of the following methods:
  - **a.** Enter address O, then press the  $|_{DELETE}$  key on the MDI panel.
  - **b.** Alternatively, press the RESET key. In this case, set bit 7 of parameter 3203 to 1 in advance.

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5 To execute a program, set the cursor on the head of the program. (Start from an intermediate point is possible.) Push Cycle Start button on the operator's panel. By this action, the prepared program will start. (For the two–path control, select the tool post to be operated with the tool post selection switch on the machine operator's panel beforehand.)

When the program end (M02, M30) or ER (%) is executed, the prepared program will be automatically erased and the operation will end.

By command of M99, control returns to the head of the prepared program.

O0001 N00003 PROGRAM (MDI) **O0000** G00 X100.0 Z200. ; M03 G01 Z120.0 F500 ; M93 P9010 ; G00 Z0.0 ; % G00 G90 G94 G40 G80 G50 G54 G69 G17 G22 G21 G49 G98 G67 G64 G15 ΗМ B Т D S F > MDI 12:42:39 PRGRM ) ( MDI ) ( CURRNT ) ( NEXT ) (OPRT)

- **6** To stop or terminate MDI operation in midway through, follow the steps below.
  - a. Stopping MDI operation

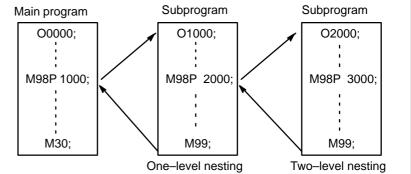
Press the feed hold switch on the machine operator's panel. The feed hold LED goes on and the cycle start LED goes off. The machine responds as follows:

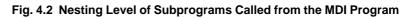
- (i) When the machine was moving, feed operation decelerates and stops.
- (ii) When dwell was being performed, dwell is stopped.
- (iii) When M, S, or T was being executed, the operation is stopped after M, S, or T is finished.When the cycle start switch on the machine operator's panel is pressed, machine operation restarts.
- b. Terminating MDI operation

Press the RESET key on the MDI panel.

Automatic operation is terminated and the reset state is entered. When a reset is applied during movement, movement decelerates then stops.

| Explanation  | The previous explanation of how to execute and stop memory operation<br>also applies to MDI operation, except that in MDI operation, M30 does<br>not return control to the beginning of the program (M99 performs this<br>function).  |  |
|--|---|--|
| • Erasing the program  | <ul> <li>Programs prepared in the MDI mode will be erased in the following cases:</li> <li>In MDI operation, if M02, M30 or ER(%) is executed.<br/>(If bit 6 (MER) of parameter No. 3203 is set to 1, however, the program is erased when execution of the last block of the program is completed by single–block operation.)</li> <li>In MEMORY mode, if memory operation is performed.</li> <li>In EDIT mode, if any editing is performed.</li> <li>Background editing is performed.</li> <li>When the O and PELETE key are pressed,</li> <li>Uncompared when hit 7 (MCL) of parameter No. 2202 is set to 1.</li> </ul> |  |
| • Restart  | • Upon reset when bit 7 (MCL) of parameter No. 3203 is set to 1<br>After the editing operation during the stop of MDI operation was done,<br>operation starts from the current cursor position.   |  |
| <ul> <li>Editing a program during<br/>MDI operation</li> </ul> | A program can be edited during MDI operation. The editing of a program, however, is disabled until the CNC is reset, when bit 5 (MIE) of parameter No. 3203 is set accordingly.   |  |
| Limitation   |   |  |
| <ul> <li>Program registration</li> </ul>                       | Programs created in MDI mode cannot be registered.  |  |
| <ul> <li>Number of lines in a<br/>program</li> </ul>           | A program can have as many lines as can fit on one page of the screen.<br>A program consisting of up to six lines can be created. When parameter<br>MDL (No. 3107 #7) is set to 0 to specify a mode that suppresses the<br>display of continuous-state information, a program of up to 10 lines can<br>be created.<br>If the created program exceeds the specified number of lines, % (ER) is<br>deleted (prevents insertion and modification).   |  |
| <ul> <li>Subprogram nesting</li> </ul>                         | Calls to subprograms (M98) can be specified in a program created in the MDI mode. This means that a program registered in memory can be called and executed during MDI operation. In addition to the main program executed by automatic operation, up to two levels of subprogram nesting are allowed (when the custom macro option is provided, up to four levels are allowed).  |  |
|  | Main program Subprogram Subprogram  |  |



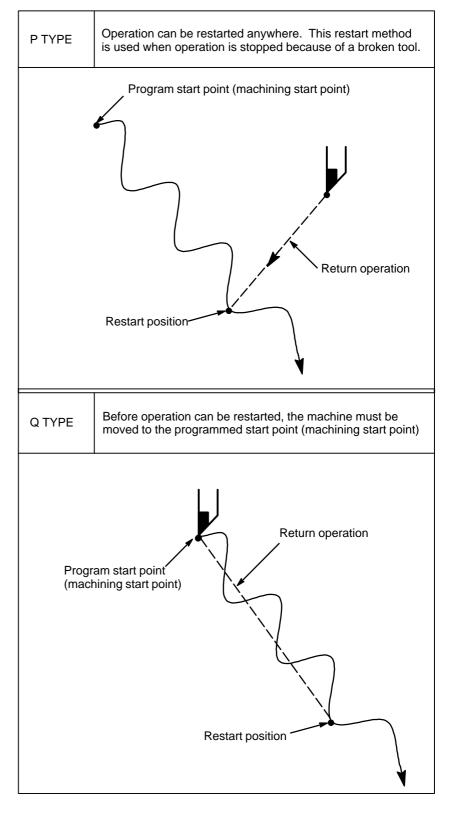


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|---------------------------------|--|---|
| ● Macro call                    | created, called, and executed in commands cannot be executed w | provided, macro programs can also be<br>the <b>MDI</b> mode. However, macro call<br>hen the mode is changed to <b>MDI</b> mode<br>d during execution of a subprogram. |
| <ul> <li>Memory area</li> </ul> | 1 6  | e <b>MDI</b> mode, an empty area in program nory is full, no programs can be created  |

## 4.3 PROGRAM RESTART

This function specifies Sequence No. or Block No. of a block to be restarted when a tool is broken down or when it is desired to restart machining operation after a day off, and restarts the machining operation from that block. It can also be used as a high–speed program check function.

There are two restart methods: the P-type method and Q-type method.



| Procedure for Program restart by Specifying a sequence number |                |     |  |  |
|---|----------------|-----|--|--|
| Procedure 1   |                |     |  |  |
| [ P TYPE ]  |                | 1   | Retract the tool and replace it with a new one. When necessary, change the offset. (Go to step 2.)   |  |
| [ Q TYPE ]  |                | 1   | When power is turned ON or emergency stop is released, perform all necessary operations at that time, including the reference position return.                                   |  |
|   |                | 2   | Move the machine manually to the program starting point (machining start point), and keep the modal data and coordinate system in the same conditions as at the machining start. |  |
|   |                | 3   | If necessary, modify the offset amount.  |  |
| Procedure 2   |                |     |  |  |
| [COMMON TC  | P TYPE /       | 1   | Turn the program restart switch on the machine operator's panel ON.  |  |
| Q TYPE]   |                | 2   | Press function key to display the desired program.   |  |
| N <u>00000</u>  | [Q TYPE]       | 3   | Find the program head.   |  |
|   | or<br>[P TYPE] | 4   | Enter the sequence number of the block to be restarted, then press the <b>[P TYPE]</b> or <b>[Q TYPE]</b> soft key.  |  |
| L→ Se   | equence number |     |  |  |
|   | [Q TYPE]       |     |  |  |
| N <u>○○○</u> <u>○○○</u><br>Frequency                          | or<br>[P TYPE] |     | If the same sequence number appears more than once, the location of<br>the target block must be specified. Specify a frequency and a<br>sequence number.                         |  |
|   | Sequence num   | ber |  |  |

## Procedure for Program restart by Specifying a sequence number

5 The sequence number is searched for, and the program restart screen appears on the CRT display.

| PROGRAM RESTART                            |                            |                       | 000               | 02 N00100                     |  |
|--|----------------------------|-----------------------|-------------------|-------------------------------|--|
| DESTINATION<br>X 57. 096<br>Z 56. 943      | Μ                          | 1<br>1<br>1<br>1<br>1 | * * * * *         | 2<br>2<br>2<br>2<br>2<br>2    |  |
| DISTANCE TO GO<br>1 X 1. 459<br>2 Z 7. 320 | *****<br>T *****<br>S **** | * * * *               | *****<br>*****    | * * * *<br>* * * *<br>0 T0000 |  |
| MEM **** *** ***<br>( <b>RSTR</b> )()()(   | FL.SDL                     |                       | 3<br>10 : 40<br>) | ( (OPRT) )                    |  |

DESTINATION shows the position at which machining is to restart. DISTANCE TO GO shows the distance from the current tool position to the position where machining is to restart. A number to the left of each axis name indicates the order of axes (determined by parameter setting) along which the tool moves to the restart position.

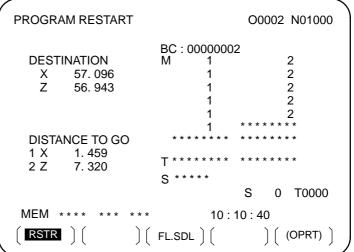
The coordinates and amount of travel for restarting the program can be displayed for up to five axes. If your system supports six or more axes, pressing the **[RSTR]** soft key again displays the data for the sixth and subsequent axes. (The program restart screen displays only the data for CNC–controlled axes.)

- M: Fourteen most recently specified M codes
- T: Two most recently specified T codes
- S: Most recently specified S code

Codes are displayed in the order in which they are specified. All codes are cleared by a program restart command or cycle start in the reset state.

- **6** Turn the program re-start switch OFF. At this time, the figure at the left side of axis name DISTANCE TO GO blinks.
- 7 Check the screen for the M, S, and T codes to be executed. If they are found, enter the MDI mode, then execute the M, S and T functions. After execution, restore the previous mode. These codes are not displayed on the program restart screen.
- 8 Check that the distance indicated under DISTANCE TO GO is correct. Also check whether there is the possibility that the tool might hit a workpiece or other objects when it moves to the machining restart position. If such a possibility exists, move the tool manually to a position from which the tool can move to the machining restart position without encountering any obstacles.
- **9** Press the cycle start button. The tool moves to the machining restart position at the dry run feedrate sequentially along axes in the order specified by parameter settings (No. 7310). Machining is then restarted.

### Procedure for Program Restart by Specifying a Block Number **Procedure 1** [P TYPE] 1 Retract the tool and replace it with a new one. When necessary, change the offset. (Go to step 2.) 1 When power is turned ON or emergency stop is released, perform all [Q TYPE] necessary operations at that time, including the reference position return. 2 Move the machine manually to the program starting point (machining start point), and keep the modal data and coordinate system in the same conditions as at the machining start. 3 If necessary, modify the offset amount. **Procedure 2** [COMMON TO P TYPE / Turn the program restart switch on the machine operator's panel ON. 1 Q TYPE] Press function **PROG** key to display the desired program. 2 Find the program head. Press function RESET key. IQ TYPE1 3 <u>00000000</u> Enter the number of the block to be restarted then press the **[P TYPE]** 4 or [Q TYPE] soft key. The block number cannot exceed eight digits. Block number 5 The block number is searched for, and the program restart screen appears on the display.



DESTINATION shows the position at which machining is to restart. DISTANCE TO GO shows the distance from the current tool position to the position where machining is to restart. A number to the left of each axis name indicates the order of axes (determined by parameter setting) along which the tool moves to the restart position. The coordinates and amount of travel for restarting the program can be displayed for up to five axes. If your system supports six or more axes, pressing the **[RSTR]** soft key again displays the data for the sixth and subsequent axes. (The program restart screen displays only the data for CNC–controlled axes.)

M: Fourteen most recently specified M codes

- T: Two most recently specified T codes
- S: Most recently specified S code
- B: Most recently specified B code

Codes are displayed in the order in which they are specified. All codes are cleared by a program restart command or cycle start in the reset state.

- **6** Turn the program re-start switch OFF. At this time, the figure at the left side of axis name DISTANCE TO GO blinks.
- 7 Check the screen for the M, S, T, and B codes to be executed. If they are found, enter the MDI mode, then execute the M, S, T, and B functions. After execution, restore the previous mode. These codes are not displayed on the program restart screen.
- 8 Check that the distance indicated under DISTANCE TO GO is correct. Also check whether there is the possibility that the tool might hit a workpiece or other objects when it moves to the machining restart position. If such a possibility exists, move the tool manually to a position from which the tool can move to the machining restart position without encountering any obstacles.
- **9** Press the cycle start button. The tool moves to the machining restart position at the dry run feedrate sequentially along axes in the order specified by parameter settings (No. 7310). Machining is then restarted.

### **Explanations**

• Block number

When the CNC is stopped, the number of executed blocks is displayed on the program screen or program restart screen. The operator can specify the number of the block from which the program is to be restarted, by referencing the number displayed. The displayed number indicates the number of the block that was executed most recently. For example, to restart the program from the block at which execution stopped, specify the displayed number, plus one.

The number of blocks is counted from the start of machining, assuming one NC line of a CNC program to be one block.

#### < Example 1 >

| CNC Program        | Number of blocks |
|--------------------|------------------|
| O 0001 ;           | 1                |
| G90 G92 X0 Y0 Z0 ; | 2                |
| G01 X100. F100 ;   | 3                |
| G03 X01 –50. F50 ; | 4                |
| M30 ;              | 5                |

| < Example 2 : | > |
|---------------|---|
|---------------|---|

|  | CNC Program   | Number of blocks   |
|--|---|--|
|  | O 0001 ;<br>G90 G92 X0 Y0 Z0 ;<br>G90 G00 Z100. ;<br>G81 X100. Y0. Z-120. R-80. F50. ;<br>#1 = #1 + 1 ;<br>#2 = #2 + 1 ;<br>#3 = #3 + 1 ;<br>G00 X0 Z0 ;<br>M30 ;<br>Macro statements are not counted a   | 1<br>2<br>3<br>4<br>4<br>4<br>4<br>5<br>6  |
| <ul> <li>Storing / clearing the<br/>block number</li> </ul>          |   | bry while no power is supplied. The  |
| <ul> <li>Block number when a program is halted or stopped</li> </ul> | <ul> <li>being executed. When the executive is reset, or the program is executive program screen displays the numb most recently.</li> <li>When a CNC program is halted single–block stop, the following black feed hold : Block being execute Reset : Block executed most recently.</li> </ul> | d<br>ently<br>ted most recently<br>during the execution of block 10, the   |
| • MDI intervention   | -   | ned while the program is stopped by<br>nands used for intervention are not   |
| <ul> <li>Block number exceeding<br/>eight digits</li> </ul>          | When the block number displayed digits, the block number is reset to  | on the program screen exceeds eight 0 and counting continues.  |
| Limitation   |   |  |
| • P-type restart   | <ul> <li>performed:</li> <li>When automatic operation has was turned on</li> <li>When automatic operation has no stop was released</li> <li>When automatic operation has</li> </ul>   | nditions, P-type restart cannot be<br>not been performed since the power<br>of been performed since an emergency<br>as not been performed since the<br>or shifted (change in an external offset<br>bint) |
| <ul> <li>Restart block</li> </ul>                                    | operation can restart with any block  | be the block which was interrupted;<br>c. When P–type restart is performed,<br>coordinate system as when operation   |

| <ul> <li>Single block</li> </ul>                  | When single block operation is ON during movement to the restart<br>position, operation stops every time the tool completes movement along<br>an axis. When operation is stopped in the single block mode, MDI<br>intervention cannot be performed.                         |
|---|---|
| <ul> <li>Manual intervention</li> </ul>           | During movement to the restart position, manual intervention can be used<br>to perform a return operation for an axis if it has not yet been performed<br>for the axis. A return operation cannot be done further on axes for which<br>a return has already been completed. |
| • Reset   | Never reset during the time from the start of a search at restart until machining is restarted. Otherwise, restart must be performed again from the first step.   |
| <ul> <li>Manual absolute</li> </ul>               | Regardless of whether machining has started or not, manual operation<br>must be performed when the manual absolute mode is on.  |
| <ul> <li>Reference position<br/>return</li> </ul> | If no absolute–position detector (absolute pulse coder) is provided, be<br>sure to perform reference position return after turning on the power and<br>before performing restart.   |

## Alarm

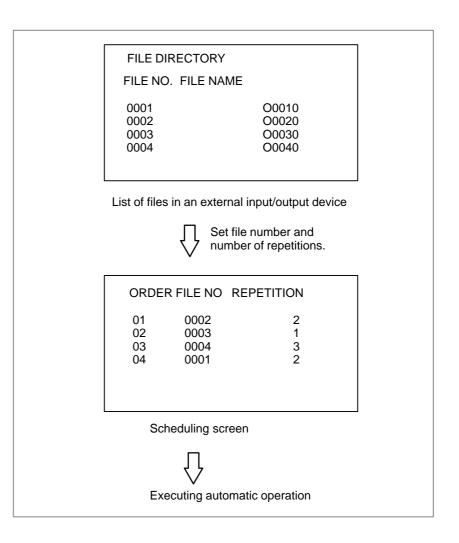
| Alarm No. | Contents   |
|-----------|--|
| 071       | The specified block number for restarting the program is not found.  |
| 094       | After interruption, a coordinate system was set, then P-type restart was specified.  |
| 095       | After interruption, the coordinate system shift was changed, then P–type restart was specified.  |
| 096       | After interruption, the coordinate system was changed, then P–type restart was specified.  |
| 097       | When automatic operation has not been performed since<br>the power was turned on, emergency stop was released, or<br>P/S alarm (Nos. 094 to 097) was reset, P-type restart was<br>specified. |
| 098       | After the power was turned on, restart operation was per-<br>formed without reference position return, but a G28 com-<br>mand was found in the program.                                      |
| 099       | A move command was specified from the MDI panel during a restart operation.  |
| 5020      | An erroneous parameter was specififed for restarting a pro-<br>gram.   |

### WARNING

- As a rule, the tool cannot be returned to a correct position under the following conditions.
- Special care must be taken in the following cases since none of them cause an alarm:
- Manual operation is performed when the manual absolute mode is OFF.
- Manual operation is performed when the machine is locked.
- When the mirror image is used.
- When manual operation is performed in the course of axis movement for returning operation.
- When the program restart is commanded for a block between the block for skip cutting and subsequent absolute command block.
- When program restart specified for an intermediate block for a multiple repetitive canned cycle.

# 4.4 SCHEDULING FUNCTION

The schedule function allows the operator to select files (programs) registered on a floppy-disk in an external input/output device (Handy File, Floppy Cassette, or FA Card) and specify the execution order and number of repetitions (scheduling) for performing automatic operation. It is also possible to select only one file from the files in the external input/output device and execute it during automatic operation.



## **Procedure for Scheduling Function**

- •Procedure for executing one file
- Press the MEMORY switch on the machine operator's panel, then press the PROG function key on the MDI panel.
- 2 Press the rightmost soft key (continuous menu key), then press the [FL. SDL] soft key. A list of files registered in the Floppy Cassette is displayed on screen No. 1. To display more files that are not displayed on this screen, press the page key on the MDI panel. Files registered in the Floppy Cassette can also be displayed successively.

| <i>c</i>                    |                 |
|-----------------------------|-----------------|
| FILE DIRECTORY              | O0001 N00000    |
| CURRENT SELECTED : SCHEDULE |                 |
| NO. FILE NAME               | (METER) VOL     |
| 0000 SCHEDULE               |                 |
| 0001 PARAMETER              | 58.5            |
| 0002 ALL PROGRAM            | 11.0            |
| 0003 O0001                  | 1.9             |
| 0004 O0002                  | 1.9             |
| 0005 O0010                  | 1.9             |
| 0006 O0020                  | 1.9             |
| 0007 O0040                  | 1.9             |
| 0008 O0050                  | 1.9             |
| MEM **** *** *** 19         | 9 : 14 : 47     |
| (PRGRM)()                   | SCHDUL)((OPRT)) |
|                             |                 |

Screen No. 1

3 Press the [(OPRT)] and [SELECT] soft keys to display "SELECT FILE NO." (on screen No. 2). Enter a file number, then press the [F SET] and [EXEC] soft keys. The file for the entered file number is selected, and the file name is indicated after "CURRENT SELECTED:".

| FILE DIRECTORY                                      | O0001 N00000 |
|---|--------------|
| CURRENT SELECTED:00040<br>NO. FILE NAME             | (METER) VOL  |
| 0000 SCHEDULE<br>0001 PARAMETER<br>0002 ALL PROGRAM | 58.5<br>11.0 |
| 0002 ALL 1 NOGRAM<br>0003 00001<br>0004 00002       | 1.9<br>1.9   |
| 0005 O0010<br>0006 O0020                            | 1.9<br>1.9   |
| 0007 00040<br>0008 00050<br>SELECT FILE NO.=7       | 1.9<br>1.9   |
| >_<br>MEM **** *** ***                              | 19 : 17 : 10 |
| ( [ F SET ] [ ] [                                   | )( )( EXEC ) |



4 Press the REMOTE switch on the machine operator's panel to enter the RMT mode, then press the cycle start switch. The selected file is executed. For details on the REMOTE switch, refer to the manual supplied by the machine tool builder. The selected file number is indicated at the upper right corner of the screen as an F number (instead of an O number).

| 1 |   |   |
|---|---|---|
| ( | FILE DIRECTORY                          | F0007 N00000                            |
|   | CURRENT SELECTED:00040                  |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   | DMT                                     | 40.07.54                                |
|   | RMT **** *** ***<br>( PRGRM ) ( ) ( DIR | 13 : 27 : 54<br>) ( SCHDUL ) ( (OPRT) ) |
|   |   |   |

Screen No. 3

- 1 Display the list of files registered in the Floppy Cassette. The display procedure is the same as in steps 1 and 2 for executing one file.
- 2 On screen No. 2, press the [(OPRT)] and [SELECT] soft keys to display "SELECT FILE NO."
- **3** Enter file number 0, and press the **[F SET]**, and **[EXEC]** soft keys. "SCHEDULE" is indicated after "CURRENT SELECTED:".
- 4 Press the left most soft key (return menu key) and the **[SCHDUL]** soft key. Screen No. 4 appears.

|                |   |                    | )               |  |  |
|----------------|---|--------------------|-----------------|--|--|
| FILE DIRECTORY |   |                    | F0000 N02000    |  |  |
|                | ORDER<br>01<br>02<br>03<br>04<br>05<br>06<br>07<br>08<br>09<br>10 | FILE NO.           | REQ.REP CUR.REP |  |  |
|                | >_<br>MEM ****<br>( prgrm ) (                                     | *** ***<br>) ( DIR | 22:07:00        |  |  |



Move the cursor and enter the file numbers and number of repetitions in the order in which to execute the files. At this time, the current number of repetitions "CUR.REP" is 0.

**5** Press the **REMOTE** switch on the machine operator's panel to enter the **RMT** mode, then press the start switch. The files are executed in the specified order. When a file is being executed, the cursor is positioned at the number of that file.

The current number of repetitions CUR.REP is increased when M02 or M30 is executed in the program being run.

• Procedure for executing the scheduling function

| FILE DIRI | ECTORY            | (       | 20000 N02000   |
|-----------|-------------------|---------|----------------|
| ORDER     | FILE NO.          | REQ.REP | CUR.REP        |
| 01        | 0007              | 5       | 5              |
| 02        | 0003              | 23      | 23             |
| 03        | 0004              | 9999    | 156            |
| 04        | 0005              | LOOP    | 0              |
| 05        |                   |         |                |
| 06        |                   |         |                |
| 07        |                   |         |                |
| 08        |                   |         |                |
| 09        |                   |         |                |
| 10        |                   |         |                |
| RMT *     | * * * * * * * * * | 10 : 10 | : 40           |
|           | )()(              |         | ■ ) ( (OPRT) ) |

Screen No. 5

# Explanations

| <ul> <li>Specifying no file<br/>number</li> </ul>                                      | If no file number is specified on screen No. 4 (the file number field is left blank), program execution is stopped at that point. To leave the file number field blank, press numeric key $\bigcirc$ then $\bigcirc$ then $\bigcirc$ . |
|--|--|
| <ul> <li>Endless repetition</li> </ul>   | If a negative value is set as the number of repetitions, <b><loop></loop></b> is displayed, and the file is repeated indefinitely.   |
| • Clear  | When the <b>[(OPRT)]</b> , <b>[CLEAR]</b> , and <b>[EXEC]</b> soft keys are pressed on screen No. 4, all data is cleared. However, these keys do not function while a file is being executed.  |
| <ul> <li>Return to the program<br/>screen</li> </ul>                                   | When the <b>[PRGRM]</b> soft key is pressed on screen No. 1, 2, 3, 4, or 5, the program screen is displayed.   |
| Limitation   |  |
| <ul> <li>Number of repetitions</li> </ul>  | Up to 9999 can be specified as the number of repetitions. If 0 is set for a file, the file becomes invalid and is not executed.  |
| <ul> <li>Number of files<br/>registered</li> </ul>                                     | By pressing the page key on screen No. 4, up to 20 files can be registered.  |
| • M code   | When M codes other than M02 and M30 are executed in a program, the current number of repetitions is not increased.   |
| <ul> <li>Displaying the floppy<br/>disk directory during file<br/>execution</li> </ul> | During the execution of file, the floppy directory display of background editing cannot be referenced.   |
| <ul> <li>Restarting automatic<br/>operation</li> </ul>                                 | To resume automatic operation after it is suspended for scheduled operation, press the reset button.   |
| <ul> <li>Scheduling function for<br/>the two–path control</li> </ul>                   | The scheduling function can be used only for a single tool post.   |

## Alarm

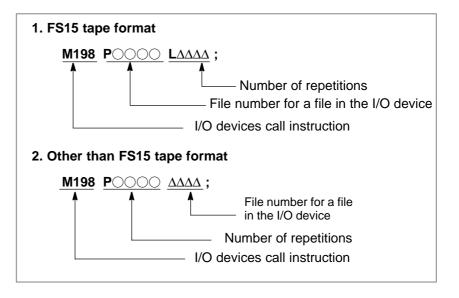
| Alarm No. | Description   |
|-----------|---|
| 086       | An attempt was made to execute a file that was not regis-<br>tered in the floppy disk.            |
| 210       | M198 and M99 were executed during scheduled operation, or M198 was executed during DNC operation. |

# 4.5 SUBPROGRAM CALL FUNCTION (M198)

The subprogram call function is provided to call and execute subprogram files stored in an external input/output device (Handy File, FLOPPY CASSETTE, FA Card) during memory operation.

When the following block in a program in CNC memory is executed, a subprogram file in the external input/output device is called:

To use this function, the Floppy Cassette directory display option must be installed.



### Explanation

The subprogram call function is enabled when parameter No. 0102 for the input/output device is set to 3. When the custom macro option is provided, either format 1 or 2 can be used. A different M code can be used for a subprogram call depending on the setting of parameter No. 6030. In this case, M198 is executed as a normal M code. The file number is specified at address P. If the SBP bit (bit 2) of parameter No. 3404 is set to 1, a program number can be specified. When a file number is specified at address P, Fxxxx is indicated instead of Oxxxx.

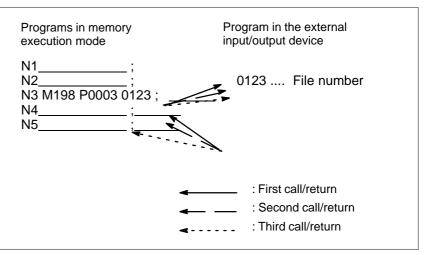


Fig. 4.5 Program Flow When M198 is Specified

Restrictions

For the two-path control, subprograms in a floppy cassette cannot be called for the two tool posts at the same time.

## Format

## NOTE

- 1 When M198 in the program of the file saved in a floppy cassette is executed, a P/S alarm (No.210) is given. When a program in the memory of CNC is called and M198 is executed during execution of a program of the file saved in a floppy cassette, M198 is changed to an ordinary M–code.
- 2 When MDI is intervened and M198 is executed after M198 is commanded in the memory mode, M198 is changed to an ordinary M-code. When the reset operation is done in the MDI mode after M198 is commanded in the MEMORY mode, it does not influence on the memory operation and the operation is continued by restarting it in the MEMORY mode.

# 4.6 MANUAL HANDLE INTERRUPTION

The movement by manual handle operation can be done by overlapping it with the movement by automatic operation in the automatic operation mode.

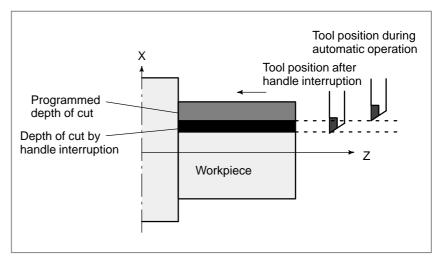


Fig. 4.6 Manual Handle Interruption

• Handle interruption axis selection signals For the handle interruption axis selection signals, refer to the manual supplied by the machine tool builder.

During automatic operation, handle interruption is enabled for an axis if the handle interruption axis selection signal for that axis is on. Handle interruption is performed by turning the handle of the manual pulse generator.

#### WARNING

The travel distance by handle interruption is determined according to the amount by which the manual pulse generator is turned and the handle feed magnification ( $\times 1$ ,  $\times 10$ ,  $\times M$ ,  $\times N$ ).

Since this movement is not accelerated or decelerated, it is very dangerous to use a large magnification value for handle interruption.

The move amount per scale at  $\times 1$  magnification is 0.001 mm (metric output) or 0.0001 inch (inch output).

### NOTE

Handle interruption is disabled when the machine is locked during automatic operation.

### **Explanations**

• Relation with other functions

The following table indicates the relation between other functions and the movement by handle interrupt.

| Display      | Relation  |
|--------------|---|
| Machine lock | Machine lock is effective. The tool does not move even when this signal turns on.   |
| Interlock    | Interlock is effective. The tool does not move even when this signal turns on.  |
| Mirror image | Mirror image is not effective. Interrupt functions on the plus direction by plus direction command, even if this signal turns on. |

### • Position display

The following table shows the relation between various position display data and the movement by handle interrupt.

| Display                   | Relation  |
|---------------------------|---|
| Absolute coordinate value | Handle interruption does not change absolute coordi-<br>nates.                                |
| Relative coordinate value | Handle interruption does not change relative coordinates.                                     |
| Machine coordinate value  | Machine coordinates are changed by the travel dis-<br>tance specified by handle interruption. |

### Travel distance display

Press the function key POS, then press the chapter selection soft key

### [HNDL].

The move amount by the handle interrupt is displayed. The following 4 kinds of data are displayed concurrently.

| ·                       | )                    |
|-------------------------|----------------------|
| HANDLE INTERRUPTION     | O0000 N00200         |
| (INPUT UNIT)            | (OUTPUT UNIT)        |
| X 69.594                | X 69.594             |
| Z –61.439               | Z –61.439            |
|                         |                      |
| (RELATIVE)              | (DISTANCE TO GO)     |
| U 0.000                 | X 0.000              |
| W0.000                  | Z 0.000              |
| DAD                     | T COUNT 287          |
| RUN TIME 1H 12M CYCLE   |                      |
|                         |                      |
| MDI **** *** ***        | 10 : 29 : 51         |
| ( ABS ) ( REL ) ( ALL ) |                      |
|                         | $\sim$ $\sim$ $\sim$ |

### (a) INPUT UNIT :

Handle interrupt move amount in input unit system Indicates the travel distance specified by handle interruption according to the least input increment.

(b) OUTPUT UNIT :

Handle interrupt move amount in output unit system Indicates the travel distance specified by handlei nterruption according to the least command increment.

### (c) RELATIVE :

Position in relative coordinate system

These values have no effect on the travel distance specified by handle interruption.

(d) DISTANCE TO GO :

The remaining travel distance in the current block has no effect on the travel distance specified by handle interruption.

The handle interrupt move amount is cleared when the manual reference position return ends every axis.

# 4.7 MIRROR IMAGE

During automatic operation, the mirror image function can be used for movement along an axis. To use this function, set the mirror image switch to ON on the machine operator's panel, or set the mirror image setting to ON from the CRT/MDI (or LCD/MDI).

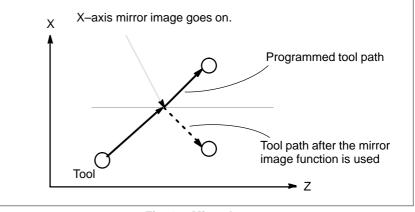


Fig. 4.7 Mirror Image

The following procedure is given as an example. For actual operation, refer to the manual supplied by the machine tool builder.

- 1 Press the single block switch to stop automatic operation. When the mirror image function is used from the beginning of operation, this step is omitted.
- **2** Press the mirror image switch for the target axis on the machine operator's panel.

Alternatively, turn on the mirror image setting by following the steps below:

2–1 Set the MDI mode.

- **2–2** Press the  $\left| \begin{array}{c} OFFSET \\ SETTING \end{array} \right|$  function key.
- **2–3** Press the **[SETING]** soft key for chapter selection to display the setting screen.

| SETTING (MIRROR IMAGE) O0020 N00001  |   |
|--|---|
| MIRROR IMAGE $X = 1$ (0 : OFF 1 : ON)MIRROR IMAGE $Z = 0$ (0 : OFF 1 : OM)   |   |
|  |   |
|  |   |
| >_<br>MEM **** *** *** 14:47:57  |   |
| $\left( OFFSET \right) \left( \begin{array}{c} SETING \end{array} \right) \left( \begin{array}{c} WORK \end{array} \right) \left( \begin{array}{c} \end{array} \right) \left( \begin{array}{c} (OPRT) \end{array} \right)$ | ) |

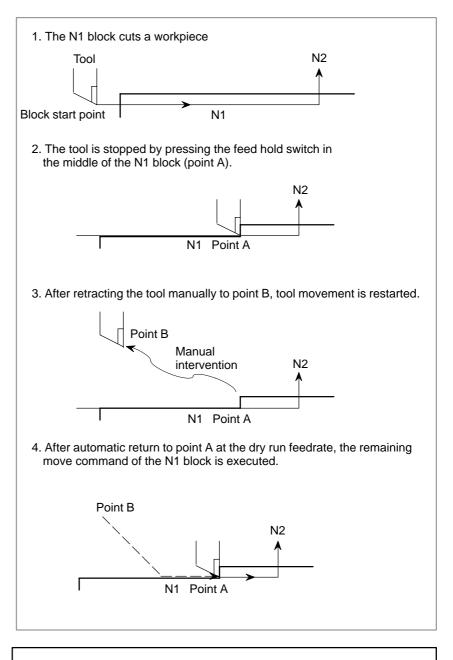
**2–4** Move the cursor to the mirror image setting position, then set the target axis to 1.

## Procedure

| B-63004EN/02 | OPERATION   | 4. AUTOMATIC OPERATION  |
|--------------|---|---|
|              | 1   | on mode (memory mode or MDI mode),<br>tton to start automatic operation.                          |
| Explanations |   |   |
|              | <ul> <li>The mirror image function ca<br/>0 (MIRx) of parameter (No.</li> </ul> | an also be turned on and off by setting bit 0012) to 1 or 0.                                      |
|              | • For the mirror image switch machine tool builder.                             | es, refer to the manual supplied by the   |
| Restrictions |   | ring manual operation, the direction of<br>e point to the reference position during<br>urn (G28). |

| 4.8<br>MANUAL<br>INTERVENTION AND<br>RETURN                                       | In cases such as when tool movement along an axis is stopped by feed hold<br>during automatic operation so that manual intervention can be used to<br>replace the tool: When automatic operation is restarted, this function<br>returns the tool to the position where manual intervention was started.<br>To use the conventional program restart function and tool withdrawal and<br>return function, the switches on the operator's panel must be used in<br>conjunction with the MDI keys. This function does not require such<br>operations. |
|---|---|
| Explanations  |   |
| <ul> <li>Manual absolute on/off</li> </ul>  | In manual absolute off mode, the tool does not return to the stop position, but instead operates according to the manual absolute on/off function.  |
| Override  | For the return operation, the dry run feedrate is used, and the jog feedrate override function is enabled.  |
| <ul> <li>Return operation</li> </ul>  | Return operation is performed according to positioning based on nonlinear interpolation.  |
| <ul> <li>Single block</li> </ul>  | If the single block stop switch is on during return operation, the tool stops at the stop position and restarts movement when the cycle start switch is pressed.  |
| Cancellation  | If a reset occurs or an alarm is issued during manual intervention or the return operation, this function is cancelled.   |
| MDI mode  | This function can be used in the MDI mode as well.  |
| Restrictions  |   |
| <ul> <li>Enabling and disabling<br/>manual intervention and<br/>return</li> </ul> | This function is enabled only when the automatic operation hold LED is<br>on. When there is no travel distance remaining, this function has no effect<br>even if a feed hold stop is performed with the automatic operation hold<br>signal *SP (bit 5 of G008).   |
| Offset  | When the tool is replaced using manual intervention for a reason such as damage, the tool movement cannot be restarted by a changed offset in the middle of the interrupted block.  |
| <ul> <li>Machine lock, mirror<br/>image, and scaling</li> </ul>                   | When performing manual intervention, never use the machine lock, mirror image, or scaling functions.  |

### Example



### WARNING

When performing manual intervention, pay particular attention of machining and the shape of the workpiece so that the machine and tool are not damaged.

| 4.9<br>DNC OPERATION   | By activating automatic operation during the DNC operation mode (RMT), it is possible to perform machining (DNC operation) while a program is being read in via reader/puncher interface, or remote buffer. If the floppy cassette directory display option is available, it is possible to select files (programs) saved in an external input/output unit of a floppy format (Handy File, Floppy Cassettes, or FA card) and specify (schedule) the sequence and frequency of execution for automatic operation. To use the DNC operation function, it is necessary to set the parameters related to the reader/punch interface, and remote buffer in advance. |
|--|--|
| DNC OPERATION  |  |
| Procedure  | <b>1</b> Search for the program (file) to be executed.   |
|  | 2 Press the REMOTE switch on the machine operator's panel to set<br>RMT mode, then press the cycle start switch. The selected file is<br>executed. For details of the use of the REMOTE switch, refer to the<br>relevant manual supplied by the machine tool builder.  |
| <ul> <li>Program check screen<br/>(7 soft key type)</li> </ul> | PROGRAM CHECK       00001 N00020         N020 X100.0 Z100.0 (DNC-PROG) ;       N030 X200.0 Z200.0 ;         N050 X400.0 Z400.0 ;       (RELATIVE) (DIST TO GO) G00 G17 G90         X 100.000 X 0.000 G22 G94 G21       Y 100.000 Y 0.000 G41 G49 G80         Z 0.000 Z 0.000 G98 G50 G67       A 0.000 A 0.000 B         C 0.000 C 0.000 H M       HD.T NX.T D M         F       S M         ACT.F       SACT REPEAT         RMT STRT MTN *** *** 21:20:05       [ ABS ] [ REL ] [ ] [ ] [ (OPRT) ]  |
| <ul> <li>Program screen<br/>(7 soft key type)</li> </ul>       | PROGRAM         O0001 N00020           N020 X100.0 Z100.0 (DNC-PROG) ;         ;           N030 X200.0 Z200.0 ;         ;           N040 X300.0 Z300.0 ;         ;   |

RMT STRT MTN \*\*\* \*\*\*

[ PRGRM ] [ CHECK ] [

21:20:05

][ ][ (OPRT) ]

N050 X400.0 Z400.0 ; N060 X500.0 Z500.0 ; N070 X600.0 Z600.0 ; N080 X700.0 Z400.0 ; N090 X800.0 Z400.0 ; N100 x900.0 Z400.0 ; N110 x1000.0 z1000.0 ; N120 x800.0 z800.0 ;

#### Program screen (12 soft key type)

| PROGRAM                                  |                               |
|--|-------------------------------|
|  |                               |
|  |                               |
| N020 X100.0 (DNC-PROG) ;<br>N030 X90.0 ; | N180 Z50.0 ;<br>N190 Z40.0 ;  |
| N030 X90.0 ;<br>N040 X80.0 ;             | N190 240.0 ;<br>N200 Z30.0 ;  |
| N040 X70.0 ;                             | N210 Z20.0 ;                  |
| N060 X60.0 ;                             | N220 Z10.0 ;                  |
| N070 X50.0 :                             | N230 Z0.0 ;                   |
| N080 X40.0 ;                             | N240 M02 ;                    |
| N090 X30.0 ;                             | 8                             |
| N100 X20.0 ;                             |                               |
| N110 X10.0 ;                             |                               |
| N120 X0.0 ;                              |                               |
| N130 Z100.0 ;                            |                               |
| N140 Z90.0 ;                             |                               |
| N150 Z80.0 ;                             |                               |
| N160 Z70.0 ;<br>N170 Z60.0 ;             |                               |
| N170 260.0 ;                             |                               |
|  |                               |
|  | RMT STRT MTN *** *** 22:23:24 |
|  |                               |
|  | PRGR CHEC (OPR                |
|  | M K I T)                      |

During DNC operation, the program currently being executed is displayed on the program check screen and program screen.

The number of displayed program blocks depends on the program being executed.

Any comment enclosed between a control–out mark (() and control–in mark ()) within a block is also displayed.

**Explanations** 

#### Limitations

- Limit on number of characters
- M198 (command for calling a program from within an external input/output unit)
- Custom macro

M99

• During DNC operation, programs and macro programs stored in memory can be called.

In program display, no more than 256 characters can be displayed. Accordingly, character display may be truncated in the middle of a block.

In DNC operation, M198 cannot be executed. If M198 is executed, P/S alarm No. 210 is issued.

In DNC operation, custom macros can be specified, but no repeat instruction and branch instruction can be programmed. If a repeat instruction or branch instruction is executed, P/S alarm No. 123 is issued. When reserved words (such as IF, WHILE, COS, and NE) used with custom macros in DNC operation are displayed during program display, a blank is inserted between adjacent characters.

[During DNC operation]

Example

| #102=SIN[#100];   | $\rightarrow$ | #102 = S I N[#100];      |
|-------------------|---------------|--------------------------|
| IF[#100NE0]GOTO5; | $\rightarrow$ | I F[#100NE0] G O T O 5 ; |

When control is returned from a subprogram or macro program to the calling program during DNC operation, it becomes impossible to use a return command (M99P\*\*\*\*) for which a sequence number is specified.

#### Alarm

| Number | Message                             | Contents   |
|--------|-------------------------------------|--|
| 086    | DR SIGNAL OFF                       | When entering data in the memory by<br>using Reader / Puncher interface, the<br>ready signal (DR) of reader / puncher<br>was turned off.<br>Power supply of I/O unit is off or cable is<br>not connected or a P.C.B. is defective. |
| 123    | CAN NOT USE MACRO<br>COMMAND IN DNC | Macro control command is used during<br>DNC operation.<br>Modify the program.  |
| 210    | CAN NOT COMAND<br>M198/M199         | Or M198 is executed in the DNC opera-<br>tion. Modify the program.   |

# 4.10 DNC OPERATION WITH MEMORY CARD

| 4.10.1<br>Specification | "DNC operation with Memory Card" is a function that it is possible to<br>perform machining with executing the program in the memory card,<br>which is assembled to the memory card interface, where is the left side<br>of the screen.  |
|-------------------------|---|
|                         | <ul><li>There are two methods to use this function as follows.</li><li>(a) By starting automatic operation (cycle start) during the DNC operation mode (RMT), it is possible to perform machining (DNC operation) while a program is being read from a memory card, as by</li></ul> |
|                         | using the external input/output unit such as a floppy cassette and so on.<br>(Fig. 4.10.1 (a))  |
|                         | <ul><li>(b) It is possible to read sub–programs written in the memory card and execute them by the command Subprogram call (M198). (Fig. 4.10.1 (b))</li></ul>  |

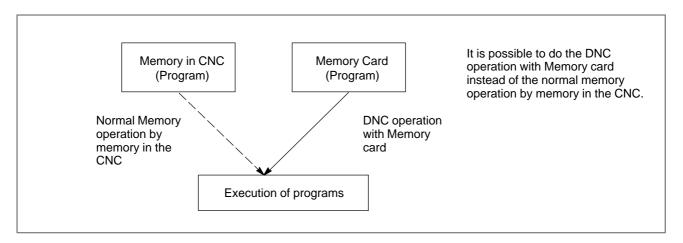


Fig. 4.10.1 (a)

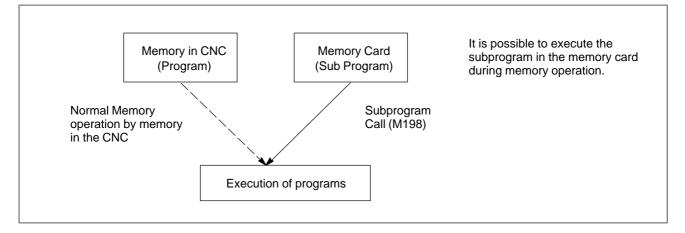


Fig. 4.10.1 (b)

#### NOTE

- 1 To use this function, it is necessary to set the parameter of No.20 to 4 by setting screen.
  - No.20 [I/O CHANEL: Setting to select an input/output unit] Setting value is 4.: It means using the memory card interface.
- 2 When CNC control unit is a stand–alone type, the memory card interface on the left side of the screen of the display unit is available. But the interface on the control unit is not available.

## 4.10.2 Operations

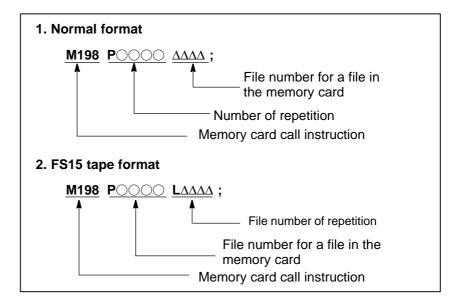
# 4.10.2.1 DNC operation

Handling explanation Please set the parameter of No.20 to 4 in the setting screen in advance. (1) Change to RMT mode. (2) Push [PROGRAM] function key. (3) Push [>] soft key (continuance menu). (4) When [DNC-CD] soft key is pushed, the following screen is displayed. (5) The screen can be scrolled by page key. An arbitrary file number is input, and [F SRH] soft key is pushed. Then the arbitrary file name is displayed at the top of DNC operation (memory card) screen. (6) When the file number that is executed is input and the [DNC-ST] soft key is pushed, the file name that is selected is set to DNC FILE. (7) When the cycle start is done, the program that is selected is executed. DNC OPERATION (M CARD) 00001 N00001 FILE NAME DATE NO. SIZE 0001 MAIN. PRG 800013 99 02 03 0002 DNC1. PRG 50 99-03-23 0003 DNC2. PRG 38 99 03 24 0004 DNC3. PRG 32 99-03-24 0005 DNC4. PRG 99 03 23 50 0006 CNCPARAM. DAT 2304 99-03-24 0007 TOOLOFST. DAT 838 99 03 24 0008 01234 170 99-03-24 0009 07777 528 99 03 24 DNC FILE NAME : MAIN. PRG 14:20:23 \*\*\*\* \* \*\*\* DNC-ST SRH

### 4.10.2.2 Subprogram call (M198)

When the following block in a program in CNC memory is executed, a subprogram file in memory card is called.

Format



#### Explanation

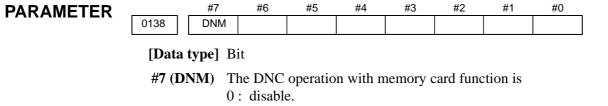
When the custom macro option is provided, both format 1 and 2 can be used. A different M code can be used for a subprogram call depending on the setting of parameter No. 6030. In this case, M198 is executed as a normal M code. The file number is specified at address P. If the SBP (bit 2) of parameter No. 3404 is set to 1, a program number can be specified. When a file number is specified at address P, Fxxxx is indicated instead of Oxxxx.

#### NOTE

Please set the parameter of No. 20 to 4 in the setting screen in advance.

| 4.10.3<br>LIMITATION and | (1) The memory card can not be accessed, such as display of memory card list and so on, during the DNC operation with memory card.   |
|--------------------------|--|
| NOTES                    | (2) It is possible to execute the DNC operation with memory card on multi path system. However, it is not possible to call programs from the plural paths at the same time.  |
|                          | (3) The selection of DNC operation file that is set at DNC OPERATION screen is cleared by the power supply turn off and on. After the power supply is turned on again, it is necessary to select the DNC operation file again. |
|                          | (4) Please do not pull out and insert memory card during the DNC operation with memory card.   |
|                          | (5) It is not possible to call a program in the memory card from the DNC operation program.  |
|                          | (6) In case of using this function, the PMCIA card attachment written at section 6 must be used to prevent a poor connection of the memory card from occurring by vibration of the machine.                                    |
|                          | (7) In case of the stand–alone type <i>i</i> series that the display unit is a Display link unit, this function can not be used.   |
|                          | (8) The memory card interface on the stand–alone type controller is not available. Please use the memory card interface on the display unit.   |

# 4.10.4



1 : enable.

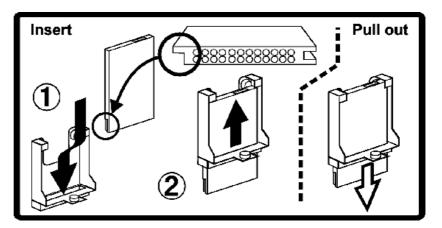
| 4.10.5           | FS16 <i>i</i> -TA | B1F2-04 or later |
|------------------|-------------------|------------------|
| Applied Software | FS18 <i>i</i> –TA | BEF2–04 or later |

## 4.10.6 **Connecting PCMCIA** Card Attachment

#### 4.10.6.1 Specification number

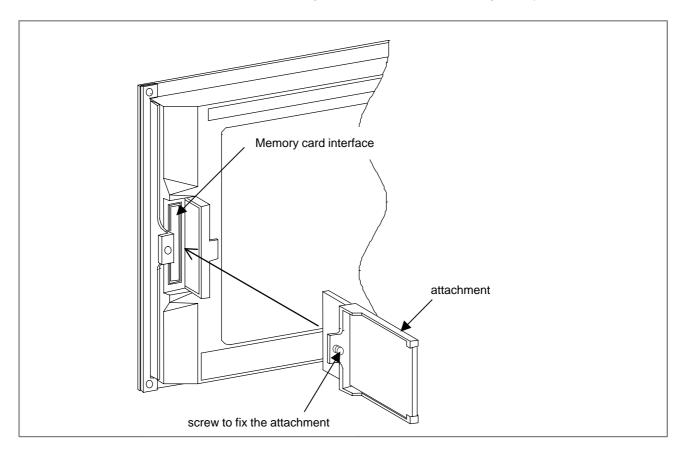
| Specification number   | Specification                    | Remarks                               |
|------------------------|----------------------------------|---------------------------------------|
|                        | A02B-0236-K160                   | For 7.2" LCD or 8.4" LCD              |
|                        | A02B-0236-K161                   | For 9.5" LCD or 10.4" LCD             |
| 4.10.6.2<br>Assembling | screwing together as follow figu | thick. Pay attention for the length o |
|                        |                                  |                                       |
| Attachment guide       |                                  |                                       |

- 2) How to mount the card
  - (a) Insert the card to slit of the attachment. Please pay attention to the direction of the card. (Please mach the direction of ditch on the card.)
  - (b) Push up the card to the upper end of the attachment.



3) Assembling of the attachment

Insert the memory card with the attachment into the memory card interface as following figure. And, fix the attachment guide by screwing the screw of the attachment guide by manual.



 FANUC Series 181-M

 Unit resistant
 OBC01 NC0001

 100.000
 None None

 100.000</

#### 4) Appearance after connection

#### NOTE

- 1 In both case of stand–alone type *i* series and LCD mounted type *i* series, the memory card interface where is the left side of the screen of the display unit. (The memory card interface on the stand–alone type controller is not available.)
- 2 It is impossible to assemble the display unit and the attachment guide from inside of the cabinet.
- 3 The memory card must be used in the condition, as the coolant cannot be poured directly on it.

# 4.10.7 Recommended Memory Card

| Maker              | Туре       | Capacity |
|--------------------|------------|----------|
| Hitachi LTD        | HB289016A4 | 16MB     |
|                    | HB289032A4 | 32MB     |
|                    | HB289160A4 | 160MB    |
| Matushita electric | BN-012AB   | 12MB     |
|                    | BN-020AB   | 20MB     |
|                    | BN-040AB   | 40MB     |
| SanDisk            | SDP3B-4    | 4MB      |
|                    | SDP3B-20   | 20MB     |
|                    | SDP3B-40   | 40MB     |

# 5 TEST OPERATION

The following functions are used to check before actual machining whether the machine operates as specified by the created program.

- 1. Machine Lock and Auxiliary Function Lock
- 2. Feedrate Override
- 3. Rapid Traverse Override
- 4. Dry Run
- 5. Single Block

# 5.1 MACHINE LOCK AND AUXILIARY FUNCTION LOCK

To display the change in the position without moving the tool, use machine lock.

There are two types of machine lock, all-axis machine lock, which stops the movement along all axes, and specified-axis machine lock, which stops the movement along specified axes only. In addition, auxiliary function lock, which disables M, S, and T commands, is available for checking a program together with machine lock.

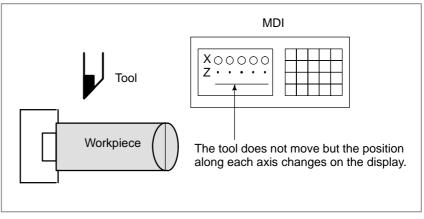


Fig. 5.1 Machine lock

provided by the machine tool builder for auxiliary function lock.

#### **Procedure for Machine Lock and Auxiliary Function Lock**

| • Machine Lock            | Press the machine lock switch on the operator's panel. The tool does not<br>move but the position along each axis changes on the display as if the tool<br>were moving.<br>Some machines have a machine lock switch for each axis. On such<br>machines, press the machine lock switches for the axes along which the<br>tool is to be stopped. Refer to the appropriate manual provided by the<br>machine tool builder for machine lock. |  |
|---------------------------|--|--|
|                           | WARNING<br>The positional relationship between the workpiece<br>coordinates and machine coordinates may differ before and<br>after automatic operation using machine lock. In such a<br>case, specify the workpiece coordinate system by using a<br>coordinate setting command or by performing manual<br>reference position return.   |  |
| • Auxiliary Function Lock | Press the auxiliary function lock switch on the operator's panel. M, S, and T codes are disabled and not executed. Refer to the appropriate manual   |  |

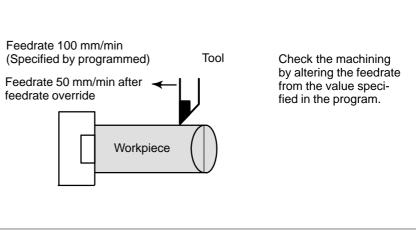
#### Restrictions

- M, S, T command by only M, S, and T commands are executed in the machine lock state. machine lock
- Reference position return under Machine Lock When a G27, G28, or G30 command is issued in the machine lock state, the command is accepted but the tool does not move to the reference position and the reference position return LED does not go on.
- M codes not locked by auxiliary function lock

M00, M01, M02, M30, M98, and M99 commands are executed even in the auxiliary function lock state.

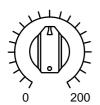
# 5.2 FEEDRATE OVERRIDE

A programmed feedrate can be reduced or increased by a percentage (%) selected by the override dial. This feature is used to check a program. For example, when a feedrate of 100 mm/min is specified in the program, setting the override dial to 50% moves the tool at 50 mm/min.



#### Fig. 5.2 Feedrate override

#### **Procedure for Feedrate Override**



JOG FEED RATE OVERRIDE

#### Restrictions

- Override Range
- Override during thread

Set the feedrate override dial to the desired percentage (%) on the machine operator's panel, before or during automatic operation. On some machines, the same dial is used for the feedrate override dial and manual continuous feedrate dial. Refer to the appropriate manual provided by the machine tool builder for feedrate override.

- The override that can be specified ranges from 0 to 254%. For individual machines, the range depends on the specifications of the machine tool builder.
  - During threading, the override is ignored and the feedrate remains as specified by program.

# 5.3 RAPID TRAVERSE OVERRIDE

An override of four steps (F0, 25%, 50%, and 100%) can be applied to the rapid traverse rate. F0 is set by a parameter (No. 1421).

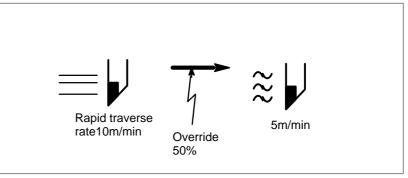
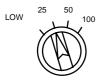


Fig. 5.3 Rapid traverse override

#### **Procedure for Rapid Traverse Override**

Select one of the four feedrates with the rapid traverse override switch during rapid traverse. Refer to the appropriate manual provided by the machine tool builder for rapid traverse override.



Rapid traverse override

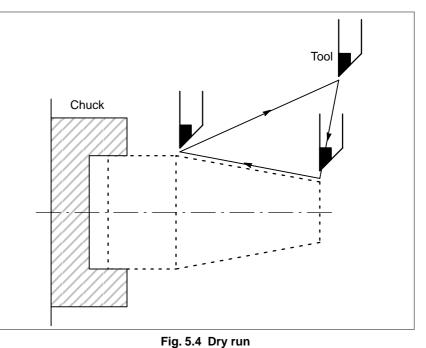
#### Explanation

The following types of rapid traverse are available. Rapid traverse override can be applied for each of them.

- 1) Rapid traverse by G00.
- 2) Rapid traverse during a canned cycle.
- 3) Rapid traverse in G27, G28 and G30.
- 4) Manual rapid traverse.
- 5) Rapid traverse of manual reference position return

# 5.4 DRY RUN

The tool is moved at the feedrate specified by a parameter regardless of the feedrate specified in the program. This function is used for checking the movement of the tool under the state that the workpiece is removed from the table.

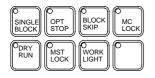


**Procedure for Dry Run** 

Press the dry run switch on the machine operator's panel during automatic operation. The tool moves at the feedrate specified in a parameter. The rapid traverse switch can also be used for changing the feedrate. Refer to the appropriate manual provided by the machine tool builder for dry run.

#### **Explanation**

#### • Dry run feedrate



The dry run feedrate changes as shown in the table below according to the rapid traverse switch and parameters.

| · ·    | Program command                                  |                            |
|--------|--|----------------------------|
| button | Rapid traverse                                   | Feed                       |
| ON     | Rapid traverse rate                              | Dry run feedrate×JVmax *2) |
| OFF    | Dry run speed × JV,or rapid<br>traverse rate *1) | Dry run feedrate × JV      |

Max. cutting feedrateSetting by parameter No. 1422Rapid traverse rateSetting by parameter No. 1420Dry run feedrateSetting by parameter No. 1410

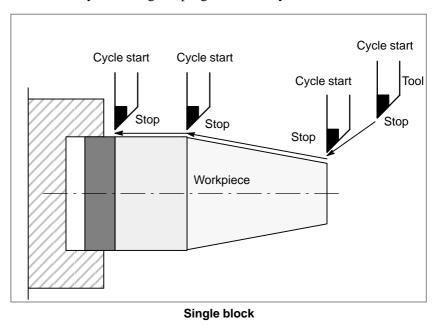
JV: Jog feedrate override

- \*1) Dry run feedrate x JV when parameter RDR (bit 6 of No. 1401) is 1. Rapid traverse rate when parameter RDR is 0.
- \*2) Clamped to the maximum cutting feedrate

JVmax: Maximum value of jog feedrate override

# 5.5 SINGLE BLOCK

Pressing the single block switch starts the single block mode. When the cycle start button is pressed in the single block mode, the tool stops after a single block in the program is executed. Check the program in the single block mode by executing the program block by block.



#### **Procedure for Single Block**

- **1** Press the single block switch on the machine operator's panel. The execution of the program is stopped after the current block is executed.
- 2 Press the cycle start button to execute the next block. The tool stops after the block is executed.

Refer to the appropriate manual provided by the machine tool builder for single block execution.

OPERATION

#### Explanation

 Reference position return and single block If G28 to G30 are issued, the single block function is effective at the intermediate point.

• Single block during a canned cycle

In a canned cycle, the single block stop points are as follows.

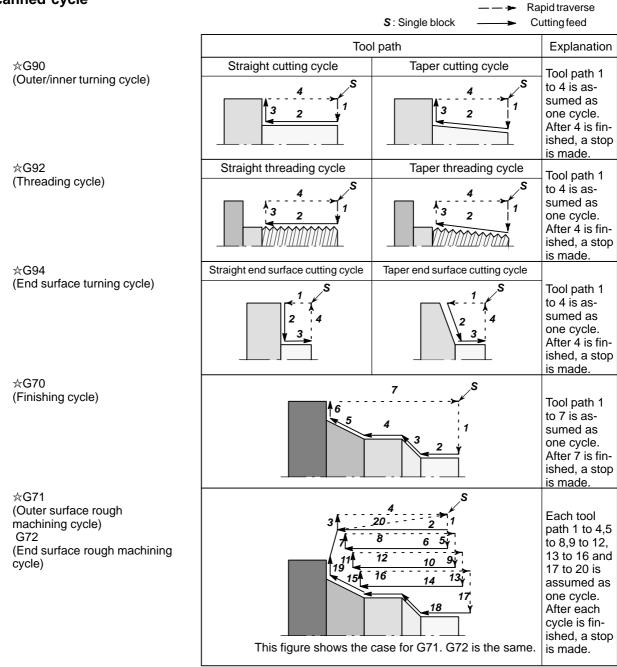
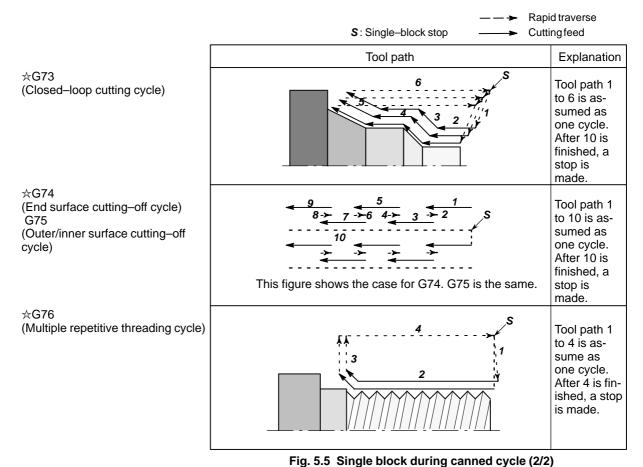


Fig. 5.5 Single block during canned cycle (1/2)

#### 5. TEST OPERATION



• Subprogram call and single block

Single block stop is not performed in a block containing M98P\_;. M99;

or G65. However, single block stop is even performed in a block with M98P\_ or

M99 command, if the block contains an address other than O, N or P.

| Special single-block | Two-path control supports a single-block command signal for each of       |
|----------------------|---|
| control              | tool posts 1 and 2. Single-block stop can thus be specified for the       |
|                      | automatic operation program for each tool post. Note, however, that when  |
|                      | the single–block command signals for both tool posts 1 and 2 are turned   |
|                      | on, the tools may stop at different positions according to the command    |
|                      | programs.   |
|                      | The special single-block control function eliminates such a difference by |
|                      | analyzing food hold to a tool most when the other tool most enter         |

applying feed hold to a tool post when the other tool post enters single–block stop mode.

The special single–block control function is enabled when bit 6 (DSB) of parameter No. 8100 is set to 1.

The single–block command signals for tool posts 1 and 2 are effective even when the special single–block control function is used.

When tool post 1 or 2 is placed in the single–block mask state or feed–hold mask state by a threading or custom macro program, the tool is not stopped until the mask state is terminated.

The tool posts are not synchronized. Therefore, if the following programs are executed, feed hold is applied to tool post 2 upon the completion of X10.0 for tool post 1, but the tool of tool post 2 is not stopped exactly at X10.0.

 Tool post 1
 Tool post 2

 O0001 ;
 O0002 ;

 G50 X0 ;
 G50 X0 ;

 G01 X10. F100 ;
 G01 X20. F100 ;

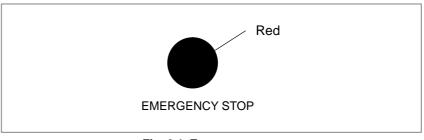
 G01 X20. ;
 G01 X20. F100 ;

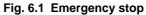
6 SAFETY FUNCTIONS

To immediately stop the machine for safety, press the Emergency stop button. To prevent the tool from exceeding the stroke ends, Overtravel check and Stroke check are available. This chapter describes emergency stop, overtravel check, and stroke check.

# 6.1 EMERGENCY STOP

If you press Emergency Stop button on the machine operator's panel, the machine movement stops in a moment.





This button is locked when it is pressed. Although it varies with the machine tool builder, the button can usually be unlocked by twisting it.

**Explanation** 

EMERGENCY STOP interrupts the current to the motor. Causes of trouble must be removed before the button is released.

# 6.2 OVERTRAVEL

When the tool tries to move beyond the stroke end set by the machine tool limit switch, the tool decelerates and stops because of working the limit switch and an OVER TRAVEL is displayed.

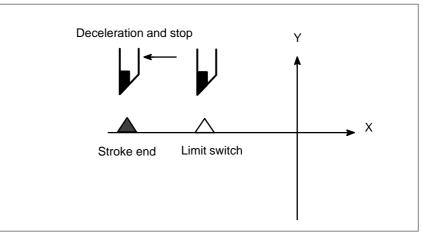


Fig. 6.2 Overtravel

#### **Explanation**

- Overtravel during automatic operation
- Overtravel during manual operation
- Releasing overtravel
- Alarm

When the tool touches a limit switch along an axis during automatic operation, the tool is decelerated and stopped along all axes and an overtravel alarm is displayed.

In manual operation, the tool is decelerated and stopped only along the axis for which the tool has touched a limit switch. The tool still moves along the other axes.

Press the reset button to reset the alarm after moving the tool to the safety direction by manual operation. For details on operation, refer to the operator's manual of the machine tool builder.

| No. | Message        | Description  |
|-----|----------------|--|
| 506 | Overtravel: +n | The tool has exceeded the hardware–spe-<br>cified overtravel limit along the positive nth<br>axis (n: 1 to 8). |
| 507 | Overtravel: –n | The tool has exceeded the hardware–spe-<br>cified overtravel limit along the negative nth<br>axis (n: 1 to 8). |

# 6.3 STORED STROKE CHECK

There areas which the tool cannot enter can be specified with stored stroke check 1, stored stroke check 2, and stored stroke check 3.

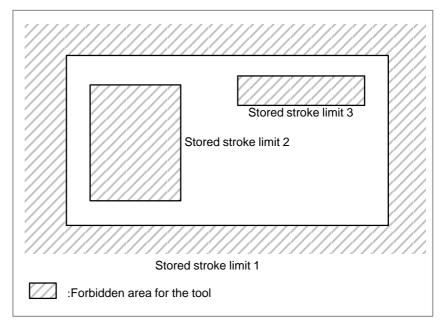


Fig. 6.3 (a) Stroke check

When the tool exceeds a stored stroke limit, an alarm is displayed and the tool is decelerated and stopped.

When the tool enters a forbidden area and an alarm is generated, the tool can be moved in the reverse direction from which the tool came.

#### Explanation

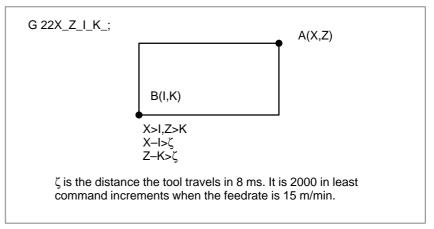
- Stored stroke check 1
- Stored stroke check 2 (G22, G23)

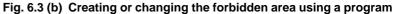
Parameters (Nos. 1320, 1321 or Nos. 1326, 1327) set boundary. Outside the area of the set limits is a forbidden area. The machine tool builder usually sets this area as the maximum stroke.

Parameters (Nos. 1322, 1323) or commands set these boundaries. Inside or outside the area of the limit can be set as the forbidden area. Parameter OUT (No. 1300#0) selects either inside or outside as the forbidden area.

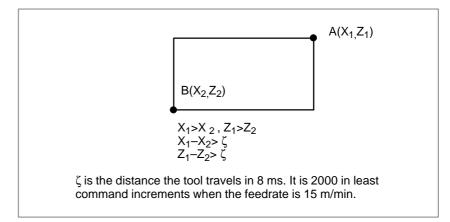
In case of program command a G22 command forbids the tool to enter the forbidden area, and a G23 command permits the tool to enter the forbidden area. Each of G22; and G23; should be commanded independently of another commands in a block.

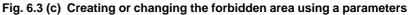
The command below creates or changes the forbidden area:





When setting the area by parameters, points A and B in the figure below must be set.





In stored stroke check 2, even if you mistake the order of the coordinate value of the two points, a rectangular, with the two points being the apexes, will be set as the area.

When you set the forbidden area  $X_1$ ,  $Z_1$ ,  $X_2$ , and  $Z_2$  through parameters (Nos. 1322, 1323), the data should be specified by the distance from the reference position in the least command increment. (Output increment)

If set the forbidden area XZIK by a G22 command, specify the data by the distance from the reference position in the least input increment (Input increment.) The programmed data are then converted into the numerical values in the least command increment, and the values are set as the parameters.

• Stored stroke check 3

Set the boundary with parameters No. 1324 and 1325. The area inside the boundary becomes the forbidden area.

OPERATION

The parameter setting or programmed value (XZIK) depends on which part of the tool or tool holder is checked for entering the forbidden area. Confirm the checking position (the top of the tool or the tool chuck) before programming the forbidden area.

If point C (The top of the tool) is checked in Fig. 6.3 (d), the distance "c" should be set as the data for the stored stroke limit function. If point D (The tool chuck) is checked, the distance "d" must be set.

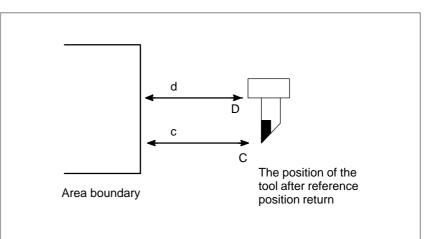


Fig. 6.3 (d) Setting the forbidden area

Area can be set in piles.

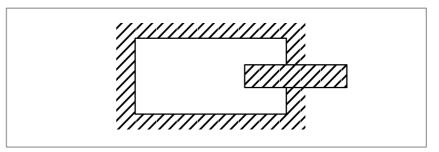


Fig. 6.3 (e) Setting the forbidden area over lapping

Unnecessary limits should be set beyond the machine stroke.

Each limit becomes effective after the power is turned on and manual reference position return or automatic reference position return by G28 has been performed.

After the power is turned on, if the reference position is in the forbidden area of each limit, an alarm is generated immediately. (Only in G22 mode for stored stroke limit 2).

When the tool has become unmovable in the forbidden area, push the emergency stop button to release the forbidden condition and move the tool out of the forbidden area in the G23 mode; then, if the setting is wrong, correct it and perform the reference position return again.

• Change from G23 to G22 in a forbidden area

Releasing the alarms

When G23 is switched to G22 in the forbidden area, the following results.

- (1) When the forbidden area is inside, an alarm is informed in the next move.
- (2) When the forbidden area is outside, an alarm is informed immediately.

#### Forbidden area overlapping

• Effective time for a

forbidden area

| <ul> <li>Setting the forbidden<br/>area for the two-path<br/>control</li> </ul> | For the two–path control, set a forbidden area for each tool post.   |   |                                       |
|---|--|---|---------------------------------------|
|   | same,<br>(1)Wh<br>are<br>(2)Wh   | the area is as<br>nen the forbidde<br>as are forbidde<br>nen the forbidde | en area is stored stroke check 1, all |
| <ul> <li>Overrun amount of<br/>stored stroke limit</li> </ul>                   | If the maximum rapid traverse rate is F (mm/min), the maximum overrun<br>amount, L (mm), of the stored stroke limit is obtained from the following<br>expression:<br>L (mm) = F/7500<br>The tool enters the specified inhibited area by up to L (mm). Bit 7 (BFA)<br>of parameter No. 1300 can be used to stop the tool when it reaches a point<br>L mm short of the specified area. In the case, the tool will not enter the<br>inhibited area. |   |                                       |
| <ul> <li>Timing for displaying<br/>an alarm</li> </ul>                          | Parameter BFA (bit 7 of No. 1300) selects whether an alarm is displayed immediately before the tool enters the forbidden area or immediately after the tool has entered the forbidden area.  |   |                                       |
| ALram   |  |   |                                       |
|   | Number   | Message   | Contents                              |

| Number | Message            | Contents   |
|--------|--------------------|--|
| 500    | OVER TRAVEL:<br>+n | Exceeded the n-th axis (1-8) + side stored stroke limit 1.   |
| 501    | OVER TRAVEL:<br>-n | Exceeded the n-th axis $(1-8)$ - side stored stroke limit 1. |
| 502    | OVER TRAVEL:<br>+n | Exceeded the n-th axis (1-8) + side stored stroke limit 2.   |
| 503    | OVER TRAVEL:<br>-n | Exceeded the n-th axis $(1-8)$ - side stored stroke limit 2. |
| 504    | OVER TRAVEL:<br>+n | Exceeded the n-th axis (1-8) + side stored stroke limit 3.   |
| 505    | OVER TRAVEL:<br>-n | Exceeded the n-th axis (1-8) - side stored stroke limit 3.   |

# 6.4 CHUCK AND TAILSTOCK BARRIERS

The chuck–tailstock barrier function prevents damage to the machine by checking whether the tool tip fouls either the chuck or tailstock. Specify an area into which the tool may not enter (entry–inhibition area).

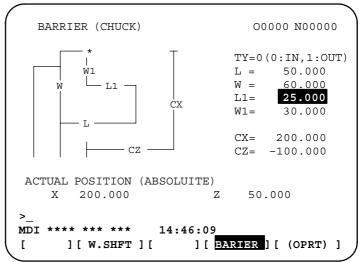
This is done using the special setting screen, according to the shapes of the chuck and tailstock. If the tool tip should enter the set area during a machining operation, this function stops the tool and outputs an alarm message.

The tool can be cleared from the area only by retracting it in the direction opposite to that in which the tool entered the area.

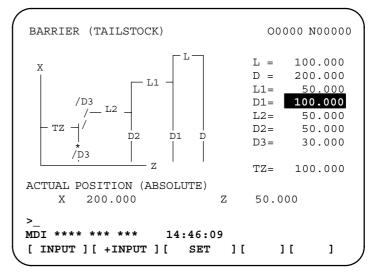
#### Setting the chuck and tailstock barriers

- Setting the shapes of the chuck and tailstock
- **1** Press the OFFSET function key.
- 2 Press the  $\bigcirc$  continuous menu key. Then, press the **[BARIER]** chapter selection soft key.
- **3** Pressing the page key toggles the display between the chuck barrier setting screen and tailstock barrier setting screen.

#### Chuck barrier setting screen



Tailstock barrier setting screen



4 Position the cursor to each item defining the shape of the chuck or tailstock, enter the corresponding value, then press the [INPUT] soft key. The value is set. Pressing the [+INPUT] soft key after a value has been entered adds the entered value to the current value, the new setting being the sum of the two values.

Items CX and CZ, both on the chuck barrier setting screen, and item TZ on the tailstock barrier setting screen can also be set in another way. Manually move the tool to the desired position, then press the **[SET]** soft key to set the coordinate(s) of the tool in the workpiece coordinate system. If a tool having an offset other than 0 is manually moved to the desired position with no compensation applied, compensate for the tool offset in the set coordinate system.

Items other than CX, CZ, and TZ cannot be set by using the **[SET]** soft key.

Example)

When the tool tip enters the entry–inhibition area during machining, the function stops the movement of the tool and displays an alarm message. Since the machine system can stop only a slight delay after the CNC stops, the tool will actually stop moving at a point within the specified boundary. For safety, therefore, set an area a little larger than the determined area. The distance between the boundaries of these two areas, L, is calculated from the following equation, based on the rapid traverse rate.

 $L = (Rapid traverse Rate) \times \frac{1}{7500}$ 

When the rapid traverse rate is 15 m/min, for example, set an area having a boundary 2 mm outside that of the determined area.

The shapes of the chuck and tailstock can be set using parameters No. 1330 to 1345.

#### CAUTION

Set G23 mode before attempting to specify the shapes of the chuck and tailstock.

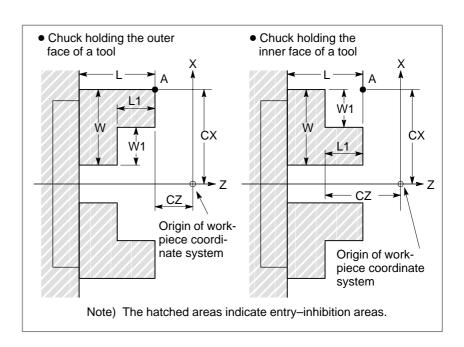
| B-63004EN/02                                      | OPERATION   | 6. SAFETY FUNCTIONS  |
|---|---|--|
| <ul> <li>Reference position<br/>return</li> </ul> | The chuck-tailstock barrier fur<br>reference position return has bee<br>When an absolute position dete<br>return need not always be perfe   | position along the X– and Z–axes.<br>action becomes effective only once<br>en completed after power on.<br>ector is provided, reference position<br>ormed. The positional relationship<br>absolute position detector, however, |
| • G22, G23  | on) makes the entry-inhibition<br>effective. Specifying G23 (st<br>function.<br>Even if G22 is specified, the entry<br>be disabled by issuing a tailstoc<br>When the tailstock is pushed up a | against a workpiece or separated from<br>ellaneous functions, PMC signals are  |

| G code | Tailstock barrier<br>signal | Chuck barrier | Tailstock barrier |
|--------|-----------------------------|---------------|-------------------|
| G22    | 0                           | Effective     | Effective         |
| 622    | 1                           | Effective     | Ineffective       |
| G23    | No relation                 | Ineffective   | Ineffective       |

G22 is usually selected when the power is turned on. Using G23, bit 7 of parameter No. 3402, however, it can be changed to G23.

## Explanations

• Setting the shape of the chuck barrier



| Symbol | Description   |
|--------|---|
| TY     | Chuck-shapeselection (0: Holding the inner face of a tool, 1: Holding the outer face of a tool) |
| сх     | Chuck position (along X-axis)   |
| CZ     | Chuck position (along Z-axis)   |
| L      | Length of chuck jaws  |
| w      | Depth of chuck jaws (radius)  |
| L1     | Holding length of chuck jaws  |
| W1     | Holding depth of chuck jaws (radius)  |

TY:

Selects a chuck type, based on its shape. Specifying 0 selects a chuck that holds the inner face of a tool. Specifying 1 selects a chuck that holds the outer face of a tool. A chuck is assumed to be symmetrical about its Z–axis.

CX, CZ:

Specify the coordinates of a chuck position, point A, in the workpiece coordinate system. These coordinates are not the same as those in the machine coordinate system. Table 6.4 (a) lists the units used to specify the data.

#### WARNING

Whether diameter programming or radius programming is used for the axis determines the programming system. When diameter programming is used for the axis, use diameter programming to enter data for the axis.

Table 6.4 (a) Units

| Increment    | Data unit   |              | Valid data rango        |
|--------------|-------------|--------------|-------------------------|
| system       | IS–A        | IS-B         | Valid data range        |
| Metric input | 0.001 mm    | 0.0001 mm    | -999999999 to +99999999 |
| Inch input   | 0.0001 inch | 0.00001 inch | -999999999 to +99999999 |

L, L1, W, W1:

Define the shape of a chuck. Table 6.4 (b) lists the units used to specify the data.

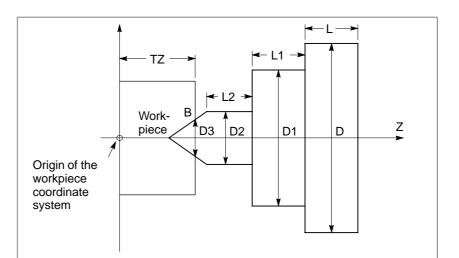
#### WARNING

Always specify W and W1 in radius. When radius programming is used for the Z-axis, specify L and L1 in radius.

| Increment    | Data unit   |              | Valid data range        |  |  |
|--------------|-------------|--------------|-------------------------|--|--|
| system       | IS-A        | IS-B         | Valid data range        |  |  |
| Metric input | 0.001 mm    | 0.0001 mm    | -999999999 to +99999999 |  |  |
| Inch input   | 0.0001 inch | 0.00001 inch | -999999999 to +99999999 |  |  |

#### Table 6.4 (b) Units

# • Setting the shape of a tailstock barrier



| Symbol | Description                           |  |
|--------|---------------------------------------|--|
| ΤZ     | Tailstock position (along the Z-axis) |  |
| L      | Tailstock length                      |  |
| D      | Tailstock diameter                    |  |
| L1     | Tailstock length (1)                  |  |
| D1     | Tailstock diameter (1)                |  |
| L2     | Tailstock length (2)                  |  |
| D2     | Tailstock diameter (2)                |  |
| D3     | Tailstock diameter (3)                |  |

TZ:

Specifies the Z coordinate of the chuck position, point B, in the workpiece coordinate system. These coordinates are not the same as those in the machine coordinate system. Table 6.4 (c) lists the units used to specify the data. A tailstock is assumed to be symmetrical about its Z-axis.

#### WARNING

Whether diameter programming or radius programming is used for the Z-axis determines the programming system.

| Table 6.4 (c) Units |             |              |                         |  |  |
|---------------------|-------------|--------------|-------------------------|--|--|
| Increment           | Data unit   |              | Valid data yanga        |  |  |
| system              | IS–A        | IS–B         | Valid data range        |  |  |
| Metric input        | 0.001 mm    | 0.0001 mm    | -999999999 to +99999999 |  |  |
| Inch input          | 0.0001 inch | 0.00001 inch | -999999999 to +99999999 |  |  |

L, L1, L2, D, D1, D2, D3:

Define the shape of a tailstock. Table 6.4 (d) lists the units used to specify the data.

#### WARNING

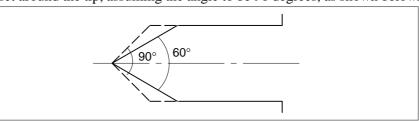
Always specify D, D1, D2, and D3 in diameter programming. When radius programming is used for the Z-axis, specify L, L1, and L2 in radius.

#### 6. SAFETY FUNCTIONS

| Increment    | Data unit   |              | Volid data rango        |
|--------------|-------------|--------------|-------------------------|
| system       | IS–A        | IS-B         | Valid data range        |
| Metric input | 0.001 mm    | 0.0001 mm    | -999999999 to +99999999 |
| Inch input   | 0.0001 inch | 0.00001 inch | -999999999 to +99999999 |

Table 6.4 (d) Units

The tip angle of the tailstock is 60 degrees. The entry–inhibition area is set around the tip, assuming the angle to be 90 degrees, as shown below.



#### Setting the entry–inhibition area for the tailstock tip

#### Limitations

- Correct setting of an entry–inhibition area
- Retraction from the entry–inhibition area

If an entry–inhibition area is incorrectly set, it may not be possible to make the area effective. Avoid making the following settings:

- L < L1 or W < W1 in the chuck-shape settings.
- D2 < D3 in the tailstock–shape settings.
- A chuck setting overlapping that of the tailstock.

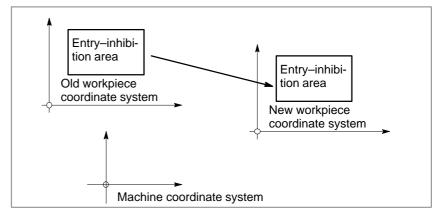
If the tool enters the entry–inhibition area and an alarm is issued, switch to manual mode, retract the tool manually, then reset the system to release the alarm. In manual mode, the tool can be moved only in the opposite direction to that in which the tool entered the area. The tool cannot be moved in the same direction (further into the area) as it was travelling when the tool entered the area.

When the entry–inhibition areas for the chuck and tailstock are enabled, and the tool is already positioned within those areas, an alarm is issued when the tool moves. When the tool cannot be retracted, change the setting of the entry–inhibition areas, such that the tool is outside the areas, reset the system to release the alarm, then retract the tool. Finally, reinstall the original settings.

#### Coordinate system

An entry-inhibition area is defined using the workpiece coordinate system. Note the following.

1 When the workpiece coordinate system is shifted by means of a command or operation, the entry–inhibition area is also shifted by the same amount.



Use of the following commands and operations will shift the workpiece coordinate system.

#### Commands:

G54 to G59, G52, G50 (G92 in G code system B or C)

**Operations:** 

Manual handle interrupt, change in offset relative to the workpiece reference point, change in tool offset (tool geometry compensation), operation with machine lock, manual operation with machine absolute signal off

- 2 When the tool enters an entry–inhibition area during automatic operation, set the manual absolute signal, \*ABSM, to 0 (on), then manually retract the tool from the area. If this signal is 1, the distance the tool moves in manual operation is not counted in the tool coordinates in the workpiece coordinate system. This results in the state where the tool can never be retracted from the entry–inhibition area.
- When both stored stroke limit 2 and the chuck–tailstock barrier function are provided, the barrier takes priority over the stroke limit. Stored stroke limit 2 is ignored.

| Number | Message         | Contents  |
|--------|-----------------|---|
| 502    | OVER TRAVEL: +X | The tool has entered the entry–inhibition area during positive–direction movement along the X–axis. |
|        | OVER TRAVEL: +Z | The tool has entered the entry–inhibition area during positive–direction movement along the Z–axis. |
| 503    | OVER TRAVEL: -X | The tool has entered the entry–inhibition area during negative–direction movement along the X–axis. |
|        | OVER TRAVEL: -Z | The tool has entered the entry–inhibition area during negative–direction movement along the Z–axis. |

#### Stored stroke limit 2

#### Alarms

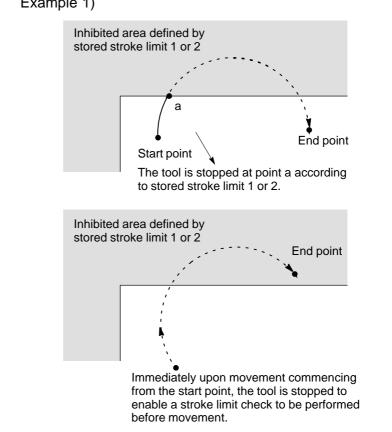
# 6.5 **STROKE LIMIT CHECK PRIOR TO** PERFORMING MOVEMENT

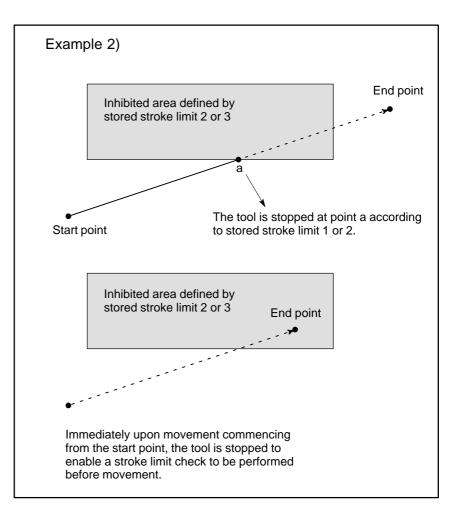
During automatic operation, before the movement specified by a given block is started, whether the tool enters the inhibited area defined by stored stroke limit 1, 2, or 3 is checked by determining the position of the end point from the current position of the machine and a specified amount of travel. If the tool is found to enter the inhibited area defined by a stored stroke limit, the tool is stopped immediately upon the start of movement for that block, and an alarm is displayed.

#### WARNING

Whether the coordinates of the end point, reached as a result of traversing the distance specified in each block, are in a inhibited area is checked. In this case, the path followed by a move command is not checked. However, if the tool enters the inhibited area defined by stored stroke limit 1, 2, or 3, an alarm is issued. (See the examples below.)







When a stroke limit check prior to movement is performed, whether to check the movement performed by a G31 (skip) block and G37 (automatic tool length measurement) block can be determined using NPC (bit 2 of parameter No. 1301).

#### Limitations

**Explanations** 

- Machine lock
- G23
- Program restart
- Manual intervention following a feed hold stop
- A block consisting of multiple operations

If machine lock is applied at the start of movement, no stroke limit check made before movement is performed.

When stored stroke limit 2 is disabled (G23 mode), no check is made to determine whether the tool enters the inhibited area defined by stored stroke limit 2.

When a program is restarted, an alarm is issued if the restart position is within a inhibited area.

When the execution of a block is restarted after manual intervention following a feed hold stop, no alarm is issued even if the end point after manual intervention is within a inhibited area.

If a block consisting of multiple operations (such as a canned cycle and exponential interpolation) is executed, an alarm is issued at the start point of any operation whose end point falls within a inhibited area.

| 6. SAFETY FUNCTIONS   | OPERATION  | B-63004EN/0       |
|---|--|-------------------|
| <ul> <li>Cyrindrical interpolation<br/>mode</li> </ul>      | In cylindrical interpolation mode, no check is made.                     |                   |
| <ul> <li>Polar coordinate<br/>interpolation mode</li> </ul> | In polar coordinate interpolation mode, no check is r                    | nade.             |
| <ul> <li>Slanted axis control</li> </ul>                    | When the slanted axis control option is selected, no                     | check is made.    |
| <ul> <li>Simple synchronous<br/>control</li> </ul>          | In simple synchronous control, only the master axis i axes are checked.  | s checked; no sla |
| • Drawing   | During drawing (while only drawing (no machining) i no check is made.    | s being performed |
| • PMC axis control  | No check is made for a movement based on PMC as                          | tis control.      |
| Chuck/tailstock barrier                                     | No check is made for a chuck/tailstock barrier area (                    | lathe system).    |
| <ul> <li>Synchronous mixed<br/>mode</li> </ul>              | No check is made for an axis placed in synchro (two-path lathe control). | nous mixed mo     |

# Alarm

| Number | Message             | Contents  |
|--------|---------------------|---|
| 506    | OVER TRAVEL :<br>+n | The pre-movement stroke limit check reveals<br>that the block end point enters the prohibited<br>area for the positive stroke limit along the n<br>axis. Correct the program. |
| 507    | OVER TRAVEL :<br>-n | The pre-movement stroke limit check reveals that the block end point enters the prohibited area for the negative stroke limit along the n axis. Correct the program.          |

# ALARM AND SELF-DIAGNOSIS FUNCTIONS

When an alarm occurs, the corresponding alarm screen appears to indicate the cause of the alarm. The causes of alarms are classified by error codes. Up to 25 previous alarms can be stored and displayed on the screen (alarm history display).

The system may sometimes seem to be at a halt, although no alarm is displayed. In this case, the system may be performing some processing. The state of the system can be checked using the self-diagnostic function.

# 7.1 ALARM DISPLAY

### **Explanations**

• Alarm screen

When an alarm occurs, the alarm screen appears.

| ALARM ME | SSAGE                | 0000         | 00000   |
|----------|----------------------|--------------|---------|
| 100      | PARAMETER WRITE ENAE | BLE          |         |
| 510      | OVER TRAVEL :+X      |              |         |
| 520      | OVER TRAVEL :+2      |              |         |
| 530      | OVER TRAVEL :+3      |              |         |
|          |                      |              |         |
| MDI **   | *** *** *** ALM 18:5 | S<br>52 · 05 | 0 T0000 |
|          |                      | )(           | )       |

• Another method for alarm displays

In some cases, the alarm screen does not appear, but an ALM is displayed at the bottom of the screen.

| PARAMETER (RS232C INTERFACE) O1000 N00010 |                |      |         |     |               |      |         |          |
|---|----------------|------|---------|-----|---------------|------|---------|----------|
| 0100                                      | ENS            |      |         |     | NCR           |      | CTV     |          |
| 0101                                      | 0<br>NFD       | 0    | 0       | 0   | 0<br>ASI      | 0    | 0       | 0<br>SB2 |
| 0.0.                                      | 0              | 0    | 0       | 0   | 0             | 0    | 0       | 1        |
|   | DEVIC<br>BAUD  |      |         | )   |               |      |         | 2<br>10  |
| 0103                                      | NFD            | NAIE | (0110)  |     | ASI           |      |         | SB2      |
| 0440                                      | 0              | 0    | 0       | 0   | 0             | 0    | 0       | 0        |
|   | DEVIC<br>BAUDI |      | · · ·   | )   |               |      |         | 0        |
| >   |                |      |         |     |               | S    | 0       | T0000    |
| ME  | M ***          | * ** | * * * * | ALN | <b>1</b> 08 : | 41:2 |         | 10000    |
| (NC                                       | o.srh)         | ( ON | :1 ) (  | OFF | :0 ) (+IN     | IPUT | ) ( INP | υт)      |

In this case, display the alarm screen as follows:

- **1** Press the function key MESSAGE .
- 2 Press the chapter selection soft key [ALARM].

| B-63004EN/02                           | 7. ALARM AND SELF–DIAGNOSIS<br>OPERATION FUNCTIONS   |
|--|--|
| <ul> <li>Reset of the alarm</li> </ul> | Error codes and messages indicate the cause of an alarm. To recover from an alarm, eliminate the cause and press the reset key.  |
| • Error codes                          | The error codes are classified as follows:<br>No. 000 to 255: P/S alarms (Program errors)* <sup>1</sup><br>No. 300 to 349: Absolute pulse coder (APC) alarms<br>No. 350 and 399: Serial pulse coder (SPC) alarms<br>No. 400 to 499: Servo alarms<br>No. 500 to 599: Overtravel alarms<br>No. 700 to 749: Overheat alarms<br>No. 750 to 799: Spindle alarms<br>No. 900 to 999: System alarms<br>No. 5000 to : P/S alarms (Program errors) |
|  | *1:For an alarm (No. 000 to 232) that occurs in association with background operation, the indication "xxxBP/S alarm" is provided (where xxx is an alarm number). Only a BP/S alarm is provided for No. 140.   |

See the error code list in the appendix for details of the error codes.

# 7.2 ALARM HISTORY DISPLAY

Up to 25 of the most recent CNC alarms are stored and displayed on the screen.

Display the alarm history as follows:

#### **Procedure for Alarm History Display**

- **1** Press the function key
- 2 Press the chapter selection soft key [HISTRY]. The alarm history appears. The following information items are displayed.
  (1)The date the alarm was issued
  (2)Alarm No.
  (3)Alarm message (some contains no message)
  (4)Page number
- 3 Change the page by page key  $\bigcap_{PAGE}$  or  $\bigcup_{PAGE}$ .
- 4 To delete the recorded information, press the softkey [(OPRT)] then the [DELETE] key.

| /  | \<br>\       |
|--|--------------|
| ALARM HISTORY  | O0100 N00001 |
| (1) <u>94.02.14 16:43:48</u>                             | PAGE=1       |
| (2)010 (3)MPROPER G-CODE                                 | (4)          |
| 94.02.13 8:22:21   |              |
| 506 OVER TRAVEL : +X                                     |              |
| 94.02.12 20:15:43<br>417 SERVO ALARM : X AXIS DGTL PARAM | I            |
|  |              |
|  |              |
|  |              |
|  |              |
|  |              |
| MEM **** *** *** 19:47                                   | : 45         |
|  |              |
|  |              |

# 7.3 **CHECKING BY** SELF-DIAGNOSTIC SCREEN

The system may sometimes seem to be at a halt, although no alarm has occurred. In this case, the system may be performing some processing. The state of the system can be checked by displaying the self-diagnostic screen.

#### **Procedure for Diagnostic**

- **1** Press the function key SYSTEM .
- 2 Press the chapter select key [DGNOS].
- 3 The diagnostic screen has more than 1 pages. Select the screen by the following operation.
  - (1) Change the page by page key  $\begin{bmatrix} \uparrow \\ I \end{bmatrix}$  or  $\begin{bmatrix} PAGE \\ I \end{bmatrix}$



- (2) Method by soft key
  - Key input the number of the diagnostic data to be displayed.
  - Press [N SRCH].

| DIAGNOSTIC (GENERAL)  | O0000 N00000                           |
|---|--|
| 000 WAITING FOR FIN SIGNAL<br>001 MOTION<br>002 DWELL<br>003 IN–POSITION CHECK<br>004 FEEDRATE OVERRIDE 0%<br>005 INTERLOCK/START–LOCK<br>006 SPINDLE SPEED ARRIVAL CHECK | :0<br>:0<br>:0<br>:0<br>:0<br>:0<br>:0 |
| )_<br>EDIT **** *** *** 14:51<br>(PARAM)(DGNOS)(PMC)(SYST   |  |

#### **Explanations**

• Self diagnostic screen at 2-path control

For the two-path control, the diagnostic screen for the tool post selected with the tool post selection switch is displayed. When displaying the diagnostic screen for the other tool post, specify the tool post with the tool post selection switch.

# **Explanations**

Diagnostic numbers 000 to 015 indicate states when a command is being specified but appears as if it were not being executed. The table below lists the internal states when 1 is displayed at the right end of each line on the screen.

| No. | Display                           | Internal status when 1 is displayed  |
|-----|-----------------------------------|--|
| 000 | WAITING FOR FIN SIGNAL            | M, S. T function being executed  |
| 001 | MOTION                            | Move command in automatic operation being executed   |
| 002 | DWELL                             | Dwell being executed   |
| 003 | IN-POSITION CHECK                 | In-position check being executed   |
| 004 | FEEDRATE OVERRIDE 0%              | Cutting feed override 0%   |
| 005 | INTERLOCK/START-LOCK              | Interlock ON   |
| 006 | SPINDLE SPEED ARRIVAL CHECK       | Waiting for spindle speed arrival signal to turn on  |
| 010 | PUNCHING                          | Data being output via reader puncher interface   |
| 011 | READING                           | Data being input via reader puncher interface  |
| 012 | WAITING FOR (UN) CLAMP            | Waiting for index table clamp/unclamp before B axis index table indexing start/after B axis index table indexing end to complete |
| 013 | JOG FEEDRATE OVERRIDE 0%          | Jog override 0%  |
| 014 | WAITING FOR RESET.ESP.RRW.OFF     | Emergency stop, external reset, reset & rewind, or MDI panel reset key on  |
| 015 | EXTERNAL PROGRAM<br>NUMBER SEARCH | External program number searching  |

Diagnostic numbers 020 to 025 indicate the states when automatic operation is stopped or paused.

| Table 7.3 (b) Alarn | n displays when | an automatic | operation is | stopped or paused |
|---------------------|-----------------|--------------|--------------|-------------------|
|---------------------|-----------------|--------------|--------------|-------------------|

| No. | Display              | Internal status when 1 is displayed   |
|-----|----------------------|---|
| 020 | CUT SPEED UP/DOWN    | Set when emergency stop turns on or when servo alarm occurs   |
| 021 | RESET BUTTON ON      | Set when reset key turns on   |
| 022 | RESET AND REWIND ON  | Reset and rewind turned on  |
| 023 | EMERGENCY STOP ON    | Set when emergency stop turns on  |
| 024 | RESET ON             | Set when external reset, emergency stop, reset, or reset & rewind key turns on  |
| 025 | STOP MOTION OR DWELL | <ul> <li>A flag which stops pulse distribution. It is set in the following cases.</li> <li>(1)External reset turned on.</li> <li>(2)Reset &amp; rewind turned on.</li> <li>(3)Emergency stop turned on.</li> <li>(4)Feed hold turned on.</li> <li>(5)The MDI panel reset key turned on.</li> <li>(6)Switched to the manual mode(JOG/HANDLE/INC).</li> <li>(7)Other alarm occurred. (There is also alarm which is not set.)</li> </ul> |

The table below shows the signals and states which are enabled when each diagnostic data item is 1. Each combination of the values of the diagnostic data indicates a unique state.

| 020   | CUT SPEED UP/DOWN    | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
|---|----------------------|---|---|---|---|---|---|---|
| 021   | RESET BUTTON ON      | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 022   | RESET AND REWIND ON  | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 023   | EMERGENCY STOP ON    | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 024   | RESET ON             | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| 025   | STOP MOTION OR DWELL | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| Emergency stop signal input<br>External reset signal input<br>MDI reset button turned on<br>Reset & rewind input<br>Servo alarm generation<br>Changed to another mode or feed hold<br>Single block stop |                      |   |   |   |   |   |   |   |

Diagnostic numbers 030 and 031 indicate TH alarm states.

| No. | Display                     | Meaning of data   |
|-----|-----------------------------|---|
| 030 | CHARACTER NUMBER<br>TH DATA | The position of the character which caused<br>TH alarm is displayed by the number of<br>characters from the beginning of the block<br>at TH alarm |
| 031 | TH DATA                     | Read code of character which caused TH alarm  |



# DATA INPUT/OUTPUT

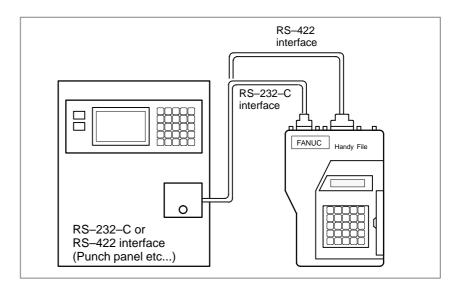
NC data is transferred between the CNC and external input/output devices such as the Handy File.

The following types of data can be entered and output :

- 1. Program
- 2. Offset data
- 3. Parameter
- 4. Pitch error compensation data
- 5. Custom macro common variable

Before an input/output device can be used, the input/output related parameters must be set.

For how to set parameters, see Chapter III–2.



| 8.1<br>FILES   | Of the external input/output devices, the FANUC Handy File use floppy<br>disks as their input/output medium.<br>In this manual, an input/output medium is generally referred to as a<br>floppy.<br>Unlike an NC tape, a floppy allows the user to freely choose from several<br>types of data stored on one medium on a file–by–file basis.<br>Input/output is possible with data extending over more than one floppy<br>disk.                          |
|--|---|
| Explanations   |   |
| • What is a File                                       | The unit of data, which is input/output between the floppy and the CNC by one input/output operation (pressing the VREADW or VPUNCHW key), is called a HfileI. When inputting CNC programs from, or outputting them to the floppy, for example, one or all programs within the CNC memory are handled as one file.<br>Files are assigned automatically file numbers 1, 2, 3, 4 and so on, with the lead file as 1.<br>File 1 File 2 File 3 File n Blank |
| <ul> <li>Request for floppy<br/>replacement</li> </ul> | When one file has been entered over two floppies, LEDs on the adaptor<br>flash alternately on completion of data input/output between the first<br>floppy and the CNC, prompting floppy replacement. In this case, take the<br>first floppy out of the adaptor and insert a second floppy in its place. Then,<br>data input/output will continue automatically.<br>Floppy replacement is prompted when the second floppy and later is                   |

Floppy replacement is prompted when the second floppy and later is required during file search–out, data input/output between the CNC and the floppy, or file deletion.

Floppy 1

| File 1 | File 2 | File 3 |  | File (k–1) | File k |  |
|--------|--------|--------|--|------------|--------|--|
|--------|--------|--------|--|------------|--------|--|

Floppy 2

|  | Continua-<br>tion of file k | File (k+1) |  | File n | Blank |
|--|-----------------------------|------------|--|--------|-------|
|--|-----------------------------|------------|--|--------|-------|

Since floppy replacement is processed by the input/output device, no special operation is required. The CNC will interrupt data input/output operation until the next floppy is inserted into the adaptor.

When reset operation is applied to the CNC during a request for floppy replacement, the CNC is not reset at once, but reset after the floppy has been replaced.

• **Protect switch** The floppy is provided with the write protect switch. Set the switch to

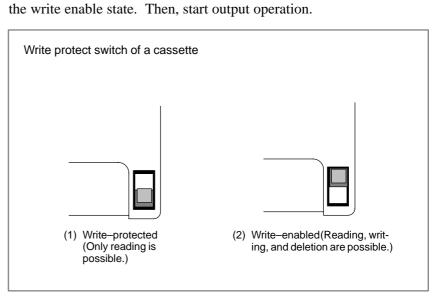


Fig. 8.1 Protect switch

• Writing memo

Once written in the cassette or card, data can subsequently be read out by correspondence between the data contents and file numbers. This correspondence cannot be verified, unless the data contents and file numbers are output to the CNC and displayed. The data contents can be displayed with display function for directory of floppy disk (See Section III–8.8).

To display the contents, write the file numbers and the contents on the memo column which is the back of floppy.

(Entry example on MEMO) File 1 NC parameters File 2 Offset data File 3 NC program O0100 ... File (n-1) NC program O0500 File n NC program O0600

— 568 —

# When the program is input from the floppy, the file to be input first 8.2 must be searched. **FILE SEARCH** For this purpose, proceed as follows: File 1 File n File 2 File 3 Blank File searching of the file n **Procedure for File Heading** 1 Press the EDIT or MEMORY switch on the machine operator's panel. 2 Press function key |PROG|, then the program contents display screen or program check screen appears. 3 Press soft key [(OPRT)] 4 Press the rightmost soft key $\triangleright$ (next-menu key). Enter address N. 5 Enter the number of the file to search for. 6 $\cdot N0$ The beginning of the cassette or card is searched. · One of N1 to N9999 Of the file Nos. 1 to 9999, a designated file is searched. · N-9999 The file next to that accessed just before is searched. · N-9998 When N-9998 is designated, N-9999 is automatically inserted each time a file is input or output. This condition is reset by the designation of N1,N1 to 9999, or N – 9999 or reset. 7 Press soft keys [FSRH] and [EXEC] The specified file is searched for. **Explanations** • File search by N-9999 The same result is obtained both by sequentially searching the files by

**by N–9999** The same result is obtained both by sequentially searching the files by specifying Nos. N1 to N9999 and by first searching one of N1 to N9999 and then using the N–9999 searching method. The searching time is shorter in the latter case.

#### Alarm

| No. | Description  |
|-----|--|
|     | The ready signal (DR) of an input/output device is off.  |
| 86  | An alarm is not immediately indicated in the CNC even when<br>an alarm occurs during head searching (when a file is not<br>found, or the like).  |
|     | An alarm is given when the input/output operation is performed<br>after that. This alarm is also raised when N1 is specified for<br>writing data to an empty floppy. (In this case, specify N0.) |

# 8.3 FILE DELETION

Files stored on a floppy can be deleted file by file as required.

| Procedure for I   | File Deletion  |  |
|---|--|--|
|   | 1 Insert the floppy into the input/output device so that it is ready for writing.  |  |
|   | 2 Press the EDIT switch on the machine operator's panel.   |  |
|   | <b>3</b> Press function key Prog , then the program contents display screen appears.   |  |
|   | 4 Press soft key [(OPRT)]  |  |
|   | 5 Press the rightmost soft key (next-menu key).  |  |
|   | 6 Enter address N.   |  |
|   | 7 Enter the number (from 1 to 9999) of the file to delete.   |  |
|   | 8 Press soft key <b>[DELETE]</b> , then press soft key <b>[EXEC]</b> .<br>The file specified in step <b>7</b> is deleted.  |  |
| Explanations  |  |  |
| <ul> <li>File number after the file<br/>is deleted</li> </ul> | When a file is deleted, the file numbers after the deleted file are each decremented by one. Suppose that a file numbered k was deleted. In this case, files are renumbered as follows:<br>Before deletion after deletion<br>1 to $(k-1) \dots 1$ to $(k-1)$<br>k Deleted<br>(k+1) to n k to $(n-1)$ |  |
| Protect switch  | <ul><li>(k+1) to n k to (n-1)</li><li>Set the write protect switch to the write enable state to delete the files.</li></ul>  |  |

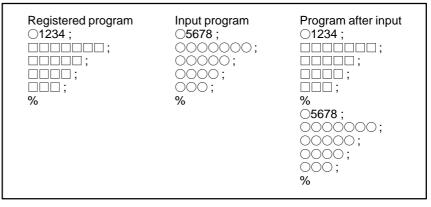
# 8.4 PROGRAM INPUT/OUTPUT

# 8.4.1 Inputting a Program

This section describes how to load a program into the CNC from a floppy or NC tape.

| Procedure for I   | nputting a Program   |  |
|---|--|--|
|   | <ol> <li>Make sure the input device is ready for reading.</li> <li>For the two-path control, select the tool post for which a program to be input is used with the tool post selection switch.</li> </ol>  |  |
|   | <b>2</b> Press the EDIT switch on the machine operator's panel.  |  |
|   | <b>3</b> When using a floppy, search for the required file according to the procedure in Section <b>III–8.2</b> .  |  |
|   | 4 Press function key $PROG$ , then the program contents display screen or  |  |
|   | program directory screen appears.  |  |
|   | 5 Press soft key [(OPRT)]  |  |
|   | 6 Press the rightmost soft key 🗁 (next–menu key).  |  |
|   | 7 After entering address O, specify a program number to be assigned to the program. When no program number is specified here, the program number used on the floppy or NC tape is assigned.  |  |
|   | 8 Press soft keys <b>[READ]</b> and <b>[EXEC]</b><br>The program is input and the program number specified in step 7 is<br>assigned to the program.  |  |
| Explanations  |  |  |
| • Collation   | If a program is input while the data protect key on the machine operator's panel turns ON, the program loaded into the memory is verified against the contents of the floppy or NC tape.<br>If a mismatch is found during collation, the collation is terminated with an P/S alarm (No. 79).<br>If the operation above is performed with the data protection key turns OFF, collation is not performed, but programs are registered in memory. |  |
| <ul> <li>Inputting multiple<br/>programs from an NC<br/>tape</li> </ul> | When a tape holds multiple programs, the tape is read up to ER (or %).   |  |
|   | O1111 M02; O2222 M30; O3333 M02; ER(%)     S   |  |

| B-63004EN/02   | OPERATION   | 8. DATA INPUT/OUTPUT  |
|--|---|---|
| • Program numbers on a NC tape                                 | <ul> <li>program. If the program has no C block is assigned to the program.</li> <li>When the program has neither previous program number is inclassigned to the program.</li> <li>When the program does not have sequence number at the start of the sequence number are used as the digits are zeros, the previously incremented by one and the resul</li> <li>When a program is entered with a The O-number on the NC tape is assigned to the program. When the program, the first additional programs, the first additional program.</li> </ul> | on the NC tape is assigned to the<br>D-number, the N-number in the first<br>an O-number nor N-number, the<br>remented by one and the result is<br>e an O-number but has a five-digit<br>he program, the lower four digits of<br>he program number. If the lower four<br>y registered program number is<br>t is assigned to the program. |
| <ul> <li>Program registration in<br/>the background</li> </ul> | The method of registration operati<br>foreground operation. However, this<br>background editing area. As with edi<br>below are required at the end to regist<br>memory.<br>[(OPRT)] [BG–END]  | operation registers a program in the toperation, the operations described   |
| <ul> <li>Additional program input</li> </ul>                   | You can input a program to be ap program.   | pended to the end of a registered   |



In the above example, all lines of program O5678 are appended to the end of program O1234. In this case, program number O5678 is not registered. When inputting a program to be appended to a registered program, press the **[READ]** soft key without specifying a program number in step 8. Then, press the **[CHAIN]** and **[EXEC]** soft keys.

- In entire program input, all lines of a program are appended, except for its O number.
- When canceling additional input mode, press the reset key or the **[CAN]** or **[STOP]** soft key.
- Pressing the **[CHAIN]** soft key positions the cursor to the end of the registered program. Once a program has been input, the cursor is positioned to the start of the new program.

#### 8. DATA INPUT/OUTPUT

 Defining the same program number as that of an existing program

# Alarm

• Additional input is possible only when a program has already been registered.

If an attempt has been made to register a program having the same number as that of a previously registered program, P/S alarm 073 is issued and the program cannot be registered.

| No. | Description  |
|-----|--|
| 70  | The size of memory is not sufficient to store the input programs   |
| 73  | An attempt was made to store a program with an existing pro-<br>gram number.   |
| 79  | The verification operation found a mismatch between a pro-<br>gram loaded into memory and the contents of the program on<br>the floppy or NC tape. |

• Efficient use of memory

# 8.4.2 **Outputting a Program**

A program stored in the memory of the CNC unit is output to a floppy or NC tape.

### Procedure for Outputting a Program

|   | <ol> <li>Make sure the output device is ready for output.<br/>For the two–path control, select the tool post for which a program to<br/>be output is used with the tool post selection switch.</li> </ol>  |  |
|---|--|--|
|   | 2 To output to an NC tape, specify the punch code system (ISO or EIA) using a parameter.   |  |
|   | <b>3</b> Press the EDIT switch on the machine operator's panel.  |  |
|   | 4 Press function key $PROG$ , then the program contents display screen or  |  |
|   | program directory screen appears.  |  |
|   | 5 Press soft key [(OPRT)].   |  |
|   | 6 Press the rightmost soft key $\triangleright$ (next-menu key).   |  |
|   | 7 Enter address O.   |  |
|   | <ul> <li>8 Enter a program number. If -9999 is entered, all programs stored in memory are output.<br/>To output multiple programs at one time, enter a range as follows : ΟΔΔΔΔ,Ο□□□□</li> <li>Programs No. ΔΔΔΔ to No. □□□□ are output.<br/>The program library screen displays program numbers in ascending order when bit 4 (SOR) of parameter No. 3107 is set to 1.</li> </ul> |  |
|   | <b>9</b> Press soft keys <b>[PUNCH]</b> and <b>[EXEC]</b><br>The specified program or programs are output.   |  |
| Explanations<br>(Output to a floppy)                            |  |  |
| <ul> <li>File output location</li> </ul>                        | When output is conducted to the floppy, the program is output as the new<br>file after the files existing in the floppy. New files are to be written from<br>the beginning with making the old files invalid, use the above output<br>operation after the N0 head searching.   |  |
| <ul> <li>An alarm while a<br/>program is output</li> </ul>      | When P/S alarm (No. 086) occurs during program output, the floppy is restored to the condition before the output.  |  |
| <ul> <li>Outputting a program<br/>after file heading</li> </ul> | When program output is conducted after N1 to N9999 head searching, the new file is output as the designated n–th position. In this case, 1 to $n-1$ files are effective, but the files after the old n–th one are deleted. If an alarm occurs during output, only the 1 to $n-1$ files are restored.   |  |

To efficiently use the memory in the cassette or card, output the program by setting parameter NFD (No. 0101#7, No. 0111#7 or 0121#7) to 1. This parameter makes the feed is not output, utilizing the memory efficiently.

| 8. DATA INPUT/OUTPUT  | OPERATION   | B-63004EN/02  |
|---|---|---|
| <ul> <li>On the memo record</li> </ul>                      | Head searching with a file No. is necessary<br>CNC to the floppy is again input to the CNC<br>the content of the CNC memory. Therefor<br>output from the CNC to the floppy, record              | C memory or compared with re, immediately after a file is                                   |
| <ul> <li>Punching programs in<br/>the background</li> </ul> | Punch operation can be performed in the sat<br>This function alone can punch out a progroperation.<br><o> (Program No.) [PUNCH] [EXEC]: Punches<br/><o> H–99991 [PUNCH] [EXEC]: Punches</o></o> | ram selected for foreground ches out a specified program.                                   |
| Explanations<br>(Output to an NC tape)                      |   |   |
| • Format  | A program is output to paper tape in the fol<br>ER Program<br>(%) Feed of 3 feet  | llowing format:<br>$\begin{array}{c} & ER \\ (\%) & \cdots \\ & Feed of 3 feet \end{array}$ |
|   | If three–feet feeding is too long, press the punching to cancel the subsequent feed pur   |   |
| • TV check  | A space code for TV check is automatically  | v punched.  |
|   |   | / F ·····   |
| ISO code  | When a program is punched in ISO code, two an LF code.  | •   |
| • ISO code  |   | •   |
| ● ISO code  | an LF code.   | o CR codes are punched after  |
| <ul> <li>ISO code</li> <li>Stopping the punch</li> </ul>    | an LF code.<br>LF CR CR<br>By setting NCR (bit 3 of parameter No. 0100  | o CR codes are punched after  |
|   | an LF code.<br>LF CR CR<br>By setting NCR (bit 3 of parameter No. 0100<br>each LF appears without a CR.   | o CR codes are punched after  |

The sequence of the programs punched is undefined.

# 8.5 OFFSET DATA INPUT AND OUTPUT

| 8.5.1<br>Inputting Offset Data | Offset data is loaded into the memory of the CNC from a floppy or NC tape. The input format is the same as for offset value output. See section <b>III–8.5.2.</b> When an offset value is loaded which has the same offset number as an offset number already registered in the memory, the loaded |
|--------------------------------|--|
|                                | offset data replaces existing data.  |

#### **Procedure for Inputting Offset Data**

| 1 | Make sure the input device is ready for reading                         |
|---|---|
|   | For the two-path control, select the tool post for which offset data to |
|   | be input is used with the tool post selection switch.                   |

- 2 Press the EDIT switch on the machine operator's panel.
- **3** When using a floppy, search for the required file according to the procedure in Section III–8.2.
- 4 Press function key of set to display tool offset screeen.
- 5 Press soft keys [(OPRT)], then the tool compensation screen appears.
- 6 Press rightmost soft key (>)(next menu key).
- 7 Press soft keys [READ] and [EXEC].
- 8 The input offset data will be displayed on the screen after completion of input operation.

# **8.5.2**All offset data is output in a output format from the memory of the CNC**Outputting Offset Data**to a floppy or NC tape.

# Procedure for Outputting Offset Data

|                                      | <ol> <li>Make sure the output device is ready for output.<br/>For the two–path control, select the tool post for which offset data to<br/>be output is used with the tool post selection switch.</li> </ol>  |
|--------------------------------------|--|
|                                      | 2 Specify the punch code system (ISO or EIA) using a parameter.  |
|                                      | <b>3</b> Press the EDIT switch on the machine operator's panel.  |
|                                      | 4 Press function key $\begin{bmatrix} OFFGET\\SETTING \end{bmatrix}$ to display tool offset screen.  |
|                                      | 5 Press soft key [(OPRT)].   |
|                                      | 6 Press the rightmost soft key 🗁 (next–menu key)   |
|                                      | 7 Press soft keys <b>[PUNCH]</b> and <b>[EXEC]</b> .<br>Offset data is output in the output format described below.  |
| Explanations                         |  |
| <ul> <li>Output format</li> </ul>    | Output format is as follows:   |
|                                      | Format   |
|                                      | G10P_X_Y_Z_R_Q_;<br>P: Offset number<br>Work sheet : P=0<br>For wear offset amount : P=Wear offset number<br>For geometry offset amount : p=10000+geometry offset number<br>X:Offset value on X axis<br>Y: Offset value on Y axis<br>Z:Offset value on Z axis<br>Q:Imaginary tool nose number<br>R:Tool nose radius offset value |
|                                      | The L1 command may be used instead of L11 for format compatibility of the conventional CNC.  |
| <ul> <li>Output file name</li> </ul> | When the floppy disk directory display function is used, the name of the output file is OFFSET.  |

| 8.6<br>INPUTTING AND<br>OUTPUTTING<br>PARAMETERS AND<br>PITCH ERROR<br>COMPENSATION<br>DATA |  | arameters and pitch error compensation data are input and output from ifferent screens, respectively. This chapter describes how to enter them.  |  |  |
|---|--|--|--|--|
| 8.6.1<br>Inputting Parameters   | Parameters are loaded into the memory of the CNC unit from a floppy or NC tape. The input format is the same as the output format. See Subsec. <b>III–8.6.2</b> . When a parameter is loaded which has the same data number as a parameter already registered in the memory, the loaded parameter replaces the existing parameter. |  |  |  |
| Procedure for   | Inpu   | utting Parameters  |  |  |
|   | 1  | Make sure the input device is ready for reading.<br>For the two–path control, select the tool post for which parameters to<br>be input are used with the tool post selection switch.         |  |  |
|   | 2  | When using a floppy, search for the required file according to the procedure in Section <b>III–8.2</b> .   |  |  |
|   | 3  | Press the EMERGENCY STOP button on the machine operator's panel.   |  |  |
|   | 4  | Press function key $\left[ \begin{array}{c} OFFSET\\ SETTING \end{array} \right]$ .  |  |  |
|   | 5  | Press the soft key <b>[SETING]</b> for chapter selection, then the setting screen appears.   |  |  |
|   | 6  | Enter 1 in response to the prompt for "PARAMETER WRITE (PWE)" in setting data. P/S alarm (No. 100 (indicating that parameters can be written)) appears.                                      |  |  |
|   | 7  | Press soft key SYSTEM .  |  |  |
|   | 8  | Press chapter selection soft key <b>[PARAM]</b> , then the parameter screen appears.   |  |  |
|   | 9  | Press soft key [(OPRT)].   |  |  |
|   | 10   | Press the rightmost soft key 🖂 (next-menu key).  |  |  |
|   | 11   | Press soft keys <b>[READ]</b> and <b>[EXEC]</b> .<br>Parameters are read into memory. Upon completion of input, the<br>"INPUT" indicator at the lower–right corner of the screen disappears. |  |  |
|   | 12   | Press function key $\begin{bmatrix} OFFSET\\SETTING \end{bmatrix}$ .   |  |  |
|   | 13   | Press soft key [SETING] for chapter selection.   |  |  |

| 8. DATA INPUT/OUTPUT           | OPERATION  | B-63004EN/02         |
|--------------------------------|--|----------------------|
|                                | 14 Enter 0 in response to the prompt for "PAF (PWE)" in setting data.  | AMETER WRITE         |
|                                | 15 Turn the power to the NC back on.   |                      |
|                                | 16 Release the EMERGENCY STOP button on the panel.   | e machine operator's |
| 8.6.2<br>Outputting Parameters | All parameters are output in the defined format from CNC to a floppy or NC tape.   | n the memory of the  |
| Procedure for                  | Outputting Parameters  |                      |
|                                | 1 Make sure the output device is ready for output<br>For the two-path control, select the tool post for<br>be input are used with the tool post selection sy | which parameters to  |
|                                | 2 Specify the punch code system (ISO or EIA) us  | sing a parameter.    |
|                                | <b>3</b> Press the EDIT switch on the machine operator   | 's panel.            |
|                                | 4 Press function key SYSTEM.   |                      |
|                                | <b>5</b> Press chapter selection soft key <b>[PARAM]</b> to discreen.  | isplay the parameter |
|                                | 6 Press soft key [(OPRT)].   |                      |
|                                | 7 Press rightmost soft key 🕞 (next-menu key)   | ).                   |
|                                | 8 Press soft key <b>[PUNCH</b> ].  |                      |
|                                | <ul><li>9 To output all parameters, press the [ALL] soft parameters which are set to other than 0, press th</li></ul>  | • • •                |
|                                | 10 Press soft key <b>[EXEC]</b> .<br>All parameters are output in the defined format   |                      |

**Explanations** 

• Output format

Output format is as follows: N... P...; N... A1P.... A2P.... AnP...; N... P...;

N:Parameter No. A:Axis No. (n is the number of control axis) P:Parameter setting value .

• Suppressing output of parameters set to 0

To suppress the output of the following parameters, press the **[PUNCH]** soft key then **[NON–0]** soft key.

|            | Other than axis type                      | Axis type  |
|------------|---|--|
| Bit type   | Parameter for which all bits are set to 0 | Parameter for an axis for which all bits are set to 0. |
| Value type | Paramter whose value is 0.                | Parameter for an axis for which the value is 0.        |

| B-63004EN/02  |   | OPERATION   | 8. DATA INPUT/OUTPUT  |
|---|---|---|---|
| • Output file name                                  |   | hen the floppy disk directory displatput file is PARAMETER.   | ay function is used, the name of the  |
|   | PA  |   | but, the output file is named ALL<br>rs which are set to other than 0 have<br>NON–0. PARAMETER. |
| 8.6.3<br>Inputting Pitch Error<br>Compensation Data | Pitch error compensation data are loaded into the memory of the CNC from a floppy or NC tape. The input format is the same as the output format. See Section <b>8.6.4</b> . When a pitch error compensation data is loaded which has the corresponding data number as a pitch error compensation data already registered in the memory, the loaded data replaces the existing data. |   |   |
| Procedure for                                       | Pito  | h Error Compensation Data   |   |
|   | 1   | -   | dy for reading.<br>the tool post for which pitch error<br>s used with the tool post selection   |
|   | 2   | When using a floppy, search for procedure in Section <b>III–8.2</b> .   | the required file according to the  |
|   | 3   | Press the EMERGENCY STOP panel.   | button on the machine operator's  |
|   | 4   | Press function key<br>SETING .  |   |
|   | 5   | Press the soft key [SETING] for   | chapter selection.  |
|   | 6   |   | ompt for "PARAMETER WRITE alarm (No. 100 (indicating that ars.                                  |
|   | 7   | Press soft key SYSTEM.  |   |
|   | 8   | Press the rightmost soft key $\triangleright$ selection soft key <b>[PITCH]</b> .   | (next-menu key)and press chapter  |
|   | 9   | Press soft key [(OPRT)].  |   |
|   | 10  | Press the rightmost soft key  | (next-menu key).  |
|   | 11  | Press soft keys <b>[READ]</b> and <b>[EXI</b><br>Pitch error compensation data<br>completion of input, the "INPUT"<br>of the screen disappears. |   |
|   | 12  | Press function key $\left[ \begin{array}{c} \text{OFFSET}\\ \text{SETTING} \end{array} \right]$ .   |   |
|   | 13  | Press soft key [SETING] for chap  | pter selection.   |

| 8. DATA INPUT/OUTPUT                                 | OPERATION   | B-63004EN/02         |
|--|---|----------------------|
|  | <b>14</b> Enter 0 in response to the prompt for "PA (PWE)" of setting data.   | RAMETER WRITE        |
|  | <b>15</b> Turn the power to the NC back on.   |                      |
|  | <b>16</b> Release the EMERGENCY STOP button on the panel.   | e machine operator's |
| Explanations   |   |                      |
| <ul> <li>Pitch error<br/>compensation</li> </ul>     | Parameters 3620 to 3624 and pitch error compensation correctly to apply pitch error compensation correct (See subsec. III–11.5.2) |                      |
| 8.6.4<br>Outputting Pitch Error<br>Compensation Data | All pitch error compensation data are output in the the memory of the CNC to a floppy or NC tape.                                 | defined format from  |

| Procedure for Outputting Pitch Error Compensation Data |   |  |
|--|---|--|
|  | <ol> <li>Make sure the output device is ready for output.<br/>For the two-path control, select the tool post for which pitch error<br/>compensation data to be output is used with the tool post selection<br/>switch.</li> </ol> |  |
|  | 2 Specify the punch code system (ISO or EIA) using a parameter.   |  |
|  | <b>3</b> Press the EDIT switch on the machine operator's panel.   |  |
|  | 4 Press function key $system$ .   |  |
|  | 5 Press the rightmost soft key >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>  |  |
|  | 6 Press soft key [(OPRT)].  |  |
|  | 7 Press rightmost soft key 🗁 (next–menu key).   |  |
|  | 8 Press soft keys <b>[PUNCH]</b> and <b>[EXEC]</b> .<br>All pitch error compensation data are output in the defined format.   |  |
| Explanations   |   |  |
| <ul> <li>Output format</li> </ul>                      | Output format is as follows:<br>N 10000 P;<br>N 11023 P;<br>N:Pitch error compensation point No. + 10000<br>P:Pitch error compensation data   |  |
| <ul> <li>Output file name</li> </ul>                   | When the floppy disk directory display function is used, the name of the output file is " <b>PITCH ERROR</b> ".   |  |

# 8.7 INPUTTING / OUTPUTTING CUSTOM MACRO COMMON VARIABLES

# 8.7.1 Inputting Custom Macro Common Variables

The value of a custom macro common variable (#500 to #999) is loaded into the memory of the CNC from a floppy or NC tape. The same format used to output custom macro common variables is used for input. See Subsec. **8.7.2.** For a custom macro common variable to be valid, the input data must be executed by pressing the cycle start button after data is input. When the value of a common variable is loaded into memory, this value replaces the value of the same common variable already existing (if any) in memory.

#### **Procedure for Inputting Custom Macro Common Variables**

- **1** Register the program which has been output, as described in Section III–8.7.2, in memory according to the program input procedure described in Section III–8.4.1.
- **2** Press the MEMORY switch on the machine operator's panel upon completing input.
- **3** Press the cycle start button to execute the loaded program.
- 4 Display the macro variable screen to check whether the values of the common variables have been set correctly.

#### Display of the macro variable screen

- Press function key Setting .
- · Press the rightmost soft key (next-menu key).
- · Press soft key [MACRO].
  - $\cdot$  Select a variable with the page keys or numeric keys and soft key **[NO.SRH]**.

#### **Explanations**

• **Common variables** The common variables (#500 to #531) can be input and output. When the option for adding a common variable is specified, values from #500 to #999 can be input and output. #100 to #199 can be input and output when bit 3 (PU5) of parameter No. 6001 is set to 1.

# 8.7.2 Outputting Custom Macro Common Variable Custom macro common variables (#500 to #999) stored in the memory of the CNC can be output in the defined format to a floppy or NC tape.

#### **Procedure for Outputting Custom Macro Common Variable**

- 1 Make sure the output device is ready for output.
- 2 Specify the punch code system (ISO or EIA) using a parameter.
- **3** Press the EDIT switch on the machine operator's panel.
- 4 Press function key OFFSET .
- **5** Press the rightmost soft key [▷] (next–menu key), then press soft key [MACRO].
- 6 Press soft key [(OPRT)].
- 7 Press the rightmost soft key  $\square$  (next–menu key).
- 8 Press soft keys **[PUNCH]** and **[EXEC]**. Common variables are output in the defined format.

#### **Explanations**

Output format

The output format is as follows:

(1) The precision of a variable is maintained by outputting the value of the variable as <expression>.

- (2) Undefined variable
- (3) When the value of a variable is 0
- When the floppy disk directory display function is used, the name of the output file is **"MACRO VAR**".

The common variables (#500 to #531) can be input and output.
When the option for adding a common variable is specified, values from #500 to #999 can be input and output.
#100 to #199 can be input and output when bit 3 (PU5) of parameter No. 6001 is set to 1.

- Output file name
- Common variable

# 8.8 DISPLAYING DIRECTORY OF FLOPPY DISK

On the floppy directory display screen, a directory of the FANUC Handy File, FANUC Floppy Cassette, or FANUC FA Card files can be displayed. In addition, those files can be loaded, output, and deleted.

| $\sim$ |                          |             |     |                           |  |
|--------|--------------------------|-------------|-----|---------------------------|--|
|        | RECTORY (I<br>NO. FILE N |             |     | 00001 N0000<br>(METER) VO |  |
|        |                          |             |     |                           |  |
|        |                          |             |     |                           |  |
|        |                          |             |     |                           |  |
|        | DIT ****                 | * * * * * * |     | 51 : 12                   |  |
| ( P    | RGRM ) (                 |             | ) [ |                           |  |

# 8.8.1 Displaying the Directory

| Displaying the Directory of Floppy Disk Files |   |  |
|---|---|--|
| Procedure 1                                   | Use the following procedure to display a directory of all the fistored in a floppy:   |  |
|   | <b>1</b> Press the EDIT switch on the machine operator's panel.   |  |
|   | <b>2</b> Press function key $PROG$ .  |  |
|   | 3 Press the rightmost soft key 🕞 (next-menu key).   |  |
|   | 4 Press soft key <b>[FROPPY]</b> .  |  |
|   | 5 Press page key $\mathbf{p}_{\text{PAGE}}$ or $\mathbf{p}_{\text{PAGE}}$ .   |  |
|   | 6 The screen below appears.   |  |
|   | DIRECTORY (FLOPPY) O0001 N00000<br>NO. FILE NAME (METER) VOL  |  |
|   | 0001         PARAMETER         58.5           0002         00001         1.9           0003         00002         1.9           0004         00010         1.3           0005         00040         1.3           0006         00050         1.9           0007         00100         1.9           0008         01000         1.9           0009         09500         1.6 |  |
|   | EDIT **** *** 11 : 53 : 04<br>( F SRH ) ( READ ) (PUNCH ) (DELETE ) ( )   |  |

Fig. 8.8.1 (a)

7 Press a page key again to display another page of the directory.

**Procedure 2** 

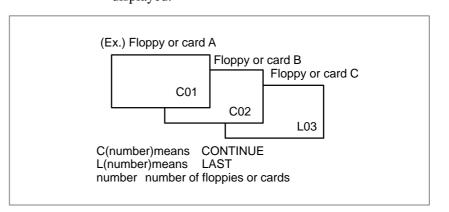
#### Use the following procedure to display a directory of files starting with a specified file number : 1 Press the EDIT switch on the machine operator's panel. Press function key PROG . 2 Press the rightmost soft key (next–menu key). 3 Press soft key [FLOPPY]. 4 Press soft key [(OPRT)]. 5 Press soft key [F SRH]. 6 7 Enter a file number. Press soft keys [F SET] and [EXEC]. 8 Press a page key to display another page of the directory. 9 10 Press soft key [CAN] to return to the soft key display shown in the screen of Fig. 8.8.1 (b).

| DIRECTORY (FLOPPY)   | 00001 N00000                       |
|--|------------------------------------|
| NO. FILE NAME  | (METER) VOL                        |
| SEARCH<br>FILE NO. =<br>>_<br>EDIT **** *** ***<br>( F SET ) ( ) ( | 11 : 54 : 19<br>) ( CAN ) ( EXEC ) |

Fig. 8.8.1 (b)

#### **Explanations**

- Screen fields and their meanings
- NO : Displays the file number
  FILE NAME : Displays the file name.
  (METER) : Converts and prints out the file capacity to paper tape length. You can also produce H (FEET)I by setting the INPUT UNIT to INCH of the setting data.
  VOL. : When the file is multi–volume, that state is displayed.



# 8.8.2 Reading Files

The contents of the specified file number are read to the memory of NC.

#### Procedure for Reading Files

- 1 Press the EDIT switch on the machine operator's panel. For the two–path control, select the tool post for which a file is to be input in memory with the tool post selection switch.
- 2 Press function key PROG .
- **3** Press the rightmost soft key  $\triangleright$  (next–menu key).
- 4 Press soft key [FLOPPY].
- 5 Press soft key [(OPRT)].
- 6 Press soft key [READ].

| DIRECTORY (FLOPPY)   | O0001 N00000  |
|--|---|
| NO. FILE NAME  | (METER) VOL   |
| READ<br>FILE NO. =<br>>_<br>EDIT **** *** ***<br>( F SET ) ( O SET ) ( STO | PROGRAM NO. =<br>11 : 55 : 04<br>P ) ( CAN ) ( EXEC ) |

- 7 Enter a file number.
- 8 Press soft key [F SET].
- **9** To modify the program number, enter the program number, then press soft key **[O SET]**.
- **10** Press soft key **[EXEC]**. The file number indicated in the lower–left corner of the screen is automatically incremented by one.
- 11 Press soft key **[CAN]** to return to the soft key display shown in the screen of **Fig. 8.8.1**. (b).

# 8.8.3 Outputting Programs

Any program in the memory of the CNC unit can be output to a floppy as a file.

#### **Procedure for Outputting Programs**

- 1 Press the EDIT switch on the machine operator's panel. For the two-path control, select the tool post for which a program is to be output from floppy with the tool post selection switch.
- 2 Press function key PROG .
- **3** Press the rightmost soft key  $\triangleright$  (next–menu key).
- 4 Press soft key [FLOPPY].
- 5 Press soft key [(OPRT)].
- 6 Press soft key [PUNCH]

| DIRECTORY (FLOPPY)<br>NO. FILE NAME                                      | 00002 N01000<br>(METER) VOL                         |
|--|---|
| PUNCH<br>FILE NO. =<br>>_<br>EDIT **** *** ***<br>(F SET )( 0 SET)( STOP | PROGRAM NO. =<br>11 : 55 : 26<br>) ( CAN ) ( EXEC ) |

- 7 Enter a program number. To write all programs into a single file, enter –9999 in the program number field. In this case, the file name "ALL.PROGRAM" is registered.
- 8 Press soft key [O SET].
- 9 Press soft key [EXEC]. The program or programs specified in step 7 are written after the last file on the floppy. To output the program after deleting files starting with an existing file number, key in the file number, then press soft key [F SET] followed by soft key [EXEC].
- 10 Press soft key **[CAN]** to return to the soft key display shown in the screen of **Fig. 8.8.1** (b).

# 8.8.4 Deleting Files

The file with the specified file number is deleted.

#### **Procedure for Deleting Files**

- **1** Press the EDIT switch on the machine operator's panel.
- 2 Press function key PROG .
- **3** Press the rightmost soft key  $\triangleright$  (next–menu key).
- 4 Press soft key [FLOPPY].
- 5 Press soft key [(OPRT)].
- 6 Press soft key [DELETE].

| ( | DIRECTORY (FLOPPY)<br>NO. FILE NAME                                       | 00001 N00000<br>(METER) VOL    |
|---|---|--------------------------------|
|   | DELETE<br>FILE NO. = NAME=<br>>_<br>EDIT **** *** ***<br>(FSET )(FNAME )( | 11:55:51<br>) ( CAN ) ( EXEC ) |

- 7 Specify the file to be deleted. When specifying the file with a file number, type the number and press soft key [F SET]. When specifying the file with a file name, type the name and press soft key [F NAME].
- 8 Press soft key **[EXEC]**. The file specified in the file number field is deleted. When a file is deleted, the file numbers after the deleted file are each decremented by one.
- 9 Press soft key [CAN] to return to the soft key display shown in the screen of Fig. 8.8.1 (b).

#### Limitations

If **[F SET]** or **[O SET]** is pressed without key inputting file number and • Inputting file numbers and program numbers program number, file number or program number shows blank. When with keys 0 is entered for file numbers or program numbers, 1 is displayed. • I/O devices To use channel 0, set a device number in parameter 102. Set the I/O device number to parameter No. 0112 when channel 1 is used. Set it to No. 0122 when channel 2 is used. • Significant For the numeral input in the data input area with FILE NO. and digits PROGRAM NO., only lower 4 digits become valid. Collation When the data protection key on the machine operator's panel is ON, no programs are read from the floppy. They are verified against the contents

of the memory of the CNC instead.

#### ALARM

| No. | Contents   |
|-----|--|
| 71  | An invalid file number or program number was entered.<br>(Specified program number is not found.)  |
| 79  | Verification operation found a mismatch between a program<br>loaded into memory and the contents of the floppy   |
| 86  | The datas et-ready signal (DR) for the input/output device is turned off. (The no file error or duplicate file error occurred on the input/output device because an invalid file number, program number, or file name was entered. |

OPERATION

# 8.9 OUTPUTTING A PROGRAM LIST FOR A SPECIFIED GROUP

CNC programs stored in memory can be grouped according to their names, thus enabling the output of CNC programs in group units. Section III–11.3.3 explains the display of a program listing for a specified group.

#### Procedure for Outputting a Program List for a Specified Group

#### Procedure

1 Display the program list screen for a group of programs, as described in Section III–11.3.3.

| ( | PROGRAM DIRECTORY (GROUP)  | O0001                | N00010            |
|---|--|----------------------|-------------------|
|   | PROGRAM (NUM.)<br>USED: 60<br>FREE: 2<br>O0020 (GEAR-1000 MAIN<br>O0040 (GEAR-1000 SUB-1<br>O0200 (GEAR-1000 SUB-2<br>O2000 (GEAR-1000 SUB-3 | -                    | R.)<br>321<br>429 |
|   | >_<br>EDIT **** *** *** ***<br>(PRGRM)( DIR )( )   | 16 : 52 : 13<br>()(( |                   |

- 2 Press the [(OPRT)] operation soft key.
- 3 Press the right–most soft key  $[\square]$  (continuous menu key).
- 4 Press the **[PUNCH]** operation soft key.
- 5 Press the [AL–GRP] operation soft key.

The CNC programs in the group for which a search is made are output. When these programs are output to a floppy disk, they are output to a file named GROUP.PROGRAM.

| (¢G-ED) (O-SRH) ( | )(       | ) (GROUP)   |
|-------------------|----------|-------------|
| ( ) (READ) (      | UNCH ) ( |             |
| (AL-GRP) ( )      | (STOP) ( | CAN) (EXEC) |

# 8.10 DATA INPUT/OUTPUT ON THE ALL IO SCREEN

To input/output a particular type of data, the corresponding screen is usually selected. For example, the parameter screen is used for parameter input from or output to an external input/output unit, while the program screen is used for program input or output. However, programs, parameters, offset data, and macro variables can all be input and output using a single common screen, that is, the ALL IO screen.

| READ/PUNCH (PRO  | )<br>GRAM)   | O1234 N12345  |
|--|--|---|
| I/O CHANNEL<br>DEVICE NUM.<br>BAUDRATE<br>STOP BIT<br>NULL INPUT (EIA)<br>TV CHECK (NOTES)<br>CD CHECK (232C)<br>PARITY BIT<br>INTERFACE | 3<br>0<br>4800<br>2<br>NO<br>ON<br>OFF<br>OFF<br>RS422 | TV CHECK OFF<br>PUNCH CODE ISO<br>INPUT CODE ASCII<br>FEED OUTPUT FEED<br>EOB OUTPUT (ISO) CR<br>BAUDRATE CLK. INNER<br>RESET/ALARM ON<br>SAT COMMAND HOST<br>COM PROTCOL A |
| END CODE<br>(0:EIA 1:ISO)>1_<br>MDI **** ***<br>(PRGRM)(PARA   | EXT<br>*** ***<br>M)(OFFS                              | COM CODE ASCII<br>12:34:56<br>ET ] [ MACRO ] [ (OPRT) ]   |

Fig. 8.10 ALL IO screen (when channel 3 is being used for input/output)

# 8.10.1 Setting Input/Output–Related Parameters

Input/output-related parameters can be set on the ALL IO screen. Parameters can be set, regardless of the mode.

### Setting input/output-related parameters

### Procedure

**1** Press function key SYSTEM .

- 2 Press the rightmost soft key 🗁 (next–menu key) several times.
- **3** Press soft key **[ALL IO]** to display the ALL IO screen.

### NOTE

- 1 If program or floppy is selected in EDIT mode, the program directory or floppy screen is displayed.
- 2 When the power is first turned on, program is selected by default.

| READ/PUNCH (PRC  | )GRAM)    | O1234          | 4 N12345 |
|------------------|-----------|----------------|----------|
| I/O CHANNEL      | 3         | TV CHECK       | OFF      |
| DEVICE NUM.      | 0         | PUNCH CODE     | ISO      |
| BAUDRATE         | 4800      | INPUT CODE     | ASCII    |
| STOP BIT         | 2         | FEED OUTPUT    | FEED     |
| NULL INPUT (EIA) | NO        | EOB OUTPUT (IS | O) CR    |
| TV CHECK (NOTES) | ON        | BAUDRATE CLK.  | INNER    |
| CD CHECK (232C)  | OFF       | RESET/ALARM    | ON       |
| PARITY BIT       | OFF       | SAT COMMAND    | HOST     |
| INTERFACE        | RS422     | COM PROTCOL    | А        |
| END CODE         | EXT       | COM CODE       | ASCII    |
| (0:EIA 1:ISO)>1_ |           |                |          |
| MDI **** ***     | *** ***   | 12:34:         | 56       |
|                  | M) (OFFSE | T)(MACRO)(     | (OPRT)   |

### NOTE

Baud rate clock, CD check (232C), reset/alarm report, and the parity bit for parameter No. 134, as well as the communication code, end code, communication protocol, interface, and SAT command for parameter No. 135 are displayed only when channel 3 is being used for input/output.

- 4 Select the soft key corresponding to the desired type of data (program, parameter, and so forth).
- 5 Set the parameters corresponding to the type of input/output unit to be used. (Parameter setting is possible regardless of the mode.)

| 8.10.2<br>Inputting and<br>Outputting Programs | A program can be input and output using the ALL IO screen.<br>When entering a program using a cassette or card, the user must specify<br>the input file containing the program (file search).   |  |
|--|---|--|
| File search                                    |   |  |
| Procedure                                      | <ol> <li>Press soft key [PRGRM] on the ALL IO screen, described in Section 8.10.1.</li> <li>Select EDIT mode. A program directory is displayed.</li> <li>Press soft key [(OPRT)]. The screen and soft keys change as shown below.</li> <li>A program directory is displayed only in EDIT mode. In all other modes, the ALL IO screen is displayed.</li> </ol>   |  |
|  | O0001 N00010<br>PROGRAM (NUM.) MEMORY (CHAR.)<br>USED : 60 3321<br>FREE : 2 429<br>O0010 O0001 O0003 O0002 O0555 O0999<br>O0062 O0004 O0005 O1111 O0969 O6666<br>O0021 O1234 O0588 O0020 O0040<br>>_<br>EDIT **** *** *** 14:46:09<br>(F SRH) (READ) (PUNCH) (DELETE) ((OPRT))  |  |
|  | <ul> <li>4 Enter address N.</li> <li>5 Enter the number of the file to be found.</li> <li>N0<br/>The first floppy file is found.</li> <li>One of N1 to N9999<br/>Among the files numbered from 1 to 9999, a specified file is found.</li> <li>N-9999<br/>The file immediately after that used most recently is found.</li> <li>N-9998<br/>When -9998 is specified, the next file is found. Then, each time<br/>a file input/output operation is performed, N-9999 is automatically<br/>inserted. This means that subsequent files can be sequentially<br/>found automatically.<br/>This state is canceled by specifying N0, N1 to N9999, or N-9999,<br/>or upon a reset.</li> </ul> |  |
| ( ) ( ) ( ) ( CAN ) ( EXEC )                   | <ul><li>6 Press soft keys [F SRH] and [EXEC].<br/>The specified file is found.</li></ul>  |  |

### **Explanations**

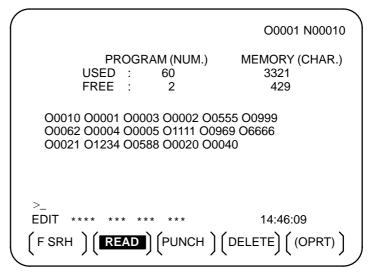
| <ul> <li>Difference between N0<br/>and N1</li> </ul>   | When a file already exists in a cassette or card, specifying N0 or N1 has<br>the same effect. If N1 is specified when there is no file on the cassette or<br>card, an alarm is issued because the first file cannot be found. Specifying<br>N0 places the head at the start of the cassette or card, regardless of whether<br>the cassette/card already contains files. So, no alarm is issued in this case.<br>N0 can be used, for example, when a program is written into a new<br>cassette or card, or when a previously used cassette or card is used once<br>all the files it contains have been erased. |
|--|---|
| <ul> <li>Alarm issue during file<br/>search</li> </ul> | If an alarm (file search failure, for example) is generated during file search, the CNC does not issue an alarm immediately. However, a P/S alarm (No. 086) is issued if input/output is subsequently performed on that file.   |
| <ul> <li>File search using N–9999</li> </ul>           | Instead of sequentially searching for files by specifying actual file numbers every time, the user can specify the first file number, then find the subsequent files by specifying N–9999. When N–9999 is specified, the time required for file search can be reduced.  |

Inputting a program

### Procedure

1 Press soft key **[PRGRM]** on the ALL IO screen, described in Section 8.10.1.

- 2 Select EDIT mode. A program directory is displayed.
- **3** Press soft key **[(OPRT)]**. The screen and soft keys change as shown below.
  - A program directory is displayed only in EDIT mode. In all other modes, the ALL IO screen is displayed.



4 To specify a program number to be assigned to an input program, enter address O, followed by the desired program number. If no program number is specified, the program number in the file or on the NC tape is assigned as is.

| 8. DATA INPUT/OUTPUT            | OPERATION   | B-63004EN/02  |
|---------------------------------|---|---|
| ( ) ( ) (STOP) ( CAN ) ( EXEC ) | <ul> <li>5 Press soft key [READ], then [EXEC].<br/>The program is input with the program nurassigned.<br/>To cancel input, press soft key [CAN].<br/>To stop input prior to its completion, press</li> </ul>  |   |
| Outputting a pro                | gram  |   |
| Procedure                       | 1 Press soft key <b>[PRGRM]</b> on the ALL IO scre<br>8.10.1.   | een, described in Section   |
|                                 | 2 Select EDIT mode. A program directory is  | displayed.  |
|                                 | 3 Press soft key <b>[(OPRT)]</b> . The screen and so below.   | ft keys change as shown   |
|                                 | • A program directory is displayed only in I modes, the ALL IO screen is displayed.   | EDIT mode. In all other   |
|                                 | C   | 00001 N00010  |
|                                 | USED : 60 3<br>FREE : 2   | ORY (CHAR.)<br>321<br>429   |
|                                 | O0010 O0001 O0003 O0002 O0555 O099<br>O0062 O0004 O0005 O1111 O0969 O6660<br>O0021 O1234 O0588 O0020 O0040  |   |
|                                 | >_<br>EDIT **** *** *** *** 14<br>(FSRH)( <b>READ</b> )(PUNCH)(DELETE   | I:46:09<br>Ξ) ( (OPRT) )  |
|                                 | 4 Enter address O.  |   |
|                                 | 5 Enter a desired program number.<br>If −9999 is entered, all programs in memory<br>To output a range of programs, enter OΔΔ<br>programs numbered from ΔΔΔΔ to □□□<br>When bit 4 (SOR) of parameter No. 3107 for<br>on the program library screen, programs are<br>from those having the smallest program num | <ul> <li>AAA, O</li> <li>The</li> <li>are output.</li> <li>sorted display is set to 1</li> <li>output in order, starting</li> </ul> |
| ( ) ( ) (STOP) ( CAN ) ( EXEC)  | 6 Press soft key <b>[PUNCH]</b> , then <b>[EXEC]</b> .<br>The specified program or programs are outpointed, the currently selected program is o   | -   |

# 6 Press soft key [PUNCH], then [EXEC].

The specified program or programs are output. If steps 4 and 5 are omitted, the currently selected program is output. To cancel output, press soft key [CAN]. To stop output prior to its completion, press soft key [STOP].

| Deleting files                                      |   |
|---|---|
| Procedure   | <ol> <li>Press soft key [PRGRM] on the ALL IO screen, described in Section<br/>8.10.1.</li> </ol>               |
|   | 2 Select EDIT mode. A program directory is displayed.   |
|   | 3 Press soft key <b>[(OPRT)]</b> . The screen and soft keys change as show below.                               |
|   | • A program directory is displayed only in EDIT mode. In all othe modes, the ALL IO screen is displayed.        |
|   | O0001 N00010  |
|   | PROGRAM (NUM.) MEMORY (CHAR.)<br>USED : 60 3321<br>FREE : 2 429   |
|   | O0010 O0001 O0003 O0002 O0555 O0999<br>O0062 O0004 O0005 O1111 O0969 O6666<br>O0021 O1234 O0588 O0020 O0040     |
|   | $\sum_{i=1}^{2} EDIT + + + + + + + + + + + + + + + + + + +$   |
|   | 4 Press soft key [DELETE].  |
|   | 5 Enter a file number, from 1 to 9999, to indicate the file to be deleted                                       |
| ()()()(CAN)(EXEC)                                   | <ul><li>6 Press soft key [EXEC].<br/>The k-th file, specified in step 5, is deleted.</li></ul>                  |
| Explanations  |   |
| <ul> <li>File numbers after<br/>deletion</li> </ul> | After deletion of the k-th file, the previous file numbers $(k+1)$ to n and decremented by 1 to k to $(n-1)$ .  |
|   | Before deletionAfter deletion1 to $(k-1)$ 1 to $(k-1)$ kDeleted $(k+1)$ to nk to $(n-1)$                        |
| Write protect                                       | Before a file can be deleted, the write protect switch of the cassette mu be set to make the cassette writable. |

# 8.10.3 Inputting and Outputting Parameters

Parameters can be input and output using the ALL IO screen.

### Inputting parameters Procedure 1 Press soft key **[PARAM]** on the ALL IO screen, described in Section 8.10.1. 2 Select EDIT mode. Press soft key [(OPRT)]. The screen and soft keys change as shown 3 below. **READ/PUNCH (PARAMETER)** O1234 N12345 I/O CHANNEL 3 TV CHECK OFF DEVICE NUM. PUNCH CODE 0 ISO BAUDRATE 4800 INPUT CODE ASCII STOP BIT 2 FEED OUTPUT FEED NULL INPUT (EIA) NO EOB OUTPUT (ISO) CR TV CHECK (NOTES) ON BAUDRATE CLK. INNER CD CHECK (232C) OFF **RESET/ALARM** ON PARITY BIT OFF COM CODE ASCII END CODE EXT COM PROTCOL Α INTERFACE SAT COMMAND HOST RS422 (0:EIA 1:ISO)>1\_ MDI 12:34:56 \* \* \* \* ) ( READ ) ( PUNCH ) ( ĴĹ

( ) ( ) ( ) ( CAN ) ( EXEC )

### 4 Press soft key **[READ]**, then **[EXEC]**.

The parameters are read, and the "INPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of input, the "INPUT" indicator is cleared from the screen. To cancel input, press soft key **[CAN]**.

| Outputtin | g parameters   |   |
|-----------|--|---|
| Procedure | 1 Press soft key <b>[PARAN</b><br>8.10.1.  | <b>1</b> ] on the ALL IO screen, described in Section |
|           | <b>2</b> Select EDIT mode.   |   |
|           | 3 Press soft key <b>[(OPRT)</b> below.   | )]. The screen and soft keys change as shown          |
|           | READ/PUNCH (PARAM  | IETER) 01234 N12345                                   |
|           | STOP BIT<br>NULL INPUT (EIA)<br>TV CHECK (NOTES)<br>CD CHECK (232C)<br>PARITY BIT<br>END CODE<br>INTERFACE R<br>(0:EIA 1:ISO)>1_<br>MDI **** *** *** |   |
|           | L J READ   |   |

( ) ( ) ( ) ( CAN ) ( EXEC )

# 4 Press soft key [PUNCH], then [EXEC].

The parameters are output, and the "OUTPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of output, the "OUTPUT" indicator is cleared from the screen. To cancel output, press soft key **[CAN]**.

# 8.10.4 Inputting and Outputting Offset Data

Offset data can be input and output using the ALL IO screen.

### Inputting offset data Procedure 1 Press soft key [OFFSET] on the ALL IO screen, described in Section 8.10.1. 2 Select EDIT mode. Press soft key [(OPRT)]. The screen and soft keys change as shown 3 below. **READ/PUNCH (OFFSET)** O1234 N12345 I/O CHANNEL 3 TV CHECK OFF DEVICE NUM. PUNCH CODE 0 ISO BAUDRATE 4800 INPUT CODE ASCII STOP BIT 2 FEED OUTPUT FEED NULL INPUT (EIA) NO EOB OUTPUT (ISO) CR TV CHECK (NOTES) ON BAUDRATE CLK. INNER CD CHECK (232C) OFF **RESET/ALARM** ON PARITY BIT OFF COM CODE ASCII END CODE EXT COM PROTCOL Α INTERFACE SAT COMMAND HOST RS422 (0:EIA 1:ISO)>1\_ MDI 12:34:56 \* \* \* \* ) ( READ ) ( PUNCH ) ( ĴĹ

Press soft key [READ], then [EXEC]. The offset data is read, and the "INPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of input, the "INPUT" indicator is cleared from the screen. To cancel input, press soft key [CAN].

( ) ( ) ( ) ( CAN ) ( EXEC )

| Outputting offset data |  |                    |   |  |
|------------------------|--|--------------------|---|--|
| Procedure              | 1 Press soft key <b>[OFF</b> 8.10.1.   |                    |   |  |
|                        | 2 Select EDIT mode   |                    |   |  |
|                        | 3 Press soft key [(OF below.   | <b>PRT)]</b> . The | screen and soft keys change as shown                    |  |
|                        | READ/PUNCH (OF   | FSET)              | O1234 N12345  |  |
|                        | I/O CHANNEL<br>DEVICE NUM.<br>BAUDRATE<br>STOP BIT<br>NULL INPUT (EIA)<br>TV CHECK (NOTES)<br>CD CHECK (232C)<br>PARITY BIT<br>END CODE<br>INTERFACE |                    | BAUDRATE CLK. INNER<br>RESET/ALARM ON<br>COM CODE ASCII |  |
|                        | (0:EIA 1:ISO)>1_<br>MDI **** ***   | *** ***            | 12:34:56  |  |
|                        | ( )( RE  | AD ) ( PUN         | сн)()()   |  |

( ) ( ) ( ) ( CAN ) ( EXEC )

# 4 Press soft key [PUNCH], then [EXEC].

The offset data is output, and the "OUTPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of output, the "OUTPUT" indicator is cleared from the screen. To cancel output, press soft key **[CAN]**.

Custom macro common variables can be output using the ALL IO screen.

# 8.10.5 Outputting Custom Macro Common Variables

( )( )( )(CAN)(EXEC)

| Outputti  | Outputting custom macro common variables |   |                            |                   |                                     |
|-----------|--|---|----------------------------|-------------------|-------------------------------------|
| Procedure | 1  | Press soft key <b>[MAC</b><br>8.10.1.   | RO] on th                  | e ALL IO screen,  | described in Section                |
|           | 2  | Select EDIT mode.   |                            |                   |                                     |
|           | 3  | Press soft key <b>[(OP</b> )<br>below.  | <b>RT)]</b> . The          | screen and soft k | eys change as show                  |
|           |  | READ/PUNCH (MAC   | CRO)                       | O123              | 4 N12345                            |
|           |  | I/O CHANNEL<br>DEVICE NUM.<br>BAUDRATE<br>STOP BIT<br>NULL INPUT (EIA)<br>TV CHECK (NOTES)<br>CD CHECK (232C)<br>PARITY BIT<br>END CODE<br>INTERFACE<br>(0:EIA 1:ISO)>1_<br>MDI **** ***<br>( ) ( REA | OFF<br>OFF<br>EXT<br>RS422 | 12.01             | . INNER<br>ON<br>ASCII<br>A<br>HOST |

### 4 Press soft key [PUNCH], then [EXEC].

The custom macro common variables are output, and the "OUTPUT" indicator blinks at the lower-right corner of the screen. Upon the completion of output, the "OUTPUT" indicator is cleared from the screen.

To cancel output, press soft key [CAN].

# NOTE

To input a macro variable, read the desired custom macro statement as a program, then execute the program.

# 8.10.6 Inputting and Outputting Floppy Files

The ALL IO screen supports the display of a directory of floppy files, as well as the input and output of floppy files.

# Procedure 1 Press the rightmost soft key [> (next-menu key) on the ALL IO screen, described in Section 8.10.1. 2 Press soft key [FLOPPY]. 3 Select EDIT mode. The floppy screen is displayed. 4 Press soft key [(OPRT)]. The screen and soft keys change as shown below. The floppy screen is displayed only in EDIT mode. In all other modes, the ALL IO screen is displayed. READ/PUNCH (FLOPPY) 01234 N12345 MDI 12:34:56 [F SRH ] (READ [PUNCH (FLOPPY])

- 5 Press soft key [F SRH].
- 6 Enter the number of the desired file, then press soft key [F SET].

(fset)()()(CAN)(EXEC)

7 Press soft key **[EXEC]**. A directory is displayed, with the specified file uppermost. Subsequent files in the directory can be displayed by pressing the page key.

| READ/P   | UNCH (FLOPPY)   | O1234 N12345   |
|----------|---|--|
| No.      | FILENAME  | (Meter) VOL  |
| 0001     | PARAMETER   | 46.1   |
|          |   | 12.3   |
|          |   | 1.9  |
|          | O0002<br>O0003  | 1.9  |
| 0006     | O0004   | 1.9<br>1.9   |
| 0007     | O0005   | 1.9  |
|          |   | 1.9  |
| 0009     | 00020   | 1.9  |
| F SRH    |   |  |
|          | e No.=2   |  |
| _        |   |  |
| EDIT     | **** *** *** ***  | 12:34:56   |
| Í F SRH  |   | ) ( CAN ) ( EXEC )   |
| ζ. οι αι |   |  |
|          | No.<br>0001<br>0002<br>0003<br>0004<br>0005<br>0006<br>0007<br>0008<br>0009<br>F SRH<br>File<br>>2_<br>EDIT | 0001 PARAMETER<br>0002 ALL.PROGRAM<br>0003 00001<br>0004 00002<br>0005 00003<br>0006 00004<br>0007 00005<br>0008 00010<br>0009 00020<br>F SRH<br>File No.=2<br>>2_ |

A directory in which the first file is uppermost can be displayed simply by pressing the page key. (Soft key **[F SRH]** need not be pressed.)

| Inputting a file |  |
|------------------|--|
| Procedure        | 1 Press the rightmost soft key $[\square]$ (next-menu key) on the ALL IO screen, described in Section 8.10.1.  |
|                  | 2 Press soft key [FLOPPY].   |
|                  | <b>3</b> Select EDIT mode. The floppy screen is displayed.   |
|                  | <ul><li>4 Press soft key [(OPRT)]. The screen and soft keys change as shown below.</li><li>The floppy screen is displayed only in EDIT mode. In all other modes, the ALL IO screen is displayed.</li></ul> |
|                  | READ/PUNCH (FLOPPY) O1234 N12345   |
|                  | ><br>MDI **** *** *** *** 12:34:56<br>(F SRH ) ( READ ) ( PUNCH ) ( DELETE ) ( )   |
|                  | 5 Press soft key <b>[READ]</b> .   |

- 6 Enter the number of a file or program to be input.
  - Setting a file number: Enter the number of the desired file, then press soft key [F SET].
  - Setting a program number: Enter the number of the desired program, then press soft key **[O SET]**.
- 7 Press soft key **[EXEC]**. The specified file or program is read, and the "INPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of input, the "INPUT" indicator is cleared from the screen.

( F SET ) (O SET) (STOP) ( CAN ) ( EXEC)

| Outputting a file |   |                                |  |
|-------------------|---|--------------------------------|--|
| Procedure         | 1 Press the rightmost soft key 🗁 (next-menu key) on the ALL IC screen, described in Section 8.10.1.                                     |                                |  |
|                   | 2 Press soft key [FLOPPY].  |                                |  |
|                   | <b>3</b> Select EDIT mode. The floppy so  | creen is displayed.            |  |
|                   | <ul> <li>Press soft key [(OPRT)]. The screbelow.</li> <li>The floppy screen is displayed or modes, the ALL IO screen is disp</li> </ul> | only in EDIT mode. In all othe |  |
|                   | READ/PUNCH (FLOPPY)   | O1234 N12345                   |  |
|                   | ><br>MDI **** *** ***<br>(FSRH)( READ)(PUNCH)   | 12:34:56                       |  |

- 5 Press soft key [PUNCH].
- 6 Enter the number of the program to be output, together with a desired output file number.
  - Setting a file number: Enter the number of the desired file, then press soft key [F SET].
  - Setting a program number: Enter the number of the desired program, then press soft key **[O SET]**.
- 7 Press soft key [EXEC].
  The specified program is output, and the "OUTPUT" indicator blinks at the lower–right corner of the screen. Upon the completion of output, the "OUTPUT" indicator is cleared from the screen. If no file number is specified, the program is written at the end of the currently registered files.

( F SET ) (O SET) (STOP) ( CAN ) ( EXEC )

| Deleting a file |   |
|-----------------|---|
| Procedure       | 1 Press the rightmost soft key ▷ (next-menu key) on the ALL IC screen, described in Section 8.10.1.   |
|                 | 2 Press soft key [FLOPPY].  |
|                 | <b>3</b> Select EDIT mode. The floppy screen is displayed.  |
|                 | <ul> <li>Press soft key [(OPRT)]. The screen and soft keys change as show below.</li> <li>The floppy screen is displayed only in EDIT mode. In all othe modes, the ALL IO screen is displayed.</li> </ul> |
|                 | READ/PUNCH (FLOPPY) O1234 N12345  |
|                 | $MDI  \text{****}  \text{***}  \text{***}  12:34:56 \\ \left( F SRH \right) \left( READ \right) \left( PUNCH \right) \left( DELETE \right) \left( \right)$  |
|                 | 5 Press soft key [DELETE].  |
|                 | 6 Enter the number of the desired file, then press soft key <b>[F SET]</b> .  |

7 Press soft key **[EXEC]**. The specified file is deleted. After the file has been deleted, the subsequent files are shifted up.

(f set ) ( ) ( ) ( CAN ) ( EXEC )

8.10.7 Data held in CNC memory can be saved to a memory card in MS–DOS format. Data held on a memory card can be loaded into CNC memory. A save or load operation can be performed using soft keys while the CNC is operating. Loading can be performed in either of two ways. In the first method, all

Loading can be performed in either of two ways. In the first method, all saved memory data is loaded. In the second method, only selected data is loaded.

| $\int$          | READ/PUNCH(M–CARD) O1234 N12345         |     |  |
|-----------------|---|-----|--|
|                 | CNC RAM Memory card                     | _   | — *1: CNC memory   |
|                 | 512K byte   2. 000M byte S- RAM         |     | <ul> <li>*2: Memory card size and type</li> </ul>  |
|                 | File ( 1/ 1)                            | - I |  |
|                 | SRAM0_5A. FDB 524288 byte 97/01/23      |     | <ul> <li>*3: Names, sizes, dates, and number of files recorded on the memory card</li> </ul> |
|                 |   | л I |  |
|                 | COMPLETED                               |     | — *4: Operation message  |
|                 |   |     |  |
|                 | Select : All data S 0 T0000             |     | <ul> <li>*5: Select a desired type of load data only<br/>when [LOAD] is selected.</li> </ul> |
|                 | EDIT **** EMG 12: 15: 00                | ļ   |  |
| $\overline{\ }$ | [FORMAT] [ SAVE ] [ LOAD ] [DELETE] [ ] |     |  |
|                 | [ CAN ] [ ] [ ] [ CAN ] [ EXEC ]        |     | ← When [FORMAT], [SAVE], or<br>[DELETE] is selected  |
|                 | [SELECT] [ ] [ ] [ CAN ] [ EXEC ]       |     | ← When [LOAD] is selected  |

- The CNC memory size (\*1) is displayed at all times.
- When no memory card is inserted, the message field (\*4) displays a message prompting the user to insert a memory card, but does not display the memory card states (\*2 and \*3).
- If an inserted memory card is invalid (if there is no attribute memory, or if the attribute memory does not contain any device information), the message field (\*4) displays an error message, but does not display the memory card states (\*2 and \*3).

# Saving memory data

Data held in CNC memory can be saved to a memory card in MS–DOS format.

### Saving memory data

### Procedure

- 1 Press the rightmost soft key ▷ (next-menu key) on the ALL IO screen, described in Section 8.10.1.
- 2 Press soft key [M-CARD].
- **3** Place the CNC in the emergency stop state.
- **4** When a memory card is inserted, the state of the memory card is displayed as shown below.

| READ/PUNCH(M–CARD)  | O1234 N12345        |
|---------------------|---------------------|
|                     | — Memory card ———   |
| 512K byte           | 2.000M byte S-RAM   |
| File                | ( 1/ 1)             |
|                     | ('''')              |
| SRAM0_5A. FDB 5     | 24288 byte 97/01/23 |
| Message             |                     |
| _                   |                     |
|                     |                     |
| Select : All data   |                     |
|                     | S 0 T0000           |
| EDIT **** EMG       |                     |
| [FORMAT] [ SAVE ] [ | LOAD ] [DELETE] [ ] |

- 5 Press soft key [SAVE].
- 6 A message prompting the user to confirm the operation is displayed. Press soft key **[EXEC]** to execute the save operation.
- 7 As the data is being saved to the card, the message "RUNNING" blinks, and the number of bytes saved is displayed in the message field.
- 8 Once all data has been saved to the card, the message "COMPLETED" is displayed in the message field, with the message "PRESS RESET KEY." displayed on the second line.
- **9** Press the RESET key. The displayed messages are cleared from the screen, and the display of the memory card state is replaced with that of the saved file.

### NOTE

All CNC memory data is saved to a memory card. CNC memory data cannot be saved selectively.

)()()(CAN)(EXEC)

### Explanations

• File name

The file name used for save operation is determined by the amount of SRAM mounted in the CNC. A file holding saved data is divided into blocks of 512KB.

### **HEAD1 SRAM file**

| Amount of SRAM                        | 256 KB        | 0.5 MB        | 1.0 MB                         | 2.5 MB  |
|---------------------------------------|---------------|---------------|--------------------------------|---|
| Number of files 1<br>2<br>3<br>4<br>5 | SRAM256A. FDB | SRAM0_5A. FDB | SRAM1_0A. FDB<br>SRAM1_0B. FDB | SRAM2_5A. FDB<br>SRAM2_5B. FDB<br>SRAM2_5C. FDB<br>SRAM2_5D. FDB<br>SRAM2_5E. FDB |

### **HEAD2 SRAM file**

| Amount of SRAM                        | 256 KB        | 0.5 MB        | 1.0 MB                         | 2.5 MB  |
|---------------------------------------|---------------|---------------|--------------------------------|---|
| Number of files 1<br>2<br>3<br>4<br>5 | SRAM256A. OP2 | SRAM0_5A. OP2 | SRAM1_0A. OP2<br>SRAM1_0B. OP2 | SRAM2_5A. OP2<br>SRAM2_5B. OP2<br>SRAM2_5C. OP2<br>SRAM2_5D. OP2<br>SRAM2_5E. OP2 |

Canceling saving
 To cancel file save prior to its completion, press the RESET key on the MDI panel.

 Memory card
 When the memory card has less than 512K bytes of free space, a memory

replacement requestcard replacement request is displayed. Insert a new memory card.Loading data into<br/>memory (restoration)CNC memory data that has been saved to a memory card can be loaded<br/>(restored) back into CNC memory.

CNC memory data can be loaded in either of two ways. In the first method, all saved memory data is loaded. In the second method, only selected data is loaded.

### Loading memory data

### Procedure

- 1 Press the rightmost soft key ▷ (next-menu key) on the ALL IO screen, described in Section 8.10.1.
- 2 Press soft key [M-CARD].
- **3** Place the CNC in the emergency stop state.
- 4 When a memory card is inserted, the state of the memory card is displayed as shown below.

| READ/PUNCH(M-CARD)    | O1234 N12345                           |
|-----------------------|--|
| CNC RAM               | – Memory card –<br>2. 000M byte S- RAM |
| File                  | ( 1/ 1)                                |
| SRAM0_5A. FDB 52      | 24288 byte 97/01/23                    |
| Message               |  |
|                       |  |
| Select : All data     | S 0 T0000                              |
| EDIT **** EMG 1       | 2: 15: 00                              |
| [FORMAT] [ SAVE ] [ L | OAD ] [DELETE] [ ]                     |

- 5 Press soft key [LOAD].
- 6 With cursor keys ↑ and ↓, select the file to be loaded from the memory card.

A system having 1.0MB or 2.5MB of CNC RAM may require the loading of multiple files. All or selective data load can be specified for each file.

7 To perform selective data loading, press soft key **[SELECT]**, then select the data to be loaded. Each time the soft key is pressed, the information displayed changes cyclically, as shown below.

| All data> Program | -> Parameter> | Offset       | > PMC data |
|-------------------|---------------|--------------|------------|
|                   | C             | <b>≺</b> — M | acro data  |

- 8 After checking the file selection, press soft key **[EXEC]**.
- **9** During loading, the message "RUNNING" blinks, and the number of bytes loaded is displayed in the message field.
- **10** Upon the completion of loading, the message "COMPLETED" is displayed in the message field, with the message "PRESS RESET KEY." displayed on the second line.
- 11 Press the RESET key. The messages are cleared from the screen.

(select) ( ) ( ) ( CAN ) (EXEC)

### **Explanations**

- Canceling loading
- To cancel file load prior to its completion, press the RESET key on the MDI panel.
- Turning off the power Depending off, then ba
- Parameter/PMC data
- Program/offset data
- Loading files from multiple memory cards

panel.

Depending on the type of data, the system power may have to be turned off, then back on, for the load to become effective. When necessary, the message "TURN OFF POWER." is displayed in the message field.

Before performing parameter/PMC data load, enable parameter write.

Before performing program/offset data load, set the data protection key, on the machine operator's panel, to the ON position.

When multiple files are to be loaded from multiple memory cards, a message requesting memory card replacement is displayed.

### NOTE

If the saved data and CNC system onto which the saved data is to be loaded do not satisfy the conditions described below, an error message is displayed in the message field, and loading is disabled. Note, however, that in selective loading, even if the CNC system structure differs from that of a saved file, the file is never the less loaded.

- The size of a saved file does not match the size of CNC RAM.
- · The saved file has a different extension.

# Memory card formatting

Before a file can be saved to a memory card, the memory card must be formatted.

### Formatting a memory card

## Procedure

- 1 Press the rightmost soft key  $\bigcirc$  (next-menu key) on the ALL IO screen, described in Section 8.10.1.
- 2 Press soft key [M-CARD].
- **3** Place the CNC in the emergency stop state.
- **4** When a memory card is inserted, the state of the memory card is displayed as shown below.

| READ/PUNCH(M-CARI                  | O) O1234 N12345                     |
|------------------------------------|-------------------------------------|
| CNC RAM                            | 2. 000M byte S- RAM                 |
| File                               | ( 1/ 1)                             |
| SRAM0_5A. FDB                      | 524288 byte 97/01/23                |
| Message                            |                                     |
| Select : All data                  | S 0 T0000                           |
| EDIT **** EMG<br>[FORMAT] [ SAVE ] | 12: 15: 00<br>[ LOAD ] [DELETE] [ ] |

- 5 Press soft key [FORMAT].
- 6 A message prompting the user to confirm the operation is displayed. Press soft key **[EXEC]** to execute the formatting operation.
- 7 As formatting is being performed, the message "FORMATTING" blinks.
- 8 Upon the completion of formatting, the message "COMPLETED" is displayed in the message field.

( )( )( )( can )(exec)

| 8. DATA INPUT/OUTPUT   | OPERATION   | B-63004EN/02  |
|------------------------|---|---|
| Deleting files         | Unnecessary saved files can be deleted from a memory  | ory card.   |
| Deleting files         |   |   |
| Procedure              | <ol> <li>Press the rightmost soft key          (next-menu l screen, described in Section 8.10.1.</li> <li>Press soft key [M-CARD].</li> <li>Place the CNC in the emergency stop state.</li> <li>When a memory card is inserted, the state of t displayed as shown below.</li> <li>READ/PUNCH(M-CARD) O1234 N123         <ul> <li>CNC RAM</li> <li>Memory card</li> <li>2.000M byte S-RAW</li> <li>File</li> <li>(1/<br/>SRAM0_5A. FDB 524288 byte 97/01/23</li> <li>Message</li> <li>Select : All data</li> <li>S 0 T0000</li> <li>EDIT **** EMG 12: 15: 00</li> <li>[FORMAT] [ SAVE ] [ LOAD ] [DELETE] [</li> </ul> </li> </ol> | the memory card is  |
| ( ) ( ) ( CAN ) (EXEC) | <ul> <li>5 Press soft key [DELETE].</li> <li>6 With cursor keys  ↑ and  ↓, select the file to memory card.</li> <li>7 After checking the file selection, press soft key</li> <li>8 As detection is being performed, the message "DE the message field.</li> <li>9 Upon the completion of deletion, the message displayed in the message field.</li> <li>NOTE An SRAM of 1M bytes or more will contain r delete the contents of such an SRAM, contained files.</li> </ul>  | <b>[EXEC]</b> .<br>ELETING" blinks in<br>"COMPLETED" is<br>nultiple files. To |

# Message and restrictions

# Messages

| Message                            | Description  |
|------------------------------------|--|
| INSERT MEMORY CARD.                | No memory card is inserted.  |
| UNUSABLE MEMORY CARD               | The memory card does not contain device information.   |
| FORMAT MEMORY CARD.                | The memory card is not formatted. Format the memory card before use.   |
| THE FILE IS UNUSABLE.              | The format or extension of the file to be loaded is invalid. Alternatively, the data stored on the memory card does not match the CNC memory size. |
| REPLACE MEMORY CARD.               | Replace the memory card.   |
|                                    | An error occurred during file system processing.   |
| SET EMERGENCY STOP STATE.          | Save/load operation is enabled in the emergency stop state only.   |
| WRITE-PROTECTED                    | Save operation: The protect switch of the memory card is set to the disabled position.<br>Load operation: Parameter write is disabled.             |
| VOLTAGE DECREASED.                 | The battery voltage of the memory card has dropped.<br>(The battery requires replacement.)   |
| DEVICE IS BUSY.                    | Another user is using the memory card. Alternatively, the device can-<br>not be accessed because automatic operation is in progress.               |
| SRAM → MEMORY CARD?                | This message prompts the user to confirm the start of data saving.   |
| MEMORY CARD $\rightarrow$ SRAM?    | This message prompts the user to confirm the start of data loading.  |
| DO YOU WANT TO DELETE FILE(S)?     | This message prompts the user to confirm the start of deletion.  |
| DO YOU WANT TO PERFORM FORMATTING? | This message prompts the user to confirm the start of formatting.  |
| SAVING                             | Saving is currently being performed.   |
| LOADING                            | Loading is currently being performed.  |
| DELETING                           | File deletion is currently being performed.  |
| FORMATTING                         | Memory card formatting is currently being performed.   |
| COMPLETED                          | Save or load processing has been completed.  |
| PRESS RESET KEY.                   | Press the RESET key.   |
| TURN OFF POWER.                    | Turn the power off, then back on again.  |

### File system error codes

| Code | Meaning  |
|------|--|
| 102  | The memory card does not have sufficient free space.                                     |
| 105  | No memory card is mounted.   |
| 106  | A memory card is already mounted.  |
| 110  | The specified directory cannot be found.   |
| 111  | There are too many files under the root directory to allow a di-<br>rectory to be added. |
| 114  | The specified file cannot be found.  |
| 115  | The specified file is protected.   |
| 117  | The file has not yet been opened.  |
| 118  | The file is already open.  |
| 119  | The file is locked.  |
| 122  | The specified file name is invalid.  |
| 124  | The extension of the specified file is invalid.  |
| 129  | A non-corresponding function was specified.  |
| 130  | The specification of a device is invalid.  |
| 131  | The specification of a pathname is invalid.  |
| 133  | Multiple files are open at the same time.  |
| 135  | The device is not formatted.   |
| 140  | The file has the read/write disabled attribute.  |

### Restrictions

• Memory card

data

specifications

• Attribute memory

• Flash ROM card

• Operation during

automatic operation

• Compatibility of saved

- Memory card size The size of the memory card to be used must be larger than that of the RAM module mounted in the CNC. The size of the RAM module can be determined from the system configuration screen.
  - Use a memory card that conforms to PCMCIA Ver. 2.0, or JEIDA Ver. 4.1.
    - A memory card which has no attribute memory, or no device information in its attribute memory, cannot be used.
    - Data saved to a memory card is compatible only with CNCs that have the same hardware configuration and the same option configuration.
      - A flash ROM card can be used only for data loading.

During automatic operation, the contents of a memory card cannot be displayed, formatted, or deleted. To enable these operations, therefore, stop or suspend automatic operation.

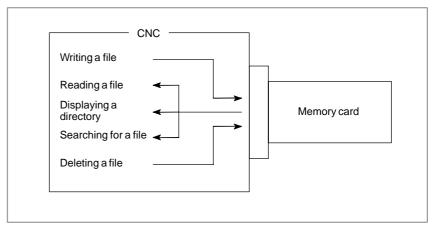
# 8.11 DATA INPUT/OUTPUT USING A MEMORY CARD

By setting the I/O channel (parameter No. 20) to 4, files on a memory card can be referenced, and different types of data such as part programs, parameters, and offset data on a memory card can be input and output in text file format.

The major functions are listed below.

- Displaying a directory of stored files The files stored on a memory card can be displayed on the directory screen.
- Searching for a file A search is made for a file on a memory card and, if found, it is displayed on the directory screen.
- Reading a file Text–format files can be read from a memory card.
- Writing a file Data such as part programs can be stored to a memory card in text file format.
- Deleting a file

A file can be selected and deleted from a memory card.



| Displaying a direc | ctory            | ry of stored files  |         |
|--------------------|------------------|---|---------|
| Procedure          | 1<br>2<br>3<br>4 | <ul> <li>Press function key PROG .</li> <li>Press the rightmost soft key (next-menu key).</li> </ul>  | . Using |
|                    |                  | $ \begin{array}{c cccc} \hline \\ \hline DIRECTORY (M-CARD) & O0034 \ N00045 \\ \hline No. & FILE \ NAME & SIZE & DATE \\ 0001 & 01000 & 123456 & 96/07/10 \\ 0002 & 01001 & 8458 & 96/07/30 \\ 0003 & 00002 & 3250 & 96/07/30 \\ 0004 & 02000 & 73456 & 96/07/31 \\ 0005 & 02001 & 3444 & 96/07/31 \\ 0006 & 03001 & 8483 & 96/08/02 \\ 0007 & 03300 & 406 & 96/08/05 \\ 0008 & 03400 & 2420 & 96/07/31 \\ 0009 & 03500 & 7460 & 96/07/31 \\ \hline \\ $ |         |

~

5 Comments relating to each file can be displayed by pressing soft key [DIR+].

| ( |      | ORY (M–CAI<br>FILE NAM |   | 00034 N00045 |
|---|------|------------------------|---|--------------|
|   | No.  | FILE NAM               | E   | COMMENT      |
|   | 0001 | O1000                  | (C  | OMMENT )     |
|   | 0002 | O1001                  | (S  | UB PROGRAM ) |
|   | 0003 | O0002                  | (1  | 2345678 )    |
|   | 0004 | O2000                  | (   | )            |
|   | 0005 | O2001                  | (   | )            |
|   | 0006 | O3001                  | (S  | KIP–K )      |
|   | 0007 | O3300                  | (H  | II–SPEED )   |
|   | 0008 | O3400                  | (   | )            |
|   | 0009 | O3500                  | (T  | EST PROGRAM) |
| ~ |      |                        |   | ~            |
|   | PROC | 3 ) í                  | $\left( DIR + \right) \right)$  |              |
|   |      |                        |   |              |
| Ĩ |      | 6)(                    | $\left( \begin{array}{c} DIR + \end{array} \right) \left( \begin{array}{c} \end{array} \right)$ |              |

6 Repeatedly pressing soft key [DIR+] toggles the screen between the display of comments and the display of sizes and dates.Any comment described after the O number in the file is displayed. Up to 18 characters can be displayed on the screen.

### Searching for a file

### Procedure

- **1** Press the EDIT switch on the machine operator's panel.
- **2** Press function key |PROG|.
- **3** Press the rightmost soft key  $[\square]$  (next–menu key).
- 4 Press soft key [CARD]. The screen shown below is displayed.

|   | /        |              |                                       |             |        |
|---|----------|--------------|---------------------------------------|-------------|--------|
|   |          | ORY (M–CAR   |                                       | O0034 N0004 | 5      |
| I | No.      | FILE NAME    | SIZE                                  | DATE        |        |
| I | 0001     | O1000        | 123456                                | 96/07/10    |        |
| I | 0002     | O1001        | 8458                                  | 96/07/30    |        |
| I | 0003     | O0002        | 3250                                  | 96/07/30    |        |
| I | 0004     | O2000        | 73456                                 | 96/07/31    |        |
| I | 0005     | O2001        | 3444                                  | 96/07/31    |        |
| I | 0006     | O3001        | 8483                                  | 96/08/02    |        |
| I | 0007     | O3300        | 406                                   | 96/08/05    |        |
| I | 0008     | O3400        | 2420                                  | 96/07/31    |        |
| I | 0009     | O3500        | 7460                                  | 96/07/31    |        |
| 1 |          |              |                                       |             | 1      |
| î | - (      | <b>-</b> ) ( | $\lambda ( \lambda ) ($               |             | ٦<br>ĩ |
|   | ( PROC   |              | $\left( \text{DIR} + \right) \right)$ | ) ( (OPRT)  |        |
| 1 | <u> </u> | / \          |                                       |             |        |

- 5 Press soft key [(OPRT)].
- 6 Set the number of the desired file number with soft key [F SRH]. Then, start the search by pressing soft key [EXEC]. If found, the file is displayed at the top of the directory screen.

When a search is made for file number 19

| CARD) 00034 N00045 |   |
|--------------------|---|
| AME COMMENT        |   |
| (MAIN PROGRAM)     |   |
| (SUBPROGRAM-1)     |   |
| (COMMENT )         |   |
| (COMMENT )         |   |
|                    | ~   |
|                    | AME COMMENT<br>(MAIN PROGRAM)<br>(SUBPROGRAM–1)<br>(COMMENT ) |

(FSRH) (FREAD) (NREAD) (PUNCH) (DELETE)

| Reading a file |   |
|----------------|---|
| Procedure      | <b>1</b> Press the EDIT switch on the machine operator's panel.   |
|                | 2 Press function key $\Pr{OG}$ .  |
|                | <b>3</b> Press the rightmost soft key $\triangleright$ (next–menu key).   |
|                | 4 Press soft key <b>[CARD]</b> . Then, the screen shown below is displayed  |
|                | $\begin{split} \hline & DIRECTORY (M-CARD) & O0034 \ N00045 \\ & No. & FILE \ NAME & SIZE & DATE \\ & 0001 & 01000 & 123456 & 96/07/10 \\ & 0002 & 01001 & 8458 & 96/07/30 \\ & 0003 & 00002 & 3250 & 96/07/30 \\ & 0004 & 02000 & 73456 & 96/07/31 \\ & 0005 & 02001 & 3444 & 96/07/31 \\ & 0006 & 03001 & 8483 & 96/08/02 \\ & 0007 & 03300 & 406 & 96/08/05 \\ & 0008 & 03400 & 2420 & 96/07/31 \\ & 0009 & 03500 & 7460 & 96/07/31 \\ & \\ \hline & PROG \ & O \ & O \ & OIR \ & O \ & OIR \ & O \ & O \ & OOPRT \ & O \ & OOPRT \$ |

- 5 Press soft key [(OPRT)].
- 6 To specify a file number, press soft key **[FREAD]**. The screen shown below is displayed.

|   | DIRECTC<br>No.<br>0019<br>0020<br>0021 | DRY (M–CARD)<br>FILE NAME<br>O1000<br>O1010<br>O1030 | O0001 N00010<br>COMMENT<br>(MAIN PROGRAM)<br>(SUBPROGRAM–1)<br>(COMMENT ) |
|---|--|--|---|
| ~ |  |  |   |
|   | READ<br>>                              | FILE NAME=20   | PROGRAM No.=120   |
|   | EDIT *                                 | ** *** ***   | 15:40:21  |
|   | (F NAM                                 | $E \left( O SET \right) \left( STOP \right)$         | ( CAN ) ( EXEC )  |

- 7 Enter file number 20 from the MDI panel, then set the file number by pressing soft key [F SET]. Next, enter program number 120, then set the program number by pressing soft key [O SET]. Then, press soft key [EXEC].
  - File number 20 is registered as O0120 in the CNC.
  - Set a program number to register a read file with a separate O number. If no program number is set, the O number in the file name column is registered.

```
(FSRH) (FREAD) (NREAD) (PUNCH) (DELETE)
```

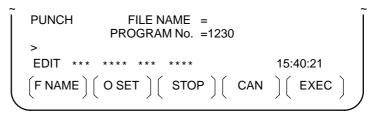
8 To specify a file with its file name, press soft key **[N READ]** in step 6 above. The screen shown below is displayed.

|        | DRY (M–CARD)      | O0001 N00010         |
|--------|-------------------|----------------------|
| No.    | FILE NAME         | COMMENT              |
| 0012   | O0050             | (MAIN PROGRAM)       |
| 0013   | TESTPRO           | (SUB PROGRAM-1)      |
| 0014   | O0060             | (MACRO PROGRAM)      |
|        |                   | · · · · ·            |
|        |                   | ~                    |
| READ   | FILE NAME         | =TESTPRO             |
|        | PROGRAM No.       |                      |
| >      |                   |                      |
|        |                   |                      |
| EDIT 🔹 | *** **** *** **** | 15:40:21             |
|        |                   | P ) ( CAN ) ( EXEC ) |
|        |                   |                      |
|        |                   |                      |

9 To register file name TESTPRO as O1230, enter file name TESTPRO from the MDI panel, then set the file name with soft key [F NAME]. Next, enter program number 1230, then set the program number with soft key [O SET]. Then, press soft key [EXEC].

| Writing a file |  |
|----------------|--|
| Procedure      | <ol> <li>Press the EDIT switch on the machine operator's panel.</li> <li>Press function key PROG .</li> </ol>  |
|                | 3 Press the rightmost soft key (next-menu key).  |
|                | 4 Press soft key <b>[CARD]</b> . The screen shown below is displayed.  |
|                | DIRECTORY (M–CARD)         O0034 N00045           No.         FILE NAME         SIZE         DATE           0001         O1000         123456         96/07/10           0002         O1001         8458         96/07/30           0003         O0022         3250         96/07/30           0004         O2000         73456         96/07/31           0005         O2001         3444         96/07/31           0006         O3001         8483         96/08/02           0007         O3300         406         96/08/05           0008         O3400         2420         96/07/31           0009         O3500         7460         96/07/31 |
|                | $\tilde{\left( \begin{array}{c} \left( \begin{array}{c} PROG \end{array} \right) \left( \begin{array}{c} \end{array} \right) \left( \begin{array}{c} DIR \end{array} + \left( \begin{array}{c} \end{array} \right) \left( \begin{array}{c} (OPRT) \end{array} \right) \\  \end{array} \right)} \\  \end{array}$  |
|                | 5 Press soft key [(OPRT)].   |

- 5 Press soft key [(OPRI)]
- 6 Press soft key [PUNCH].
- 7 Enter a desired O number from the MDI panel, then set the program number with soft key [O SET].
  When soft key [EXEC] is pressed after the setting shown below has been made, for example, the file is written under program number O1230.



8 In the same way as for O number setting, enter a desired file name from the MDI panel, then set the file name with soft key [F SET]. When soft key [EXEC] is pressed after the setting shown below has been made, for example, the file is written under program number O1230 and file name ABCD12.

| PUNCH     | FILE NAME =ABCD12<br>PROGRAM No. =1230         |           |
|-----------|--|-----------|
| >         |  |           |
| EBII      | * * * * * * * * * * *                          | 15:40:21  |
| (F NAME)( | $O SET \left( STOP \right) \left( CAN \right)$ | )( EXEC ) |

(FSRH) (FREAD) (NREAD) (PUNCH) (DELETE)

# **Explanations**

| <ul> <li>Registering the same file<br/>name</li> </ul> | When a file having the same name is already registered in the memory card, the existing file will be overwritten. |
|--|---|
| <ul> <li>Writing all programs</li> </ul>               | To write all programs, set program number $= -9999$ . If no file name is  |

- To write all programs, set program number = -99999. If no file name is specified in this case, file name PROGRAM.ALL is used for registration.
- **File name restrictions** The following restrictions are imposed on file name setting:

<File name setting>

↑ Not longer than 8 characters

 $\times \times \times \times \times \times \times \times . \square \square \square$ 

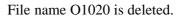
↑ Extension not longer than 3 characters

| Deleting a file |   |  |
|-----------------|---|--|
| Procedure       | 1 Press the EDIT switch on the ma   | chine operator's panel.  |
|                 | <b>2</b> Press function key $PROG$ .  |  |
|                 | 3 Press the rightmost soft key $\square$  | ) (next–menu key).   |
|                 | 4 Press soft key [CARD]. The scr  | een shown below is displayed   |
|                 | 0003         00002         32           0004         02000         734           0005         02001         34           0006         03001         84           0007         03300         4           0008         03400         24 | 456         96/07/10           458         96/07/30           250         96/07/30 |
|                 | $\tilde{\left( \begin{array}{c} PROG \end{array} \right)} \left( \begin{array}{c} DIR + \end{array} \right)$  | $\Big) \Big( \Big) \Big( (OPRT) \Big) \int$  |

6 Set the number of the desired file with soft key **[DELETE]**, then press soft key **[EXEC]**. The file is deleted, and the directory screen is displayed again.

When file number 21 is deleted

| $\boldsymbol{\mathcal{C}}$ |              |                |
|----------------------------|--------------|----------------|
| DIRECTO                    | ORY (M–CARD) | O0034 N00045   |
| No.                        | FILE NAME    | COMMENT        |
| 0019                       | O1000        | (MAIN PROGRAM) |
| 0020                       | O1010        | (SUBPROGRAM-1) |
| 0021                       | O1020        | (COMMENT )     |
| 0022                       | O1030        | (COMMENT )     |
| ~                          |              | ~              |
| ~                          |              | ~              |



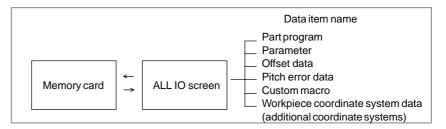
| 1                  |      |              |                |
|--------------------|------|--------------|----------------|
| DIRECTORY (M–CARD) |      | ORY (M–CARD) | O0034 N00045   |
|                    | No.  | FILE NAME    | COMMENT        |
|                    | 0019 | O1000        | (MAIN PROGRAM) |
|                    | 0020 | O1010        | (SUBPROGRAM-1) |
|                    | 0021 | O1020        | COMMENT )      |
|                    | 0022 | O1030        | (COMMENT )     |
| ~                  |      |              |                |

File number 21 is assigned to the next file name.

(FSRH) (FREAD) (NREAD) (PUNCH) (DELETE)

### Batch input/output with a memory card

On the ALL IO screen, different types of data including part programs, parameters, offset data, pitch error data, custom macros, and workpiece coordinate system data can be input and output using a memory card; the screen for each type of data need not be displayed for input/output.



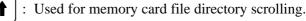
### Procedure

- **1** Press the EDIT switch on the machine operator's panel.
- 2 Press function key SYSTEM .
- **3** Press the rightmost soft key  $\triangleright$  (next–menu key) several times.
- 4 Press soft key [ALL IO]. The screen shown below is displayed.

| /  |                   |          |             |        |       |                                |  |
|--|-------------------|----------|-------------|--------|-------|--------------------------------|--|
|  | READ/PU           | NCH (PRO | )<br>DGRAM) |        | 0     | 0001 N00001                    |  |
|  | No.               | FILE NAM | ΛE          | SIZE   |       | DATE                           |  |
|  | *0001             | O0222    |             | 332010 | 96    | 6-04-06                        |  |
|  | *0002             | O1003    |             | 334450 | 96    | 6–05–04                        |  |
|  | *0003             | MACRO    | VAR.DAT     | 653400 | 96    | 6–05–12                        |  |
|  | *0004             | O0002    |             | 341205 | 96    | 6–05–13                        |  |
|  | [PRC              | DGRAM]   |             |        |       |                                |  |
|  | *O0001            | O0002    | O0003       | O0005  | O0100 | O0020                          |  |
|  | *O0006            | O0004    | O0110       | O0200  | O2200 | O0441                          |  |
|  | *O0330            |          |             |        |       |                                |  |
|  | >                 |          |             |        |       |                                |  |
|  | EDIT *** **** *** |          |             |        |       | 10:07:37                       |  |
| $\left( \begin{array}{c} PROG \end{array} \right) \left( \begin{array}{c} PARAM \end{array} \right) \left( OFFSET \right) \left( \begin{array}{c} \end{array} \right)$ |                   |          |             |        |       | $\Big)  \Big(  (OPRT)  \Big) $ |  |

Upper part: Directory of files on the memory card Lower part: Directory of registered programs

5 With cursor keys ▲ and ↓, the user can choose between upper part scrolling and lower part scrolling. (An asterisk (\*) displayed at the left edge indicates the part for which scrolling is possible.)



: Used for program directory scrolling.

6 With page keys ▲ and ♣, scroll through the file directory or program directory.

### 

### **Explanations**

• Each data item

When this screen is displayed, the program data item is selected. The soft keys for other screens are displayed by pressing the rightmost soft key (next-menu key). Soft key [M-CARD] represents a separate memory card function for saving and restoring system RAM data. (See Section 8.10.7.)

$$\left( \begin{array}{c} \left( MACRO \right) \left( PITCH \right) \left( WORK \right) \left( \right) \left( (OPRT) \right) \right) \\ \left( \right) \left( \right) \left( \right) \left( \right) \left( M-CARD \right) \left( (OPRT) \right) \right) \\ \end{array} \right)$$

When a data item other than program is selected, the screen displays only a file directory.

A data item is indicated, in parentheses, on the title line.

|   | (       |                  |              |          | ) |
|---|---------|------------------|--------------|----------|---|
| 1 | READ/PI | JNCH (PARAMETER) | O0001 N00001 |          |   |
|   | No.     | FILE NAME        | SIZE         | DATE     |   |
|   | 0001    | O0222            | 32010        | 96/04/06 |   |
| I | 0002    | O1003            | 4450         | 96/05/04 |   |
| I | 0003    | MACROVAR.DAT     | 653400       | 96/05/12 |   |
| I | 0004    | O0003            | 4610         | 96/05/04 |   |
| I | 0005    | O0001            | 4254         | 96/06/04 |   |
| I | 0006    | O0002            | 750          | 96/06/04 |   |
|   | 0007    | CNCPARAM.DAT     | 34453        | 96/06/04 |   |
|   |         |                  |              |          |   |

- Program directory display
- Using each function

Program directory display does not match bit 0 (NAM) of parameter No. 3107, or bit 4 (SOR) of parameter No. 3107.

Display the following soft keys with soft key [(OPRT)].

$$\left( F \text{ SRH } \right) \left( F \text{ READ } \right) \left( N \text{ READ } \right) \left( PUNCH \right) \left( DELETE \right)$$

The operation of each function is the same as on the directory (memory card) screen. Soft key **[O SET]**, used for program number setting, and the "PROGRAM NUMBER =" indication are not displayed for data items other than program.

[F SRH]: Finds a specified file number.
[F READ]: Reads a specified file number.
[PUNCH]: Writes a file.
[N READ]: Reads a file under a specified file name.
[DELETE]: Deletes a specified file number.

### NOTE

With a memory card, RMT mode operation and the subprogram call function (based on the M198 command) cannot be used.

# File format and error messages File format All files that are read from and written to a memory card are of text format. The format is described below. A file starts with % or LF, followed by the actual data. A file always ends with %. In a read operation, data between the first % and the next LF is skipped. Each block ends with an LF, not a semicolon (;). • LF: 0A (hexadecimal) of ASCII code • When a file containing lowercase letters, kana characters, and several special characters (such as \$, ¥, and !) is read, those letters and characters are ignored. Example: % O0001(MEMORY CARD SAMPLE FILE) G17 G49 G97 G92X-11.3Y2.33 M30 % • ASCII code is used for input/output, regardless of the setting parameter (ISO/EIA). Bit 3 (NCR) of parameter No. 0100 can be used to specify whether the end of block code (EOB) is output as "LF" only, or as "LF, CR, CR." If an error occurs during memory card input/output, a corresponding error Error messages message is displayed. 0028 O0003 7382 96-06-14 M-CARD ERROR $\times \times \times \times$ 1 PROGRAM No. =13 FILE No. = EDIT \*\*\* \*\*\*\* \*\* 15:40:21 $F SET \left( O SET \right) \left( STOP \right) \left( CAN \right) \left( EXEC \right)$

 $\times \times \times \times$  represents a memory card error code.

#### Memory card error codes

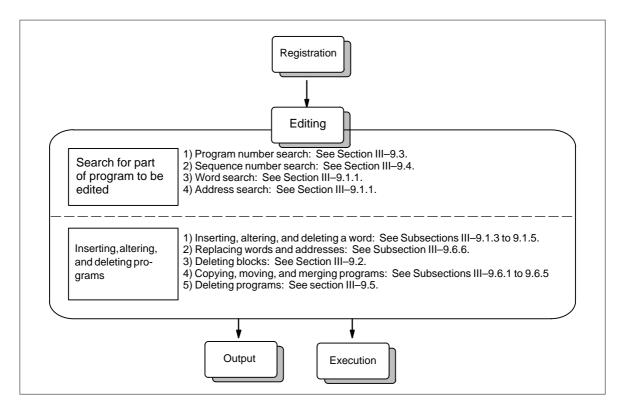
| Code | Meaning  |
|------|--|
| 102  | The memory card does not have sufficient free space.         |
| 105  | No memory card is mounted.                                   |
| 106  | A memory card is already mounted.                            |
| 110  | The specified directory cannot be found.                     |
| 111  | There are too many files under the root directory to allow a |
|      | directory to be added.                                       |
| 114  | The specified file cannot be found.                          |
| 115  | The specified file is protected.                             |
| 117  | The file has not yet been opened.                            |
| 118  | The file is already open.                                    |
| 119  | The file is locked.  |
| 122  | The specified file name is invalid.                          |
| 124  | The extension of the specified file is invalid.              |
| 129  | A non–corresponding function was specified.                  |
| 130  | The specification of a device is invalid.                    |
| 131  | The specification of a pathname is invalid.                  |
| 133  | Multiple files are open at the same time.                    |
| 135  | The device is not formatted.                                 |
| 140  | The file has the read/write disabled attribute.              |

## 9

#### **EDITING PROGRAMS**

#### General

This chapter describes how to edit programs registered in the CNC. Editing includes the insertion, modification, deletion, and replacement of words. Editing also includes deletion of the entire program and automatic insertion of sequence numbers. The extended part program editing function can copy, move, and merge programs. This chapter also describes program number search, sequence number search, word search, and address search, which are performed before editing the program.



#### 9.1 INSERTING, ALTERING AND DELETING A WORD

This section outlines the procedure for inserting, modifying, and deleting a word in a program registered in memory.

#### Procedure for inserting, altering and deleting a word

- 1 Select EDIT mode.
- 2 Press PROG .
- 3 Select a program to be edited.If a program to be edited is selected, perform the operation 4.If a program to be edited is not selected, search for the program number.
- 4 Search for a word to be modified. •Scan method •Word search method
- 5 Perform an operation such as altering, inserting, or deleting a word.

#### Explanation

 Concept of word and editing unit A word is an address followed by a number. With a custom macro, the concept of word is ambiguous.

So the editing unit is considered here.

The editing unit is a unit subject to alteration or deletion in one operation. In one scan operation, the cursor indicates the start of an editing unit. An insertion is made after an editing unit.

Definition of editing unit

- (i) Program portion from an address to immediately before the next address
- (ii) An address is an alphabet, IF, WHILE, GOTO, END, DO=, or; (EOB).

According to this definition, a word is an editing unit.

The word "word," when used in the description of editing, means an editing unit according to the precise definition.

#### WARNING

The user cannot continue program execution after altering, inserting, or deleting data of the program by suspending machining in progress by means of an operation such as a single block stop or feed hold operation during program execution. If such a modification is made, the program may not be executed exactly according to the contents of the program displayed on the screen after machining is resumed. So, when the contents of memory are to be modified by part program editing, be sure to enter the reset state or reset the system upon completion of editing before executing the program.

| 9.1.1<br>Word Search             | A word can be searched for by merely moving the cursor through the text (scanning), by word search, or by address search.   |  |
|----------------------------------|---|--|
| Procedure for scanning a program |   |  |
|                                  | <ol> <li>Press the cursor key →<br/>The cursor moves forward word by word on the screen; the cursor is displayed at a selected word.</li> <li>Press the cursor key ←<br/>The cursor moves backward word by word on the screen; the cursor is displayed at a selected word.     </li> <li>Example) When Z1250.0 is scanned<br/>Program O0050 N01234<br/>O0050 ;         N01234 X100.0 Z1250.0 ;<br/>S12 ;         N56789 M03 ;         M02 ;         </li> </ol> |  |
|                                  | <ul> <li>%</li> <li>3 Holding down the cursor key → or ← scans words continuously.</li> <li>4 The first word of the next block is searched for when the cursor key</li> </ul>   |  |
|                                  | <ul> <li>is pressed.</li> <li>5 The first word of the previous block is searched for when the cursor key  is pressed.</li> </ul>  |  |
|                                  | <ul><li>6 Holding down the cursor key ↓ or ↑ moves the cursor to the head of a block continuously.</li></ul>  |  |
|                                  | <ul> <li>Pressing the page key displays the next page and searches for the first word of the page.</li> </ul>   |  |
|                                  | 8 Pressing the page key $first$ displays the previous page and searches for the first word of the page.   |  |
|                                  | 9 Holding down the page key ↓ or ↓ displays one page after another.   |  |

#### Procedure for searching a word

#### **Example) of Searching for S12**

|   | PROGRAM<br>O0050 ;<br>N01234 X100.0 Z1250.0 ;<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>%  | O0050 N01234                                     | N01234 is being<br>searched for/<br>scanned currently.<br>S12 is searched<br>for. |
|---|---|--|---|
| 1 | Key in address S.   |  |   |
| 2 | Key in <b>12</b> .  |  |   |
|   | • S12 cannot be searched for i  | f only S1 is keye                                | d in.   |
|   | • S09 cannot be searched for t<br>To search for S09, be sure to   |  | S9.   |
| 3 | Pressing the $[SRH\downarrow]$ key starts<br>Upon completion of search ope<br>Pressing the $[SRH\uparrow]$ key rather<br>operation in the reverse direction | ration, the cursor<br>than the [ <b>SRH</b> ↓] l | is displayed at S12.  |

#### Procedure for searching an address

#### **Example) of Searching for M03**

| PROGRAM                            | O0050 N01234 | N01234 is being                     |
|------------------------------------|--------------|-------------------------------------|
| O0050 ;<br>N01234 X100.0 Z1250.0 ; | <b>~</b>     | searched for/                       |
| S12 ;                              |              | scanned currently.                  |
| N56789 M03 ; <                     |              | <ul> <li>M03 is searched</li> </ul> |
| M02 ;                              |              | for.                                |
| %                                  |              |                                     |

- 1 Key in address M
- Press the [SRH↓] key.
   Upon completion of search operation, the cursor is displayed at M03.
   Pressing the [SRH↑] key rather than the [SRH↓] key performs search operation in the reverse direction.

#### Alarm

| Alarm number | Description   |
|--------------|---|
| 71           | The word or address being searched for was not found. |

## **9.1.2**The cursor can be jumped to the top of a program. This function is called<br/>heading the program pointer. This section describes the three methods<br/>for heading the program pointer.

#### Procedure for Heading a Program

| Method 1 | 1 | Press RESET when the program screen is selected in EDIT mode.<br>When the cursor has returned to the start of the program, the contents of the program are displayed from its start on the screen. |
|----------|---|--|
| Method 2 |   | Search for the program number.   |
|          | 1 | Press address $\bigcirc$ , when a program screen is selected in the <b>MEMORY</b> or <b>EDIT</b> mode.   |
|          | 2 | Input a program number.  |
|          | 3 | Press the soft key [O SRH].  |
| Method 3 | 1 | Select <b>MEMORY</b> or <b>EDIT</b> mode.  |
|          | 2 | Press Prog.  |
|          | 3 | Press the [(OPRT)] key.  |
|          | 4 | Press the <b>[REWIND]</b> key.   |

#### 

#### 9.1.3 Inserting a Word

## Procedure for inserting a word 1 Search for or scan the word immediately before a word to be inserted. 2 Key in an address to be inserted.

- 3 Key in data.
- 4 Press the INSERT key.

#### Example of Inserting T15

#### Procedure

**1** Search for or scan Z1250.

| Program<br>00050 ;   | O0050 N01234   | Z1250.0 is  |
|--|--|---|
| N01234 X1000 <b>24125000</b> ;<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>%                |  | searched for/<br>scanned.   |
| Key in $\begin{bmatrix} T \\ 1 \end{bmatrix} \begin{bmatrix} 5 \\ . \end{bmatrix}$ . |  |   |
| Press the INSERT key.  |  |   |
| S12 ;<br>N56789 M03 ;<br>M02 ;   | O0050 N01234<br>; ◀  | – T15 is inserted.  |
|  | O0050;         N01234 X100.0         S12;         N56789 M03;         M02;         %         Key in T 1 5.         Press the INSERT key.         Program         O0050;         N01234 X100.0 Z1250.0 T15         S12;         N56789 M03; | O0050 ;       N01234 X100.0 <b>Z1250.0</b> ;          S12 ;       N56789 M03 ;         M02 ;       %         Key in T 1 5 .         Press the INSERT key.         Program       O0050 N01234         O0050 ;       N01234 X100.0 Z1250.0 T15 ;          S12 ;       N56789 M03 ;         N02 ;       '' |

#### 9.1.4 Altering a Word

| Procedu   | ire for altering a word  |
|-----------|--|
|           | <ol> <li>Search for or scan a word to be altered.</li> <li>Key in an address to be inserted.</li> <li>Key in data.</li> <li>Press the ALTER key.</li> </ol>        |
| Examp     | le of changing T15 to M15  |
| Procedure | 1 Search for or scan T15.<br>Program 00050 N01234<br>00050 ;<br>N01234 X100.0 Z1250.0 <b>T15</b> ; ← T15 is searched<br>for/scanned.<br>N56789 M03 ;<br>M02 ;<br>% |
|           | <ul> <li>2 Key in M 1 5.</li> <li>3 Press the ALTER key.</li> <li>Program O0050 N01234</li> </ul>  |
|           | O0050 ;       N1234 X100.0 Z1250.0 M15 ;       T15 is changed to         S12 ;       M15.         N5678 M03 ;       M02 ;         %       %                        |

#### 9.1.5 Deleting a Word

| Procedu   | re for deleting a word  |
|-----------|---|
|           | <ol> <li>Search for or scan a word to be deleted.</li> <li>Press the DELETE key.</li> </ol>   |
| Examp     | le of deleting X100.0   |
| Procedure | 1 Search for or scan X100.0.<br>Program O0050 N01234<br>O0050 ;<br>N01234 X100.0 Z1250.0 M15 ;<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>% |
|           | 2 Press the<br>Program 00050 N01234<br>00050 ;<br>N01234 Z1250.0 M15 ; ← X100.0 is deleted<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>%     |

OPERATION

### **9.2**A block or blocks can be deleted in a program.**DELETING BLOCKS**

#### 9.2.1 Deleting a Block

The procedure below deletes a block up to its EOB code; the cursor advances to the address of the next word.

# Procedure for deleting a block 1 Search for or scan address N for a block to be deleted. 2 Key in EOB 3 Press the DELETE Example of deleting a block of No. 1234 Procedure 1 Search for or scan N01234. Program O0050 N01234 O0050 ; N01234 is searched for/

|   | N01234 Z1250.0 M15 ;<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>% |              | <ul> <li>N01234 is<br/>searched for/<br/>scanned.</li> </ul> |
|---|---|--------------|--|
| 2 | Key in EOB.   |              |  |
| 3 | Press the $\begin{bmatrix} DELETE \end{bmatrix}$ key.       |              |  |
|   | Program<br>O0050 ;  | O0050 N01234 | Block containing   |
|   | S12;<br>N56789 M03;   |              | been deleted.  |

M02; %

#### Procedure for deleting multiple blocks

- 1 Search for or scan a word in the first block of a portion to be deleted.
- 2 Key in address N .
- 3 Key in the sequence number for the last block of the portion to be deleted.
- 4 Press the DELETE key.

Example of deleting blocks from a block containing N01234 to a block containing N56789

#### Procedure

1 Search for or scan N01234.

| Program<br>O0050 ;<br><b>N01234</b> Z1250.0 N<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>% | O0050 N01234<br>∕/15 ; ← | – N01234 is<br>searched for/<br>scanned.   |
|--|--------------------------|--|
| 2. Key in N 5 6  | 789.                     |  |
| Program<br>O0050 ;<br><b>N01234</b> Z1250.0 N<br>S12 ;<br>N56789 M03 ;<br>M02 ;<br>% | O0050 N01234             | _ Underlined<br>part is de-<br>leted.  |
| <b>3</b> Press the $\begin{bmatrix} DELETE \end{bmatrix}$ key.                       |                          |  |
| Program<br>00050 ;<br>M02 ; ◀<br>%   | O0050 N01234             | Blocks from block<br>containing<br>N01234 to block<br>containing<br>N56789 have<br>been deleted. |

#### CAUTION

When there are too many blocks to be deleted, a P/S alarm (No. 070) may be generated. If this happens, reduce the number of blocks to be deleted.

## 9.3When memory holds multiple programs, a program can be searched for.PROGRAM NUMBERThere are three methods as follows.SEARCHThere are three methods as follows.

#### Procedure for program number search Method 1 1 Select **EDIT** or **MEMORY** mode. 2 Press PROG to display the program screen. 3 Key in address O 4 Key in a program number to be searched for. 5 Press the [O SRH] key. Upon completion of search operation, the program number searched 6 for is displayed in the upper-right corner of the CRT screen. If the program is not found, P/S alarm No. 71 occurs. Method 2 1 Select **EDIT** or **MEMORY** mode. 2 Press PROG to display the program screen. **3** Press the **[O SRH]** key. In this case, the next program in the directory is searched for. Method 3 This method searches for the program number (0001 to 0015) corresponding to a signal on the machine tool side to start automatic operation. Refer to the relevant manual prepared by the machine tool builder for detailed information on operation. Select **MEMORY** mode. 1 2 Set the reset state (\*1) · The reset state is the state where the LED for indicating that automatic operation is in progress is off. (Refer to the relevant manual of the machine tool builder.) 3 Set the program number selection signal on the machine tool side to a number from 01 to 15. · If the program corresponding to a signal on the machine tool side is not registered, P/S alarm (No. 059) is raised. Press the cycle start button. 4 · When the signal on the machine tool side represents 00, program number search operation is not performed.

| Alarm No.   | Contents   |  |
|---|--|--|
| 59  | The program with the selected number cannot be searched during external program number search. |  |
| 71 The specified program number was not found during program number search. |  |  |

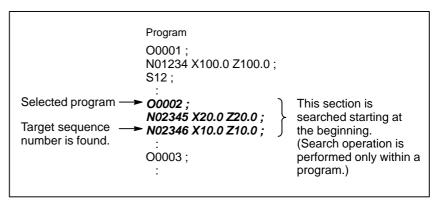
#### Alarm

OPERATION

#### 9.4 SEQUENCE NUMBER SEARCH

Sequence number search operation is usually used to search for a sequence number in the middle of a program so that execution can be started or restarted at the block of the sequence number.

Example) Sequence number 02346 in a program (O0002) is searched for.



#### Procedure for sequence number search

- 1 Select **MEMORY** mode.
- 2 Press PROG .
- 3 If the program contains a sequence number to be searched for, perform the operations 4 to 7 below.
  - If the program does not contain a sequence number to be searched for, select the program number of the program that contains the sequence number to be searched for.
- 4 Key in address N .
- 5 Key in a sequence number to be searched for.
- 6 Press the **[N SRH]** key.
- 7 Upon completion of search operation, the sequence number searched for is displayed in the upper–right corner of the CRT screen. If the specified sequence number is not found in the program currently selected, P/S alarm (No. 060) occurs.

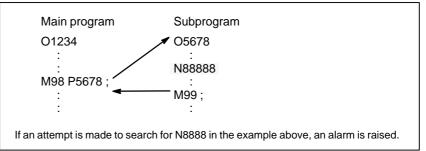
#### **Explanations**

| <ul> <li>Operation during Search</li> </ul> | <ul> <li>Those blocks that are skipped do not affect the CNC. This means that the data in the skipped blocks such as coordinates and M, S, and T codes does not alter the CNC coordinates and modal values.</li> <li>So, in the first block where execution is to be started or restarted by using a sequence number search command, be sure to enter required M, S, and T codes and coordinates. A block searched for by sequence number search usually represents a point of shifting from one process to another. When a block in the middle of a process must be searched for to restart execution at the block, specify M, S, and T codes, G codes, coordinates, and so forth as required from the MDI after closely checking the machine tool and CNC states at that point.</li> </ul> |
|---|--|
| <ul> <li>Checking during search</li> </ul>  | During search operation, the following checks are made:<br>•Optional block skip<br>•P/S alarm (No. 003 to 010)   |

#### Restrictions

• Searching in sub-program

During sequence number search operation, M98Pxxxx (subprogram call) is not executed. So an P/S alarm (No. 060) is raised if an attempt is made to search for a sequence number in a subprogram called by the program currently selected.



#### Alarm

| Alarm No. | Contents  |  |
|-----------|---|--|
| 60        | Command sequence number was not found in the se-<br>quence number search. |  |

## **9.5**Programs registered in memory can be deleted, either one program by one<br/>program or all at once. Also, More than one program can be deleted by<br/>specifying a range.

#### 9.5.1 Deleting One Program

A program registered in memory can be deleted.

## Procedure for deleting one program Select the EDIT mode. Press Proce to display the program screen. Key in address O. Key in a desired program number. Press the DELETE key. The program with the entered program number is deleted.

#### 9.5.2 Deleting All Programs

All programs registered in memory can be deleted.

## Procedure for deleting all programs Select the EDIT mode. Press Proc to display the program screen. Key in address O. Key in -9999. Press edit key Prese to delete all programs.

#### 9.5.3 Deleting More Than One Program by Specifying a Range

Programs within a specified range in memory are deleted.

#### Procedure for deleting more than one program by specifying a range

- 1 Select the **EDIT** mode.
- **2** Press **PROG** to display the program screen.
- 3 Enter the range of program numbers to be deleted with address and numeric keys in the following format: OXXXX,OYYYY where XXXX is the starting number of the programs to be deleted and YYYY is the ending number of the programs to be deleted.
- 4 Press edit key DELETE to delete programs No. XXXX to No. YYYY.

#### 9.6 EXTENDED PART PROGRAM EDITING FUNCTION

With the extended part program editing function, the operations described below can be performed using soft keys for programs that have been registered in memory.

Following editing operations are available :

- All or part of a program can be copied or moved to another program.
- One program can be merged at free position into other programs.
- A specified word or address in a program can be replaced with another word or address.

#### 9.6.1 Copying an Entire Program

A new program can be created by copying a program.

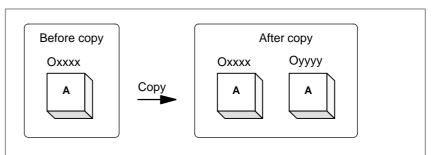
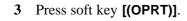


Fig. 9.6.1 Copying an Entire Program

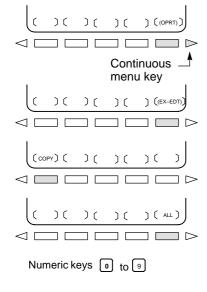
In Fig. 9.6.1, the program with program number xxxx is copied to a newly created program with program number yyyy. The program created by copy operation is the same as the original program except the program number.

#### Procedure of copying an entire program

- 1 Enter the **EDIT** mode.
- 2 Press function key |PROG|.



- 4 Press the continuous menu key.
- 5 Press soft key [EX–EDT].
- 6 Check that the screen for the program to be copied is selected and press soft key **[COPY]**.
- 7 Press soft key [ALL].
- 8 Enter the number of the new program (with only numeric keys ) and press the  $\overline{|NPUT|}$  key.
- 9 Press soft key [EXEC].





#### 9.6.2 Copying Part of a Program

A new program can be created by copying part of a program.

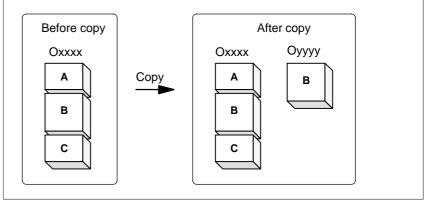
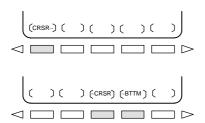


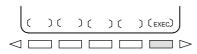
Fig. 9.6.2 Copying Part of a Program

In Fig. 9.6.2, part B of the program with program number xxxx is copied to a newly created program with program number yyyy. The program for which an editing range is specified remains unchanged after copy operation.

#### Procedure for copying part of a program

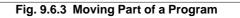


Numeric keys o to 9



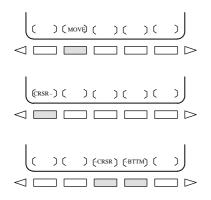
- **1** Perform steps **1** to **6** in subsection III–9.6.1.
- 2 Move the cursor to the start of the range to be copied and press soft key [CRSR~].
- 3 Move the cursor to the end of the range to be copied and press soft key [~CRSR] or [~BTTM] (in the latter case, the range to the end of the program is copied regardless of the position of the cursor).
- 4 Enter the number of the new program (with only numeric keys) and press the  $\begin{bmatrix} nput \end{bmatrix}$  key.
- **5** Press soft key **[EXEC]**.

#### 9.6.3 A new program can be created by moving part of a program. Moving Part of a Program Before copy After copy Oxxxx Oxxxx Оуууу Copy Α Α В С B С



In **Fig. 9.6.3**, part B of the program with program number xxxx is moved to a newly created program with program number yyyy; part B is deleted from the program with program number xxxx.

#### Procedure for moving part of a program



Numeric keys 0 to 9



- **1** Perform steps 1 to 5 in subsection III–9.6.1.
- 2 Check that the screen for the program to be moved is selected and press soft key [MOVE].
- 3 Move the cursor to the start of the range to be moved and press soft key [CRSR~].
- 4 Move the cursor to the end of the range to be moved and press soft key [~CRSR] or [~BTTM] (in the latter case, the range to the end of the program is copied regardless of the position of the cursor).
- 5 Enter the number of the new program (with only numeric keys) and press the  $\boxed{|NPUT|}$  key.
- 6 Press soft key [EXEC].

#### 9.6.4 Merging a Program

Another program can be inserted at an arbitrary position in the current program.

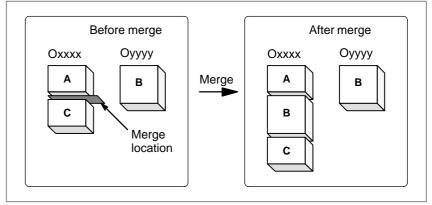
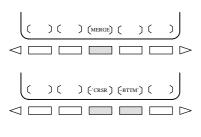


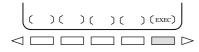
Fig. 9.6.4 Merging a program at a specified location

In **Fig. 9.6.4**, the program with program number XXXX is merged with the program with program number YYYY. The OYYYY program remains unchanged after merge operation.

#### Procedure for merging a program



Numeric keys 0 to 9



- **1** Perform steps **1** to **5** in subsection III–9.6.1.
- 2 Check that the screen for the program to be edited is selected and press soft key [MERGE].
- 3 Move the cursor to the position at which another program is to be inserted and press soft key [~'CRSR] or [~BTTM'] (in the latter case, the end of the current program is displayed).
- 4 Enter the number of the program to be inserted (with only numeric keys) and press the key.
- 5 Press soft key **[EXEC]**. The program with the number specified in step 4 is inserted before the cursor positioned in step 3.

#### 9.6.5

#### Supplementary Explanation for Copying, Moving and Merging

#### **Explanations**

• Setting an editing range

#### • Without specifying a program number

In copying program and moving program, if **[EXEC]** is pressed without specifying a program number after an editing range end point is set, a program with program number O0000 is registered as a work program. This O0000 program has the following features:

The setting of an editing range start point with **[CRSR~]** can be changed freely until an editing range end point is set with **[~CRSR]** or **[~BTTM]**. If an editing range start point is set after an editing range end point, the

The setting of an editing range start point and end point remains valid until

• An edit operation other than address search, word search/scan, and search for the start of a program is performed after a start point or end

• Processing is returned to operation selection after a start point or end

editing range must be reset starting with a start point.

an operation is performed to invalidate the setting. One of the following operations invalidates a setting:

point is set.

point is set.

- The program can be edited in the same way as a general program. (Do not run the program.)
- If a copy or move operation is newly performed, the previous information is deleted at execution time, and newly set information (all or part of the program) is re-registered. (In merge operation, the previous information is not deleted.) However, the program, when selected for foreground operation, cannot be re-registered in the background. (A BP/S140 alarm is raised.) When the program is re-registered, a free area is produced. Delete such a free area with the reset key.
- When the program becomes unnecessary, delete the program by a normal editing operation.

When the system is waiting for a program number to be entered, no edit operation can be performed.

• Editing when the system waiting for a program number to be entered

#### Restrictions

 Number of digits for program number If a program number is specified by 5 or more digits, a format error is generated.

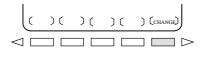
#### Alarm

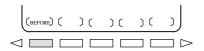
| Alarm No. | Contents   |  |
|-----------|--|--|
| 70        | Memory became insufficient while copying or inserting a pro-<br>gram. Copy or insertion is terminated.   |  |
| 101       | The power was interrupted during copying, moving, or inserting<br>a program and memory used for editing must be cleared.<br>When this alarm occurs, press the key while pressing func-<br>tion key erect.<br>Only the program being edited is deleted. |  |

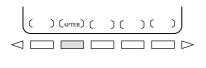
#### 9.6.6 Replacement of Words and Addresses

Replace one or more specified words. Replacement can be applied to all occurrences or just one occurrence of specified words or addresses in the program.

#### Procedure for change of words or addresses









- **1** Perform steps 1 to 5 in subsection 9.6.1.
- 2 Press soft key [CHANGE].
- 3 Enter the word or address to be replaced.
- 4 Press soft key [BEFORE].
- 5 Enter the new word or address.
- 6 Press soft key [AFTER].
- 7 Press soft key [EXEC] to replace all the specified words or addresses after the cursor.Press soft key [1–EXEC] to search for and replace the first occurrence

of the specified word or address after the cursor. Press soft key **[SKIP]** to only search for the first occurrence of the

specified word or address after the cursor.

#### **EXAMPLES**

- Replace X100 with Z200
- Replace X100Z200 with X30
- Replace IF with WHILE
- Replace X with ,C10

#### **Explanation**

 Replacing custom macros

| [CHANGE] X 1 0 0 [BEFORE] Z 2 0 0<br>[AFTER] [EXEC]       |
|---|
| [CHANGE] X 1 0 0 Z 2 0 0 [BEFORE]<br>X 3 0 [AFTER] [EXEC] |
| [CHANGE] I F [BEFORE] W H I L E<br>[AFTER] [EXEC]         |
| [CHANGE] X [BEFOR] , C 1 0 [AFTER] [EXEC]                 |

The following custom macro words are replaceable: IF, WHILE, GOTO, END, DO, BPRNT, DPRNT, POPEN, PCLOS The abbreviations of custom macro words can be specified. When abbreviations are used, however, the screen displays the abbreviations as they are key input, even after soft key **[BEFORE]** and **[AFTER]** are pressed. OPERATION

#### Restrictions

- The number of characters for replacement
- The characters for replacement

Up to 15 characters can be specified for words before or after replacement. (Sixteen or more characters cannot be specified.)

Words before or after replacement must start with a character representing an address. (A format error occurs.)

| 9.7<br>EDITING OF CUSTOM<br>MACROS                         | Unlike ordinary programs, custom macro programs are modified,<br>inserted, or deleted based on editing units.<br>Custom macro words can be entered in abbreviated form.<br>Comments can be entered in a program.<br>Refer to the section 10.1 for the comments of a program.  |  |                      |   |
|--|---|--|----------------------|---|
| Explanations   |   |  |                      |   |
| <ul> <li>Editing unit</li> </ul>                           | When editing a custom macro already entered, the user can move the cursor to each editing unit that starts with any of the following characters and symbols:  |  |                      |   |
|  | (a) Address   |  |                      |   |
|  | (b)# located at t   | he start of the lef  | t side of a substitu | ution statement   |
|  | DPRNT and<br>On the CRT   | PCLOS<br>' screen, a blank   |                      | D, POPEN, BPRNT,<br>e each of the above   |
|  | characters an   | d symbols.   |                      |   |
|  | (Example) Head positions where the cursor is placed<br><u>N001 X</u> -#100:<br><u>#1=123:</u><br><u>N002/2X[12/#3]:</u><br><u>N003 X</u> -SQRT[#3/3*[#4+1]]:<br><u>N004 X</u> -#2 <u>Z</u> #1:<br><u>N005 <u>#5 =</u>1+2-#10:<br/>IF[#1NE0] <u>G</u>OTO10:<br/><u>W</u>HILE[#2LE5] <u>D</u>O1:<br/><u>#[200+#2]=#2*10:</u><br/><u>#2=#2+1:</u><br/><u>END1:</u></u> |  |                      |   |
| <ul> <li>Abbreviations of custom<br/>macro word</li> </ul> | When a custom macro word is altered or inserted, the first two characters or more can replace the entire word.<br>Namely,   |  |                      |   |
|  | WHILE $\rightarrow$ WH<br>SIN $\rightarrow$ SI<br>TAN $\rightarrow$ TA<br>BCD $\rightarrow$ BC<br>ROUND $\rightarrow$ RO<br>DPRNT $\rightarrow$ DP<br>(Example) Key<br>WH [AB [#2 ] I<br>has the same eff<br>WHILE [ABS   | $ASIN \rightarrow AS$ $ATAN \rightarrow AT$ $BIN \rightarrow BI$ $END \rightarrow EN$ $PCLOS \rightarrow PC$ ing in<br>LE RO [#3 ] ] |                      | $AND \rightarrow AN$ $ACOS \rightarrow AC$ $ABS \rightarrow AB$ $FUP \rightarrow FU$ $BPRNT \rightarrow BP$ $THEN \rightarrow TH$ |
|  |   |  |                      |   |

| 9.8<br>BACKGROUND<br>EDITING | Editing a program while executing another program is called background<br>editing. The method of editing is the same as for ordinary editing<br>(foreground editing).<br>A program edited in the background should be registered in foreground |
|------------------------------|--|
|                              | program memory by performing the following operation:<br>During background editing, all programs cannot be deleted at once.  |

#### Procedure for background editing

| 1 Enter EDIT or MEMORY mode. |  |  |
|------------------------------|--|--|
|                              | Memory mode is allowed even while the program is being executed. |  |

- **2** Press function keym | PROG |.
- **3** Press soft key **[(OPRT)]**, then press soft key **[BG–EDT]**. The background editing screen is displayed (PROGRAM (BG–EDIT) is displayed at the top left of the screen).
- 4 Edit a program on the background editing screen in the same way as for ordinary program editing.
- 5 After editing is completed, press soft key [(OPRT)], then press soft key [BG–EDT]. The edited program is registered in foreground program memory.

#### **Explanation**

 Alarms during background editing Alarms that may occur during background editing do not affect foreground operation. Conversely, alarms that may occur during foreground operation do not affect background editing. In background editing, if an attempt is made to edit a program selected for foreground operation, a BP/S alarm (No. 140) is raised. On the other hand, if an attempt is made to select a program subjected to background editing during foreground operation (by means of subprogram calling or program number search operation using an external signal), a P/S alarm (Nos. 059, 078) is raised in foreground operation. As with foreground program editing, P/S alarms occur in background editing. However, to distinguish these alarms from foreground alarms, BP/S is displayed in the data input line on the background editing screen.

#### 9.9 PASSWORD FUNCTION

The password function (bit 4 (NE9) of parameter No. 3202) can be locked using parameter No. 3210 (PASSWD) and parameter No. 3211 (KEYWD) to protect program Nos. O9000 to O9999. In the locked state, parameter NE9 cannot be set to 0. In this state, program Nos. O9000 to O9999 cannot be modified unless the correct keyword is set. A locked state means that the value set in the parameter PASSWD differs from the value set in the parameter KEYWD. The values set in these parameters are not displayed. The locked state is released when the value already set in the parameter PASSWD is also set in parameter KEYWD. When 0 is displayed in parameter PASSWD, parameter PASSWD is not set.

#### Procedure for locking and unlocking

1 Set the MDI mode. Locking 2 Enable parameter writing. At this time, P/S alarm No. 100 is issued on the CNC. 3 Set parameter No. 3210 (PASSWD). At this time, the locked state is set. Disable parameter writing. 4 5 Press the RESET key to release the alarm state. Unlocking Set the MDI mode. 1 Enable parameter writing. At this time, P/S alarm No. 100 is issued 2 on the CNC. 3 In parameter No. 3211 (KEYWD), set the same value as set in parameter No. 3210 (PASSWD) for locking. At this time, the locked state is released. Set bit 4 (NE9) of parameter No. 3202 to 0. 4 5 Disable parameter writing. Press the RESET key to release the alarm state. 6 Subprograms from program Nos. 9000 to 9999 can now be edited. 7

#### Explanations

| Setting parameter     PASSWD                          | The locked state is set when a value is set in the parameter PASSWD.<br>However, note that parameter PASSWD can be set only when the locked<br>state is not set (when PASSWD = 0, or PASSWD = KEYWD). If an<br>attempt is made to set parameter PASSWD in other cases, a warning is<br>given to indicate that writing is disabled. When the locked state is set<br>(when PASSWD = 0 and PASSWD = KEYWD), parameter NE9 is<br>automatically set to 1. If an attempt is made to set NE9 to 0, a warning<br>is given to indicate that writing is disabled. |  |
|---|---|--|
| <ul> <li>Changing parameter<br/>PASSWD</li> </ul>     | Parameter PASSWD can be changed when the locked state is released (when PASSWD = 0, or PASSWD = KEYWD). After step 3 in the procedure for unlocking, a new value can be set in the parameter PASSWD. From that time on, this new value must be set in parameter KEYWD to release the locked state.  |  |
| <ul> <li>Setting 0 in parameter<br/>PASSWD</li> </ul> | When 0 is set in the parameter PASSWD, the number 0 is displayed, and the password function is disabled. In other words, the password function can be disabled by either not setting parameter PASSWD at all, or by setting 0 in parameter PASSWD after step 3 of the procedure for unlocking. To ensure that the locked state is not entered, care must be taken not to set a value other than 0 in parameter PASSWD.  |  |
| ● Re–locking  | After the locked state has been released, it can be set again by setting a different value in parameter PASSWD, or by turning the power to the NC off then on again to reset parameter KEYWD.   |  |
|   | <b>CAUTION</b><br>Once the locked state is set, parameter NE9 cannot be set<br>to 0 and parameter PASSWD cannot be changed until the<br>locked state is released or the memory all–clear operation<br>is performed. Special care must be taken in setting<br>parameter PASSWD.  |  |

#### 9.10 COPYING A PROGRAM BETWEEN TWO PATHS

For a 2–path control CNC, setting bit 0 (PCP) of parameter No. 3206 to 1 enables the copying of a specified machining program from one path to another. Single–program copy and specified–range copy are supported.

#### Procedure for copying a program between two paths

Procedure

- 1 Select EDIT mode for both paths.
- 2 Press function key PROG .
- 3 Press soft key [(OPRT)].
- 4 Press soft key **[P COPY]** The following soft keys appear:

| PROGRAM                 | O1357        | N00130   |
|-------------------------|--------------|----------|
| O1357 (HEAD-1 MAIN PROG | RAM) ;       |          |
| N010 G90 G00 X200.0 Z2  | 20.0 ;       |          |
| N020 T0101;             |              |          |
| N030 S30000 M03 ;       |              |          |
| N040 G40 G00 X40.0 Z18  | 0.0 ;        |          |
|                         |              |          |
| N080 X100.0 Z80.0 ;     |              |          |
| N090 Z60.0 ;            |              |          |
| N100 X140.0 Z40.0 ;     |              |          |
|                         |              |          |
| >_                      |              |          |
|                         |              |          |
| EDIT **** *** ***       | 14 : 25 : 3  | B6 HEAD1 |
|                         | 2)(          | CAN      |
|                         | <b>~</b> ) ( | J CAN J  |

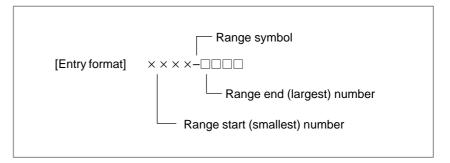
**5** Press soft key **[PATH1]** to **[PATH2]** to select the path from which a program is to be copied.

(Example) Pressing soft key **[PATH1]** causes an operation guidance, shown below, to appear on the screen.

| $\sim$ | · · · · · · · · · · · · · · · · · · ·                     | $\sim$ |
|--------|---|--------|
|        |   |        |
|        | SOURCE : PATH1 =1357<br>DEST : PATH2 = REPLACE : OFF<br>> |        |
|        | _<br>EDIT **** *** *** 14:25:36 HEAD1                     |        |
|        | (SOURCE) (DEST) (REPLACE) (CAN) (EXEC)                    |        |

First, the program currently selected for the copy source path is displayed as the program to be copied. If no program has been selected for the copy source path, "0000" is displayed.

- 6 Select one or more programs to be copied.
  - Single–program copy
  - (1)Enter the number of the program to be copied.  $\rightarrow$  " $\times \times \times \times$ "
  - (2) Press soft key **[SOURCE]** to set the number.  $\rightarrow$  SOURCE:PATH?=" $\times \times \times \times$ "
  - Specified–range copy
  - (1) Enter the range of the programs to be copied, as a number.  $\rightarrow$  " $\times \times \times \times -\square \square \square \square$ "



(2) Press soft key [SOURCE] to set the number.

- $\rightarrow$  "××××–
- To cancel the selection of the program(s) to be copied, press [SOURCE] again
- 7 Select the copy destination number.

The selected program(s) can be copied by assigning numbers other than their original numbers.

- (1) Type the destination number.  $\rightarrow$  " $\triangle \triangle \triangle$ "
- (2) Press soft key **[DEST]** to set the number.
  - $\rightarrow$  DEST:PATH?=" $\triangle \triangle \triangle$ "
  - Pressing **[DEST]** without entering any number causes the original program number(s) to be used as is.
  - To cancel the set number, press **[DEST]** again.
  - For specified-range copy, the set number is assigned to the first program of the specified range. The subsequent programs are assigned numbers obtained by repeatedly incrementing the set number by one.
- 8 Specify replacement.

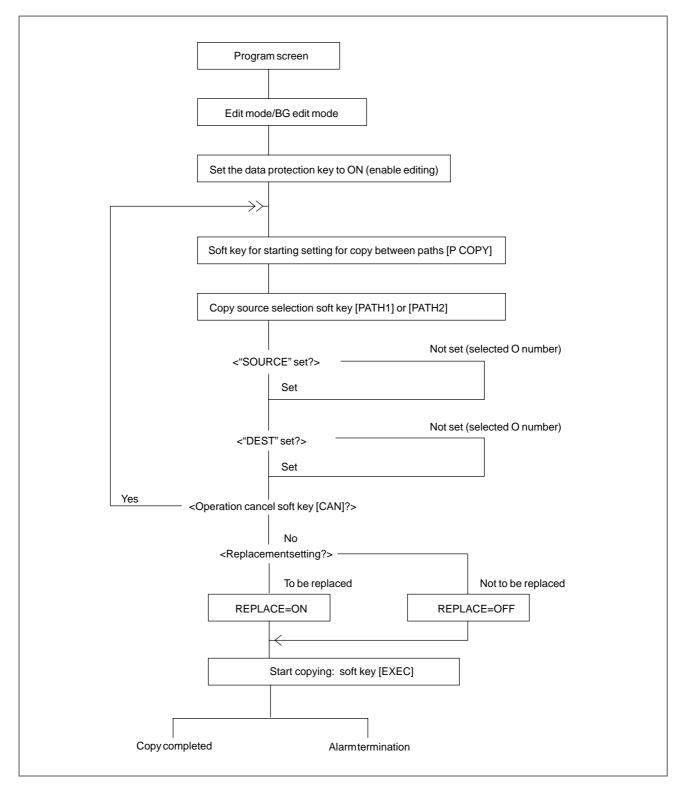
If any number to be assigned to a program to be copied is already being used for a program registered for the destination path, specify whether the existing program is to be replaced with that to be copied. If replacement is currently disabled, pressing soft key **[REPLACE]** enables replacement. Pressing **[REPLACE]** repeatedly toggles between replacement being enabled and disabled.

"REPLACE=ON" indicates that replacement is enabled. "REPLACE=OFF" indicates that replacement is disabled.

9 Press soft key **[EXEC]** to start copying.

#### **Explanations**

#### • Operation flow



Background editing

Copying can also be performed during background editing.

#### • Major related alarms

Major related alarm numbers

| Alarm number    | Description                 | Relevant path           |
|-----------------|-----------------------------|-------------------------|
| P/S 70,70 BP/S0 | Insufficient free memory    | Copy destination        |
| P/S 71,71 BP/S  | Specified program not found | Copy source             |
| P/S 72,72 BPS   | Too many programs           | Copy destination        |
| P/S 73,73 BP/S  | Duplicate registration      | Copy destination        |
| P/S 75,75 BP/S  | Protected program number    | Copy source/destination |

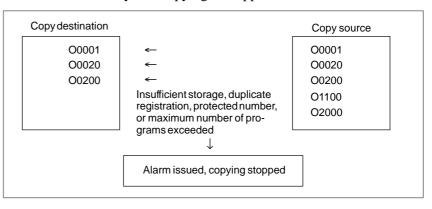
- BP/S indicates an alarm output during background editing.
- Each alarm is issued to the path for which the operation causing the alarm is being performed.

#### Restrictions

 Conditions under which copying cannot be performed Copying is not performed under any of the following conditions:

- The data protection key for the copy destination path is set to OFF.
- The specified O number is protected.
- The specified O number is already being used for a program registered for the copy destination path (if replacement is disabled).
- The part program storage for the copy destination path does not have sufficient free space.
- The copy source or destination path is placed in the alarm state. During background editing, however, only P/S alarms 000 and 101 disable copying.

During specified-range copy, if the part program storage for the copy destination path becomes insufficient, if the maximum number of programs which can be registered for the destination path is exceeded, if a specified program number has already been registered for the destination path, or if a specified program number is protected, an alarm is issued immediately and copying is stopped.



• Replacement

Even if replacement is enabled, the program is not replaced if the part program storage for the copy destination path does not have sufficient free space. During background editing, copying by replacing the currently running program is not allowed.

#### CAUTION

Once the copying of a program between paths has been started, it cannot be canceled. Carefully confirm all the settings before starting copying.

• Specified-range copy

## **CREATING PROGRAMS**

Programs can be created using any of the following methods:

- · MDI keyboard
- · PROGRAMMING IN TEACH IN MODE
- · CONVERSATIONAL PROGRAMMING INPUT WITH GRAPHIC FUNCTION
- $\cdot$  CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION
- AUTOMATIC PROGRAM PREPARATION DEVICE (FANUC SYSTEM P)

This chapter describes creating programs using the MDI panel, TEACH IN mode, and conversational programming with graphic function. This chapter also describes the automatic insertion of sequence numbers.

#### 10.1 CREATING PROGRAMS USING THE MDI PANEL

Programs can be created in the **EDIT** mode using the program editing functions described in Chapter III–9.

#### **Procedure for Creating Programs Using the MDI Panel** Enter the **EDIT** mode. Procedure 1 Press the PROG key. 2 Press address key | O | and enter the program number. 3 4 Press the INSERT key. 5 Create a program using the program editing functions described in Chapter 9. Explanation Comments in a program Comments can be written in a program using the control in/out codes. Example)O0001 (FANUC SERIES 16); M08 (COOLANT ON); • When the INSERT key is pressed after the control-out code "(", comments, and control-in code ")" have been typed, the typed comments are registered. When the WISERT key is pressed midway through comments, to enter the rest of comments later, the data typed before the INSERT key is pressed may not be correctly registered (not entered, modified, or lost) because the data is subject to an entry check which is performed in normal editing. Note the following to enter a comment: • Control-in code ")" cannot be registered by itself. Comments entered after the Key is pressed must not begin with a number, space, or address O. • If an abbreviation for a macro is entered, the abbreviation is converted into a macro word and registered (see Section 9.7). • Address O and subsequent numbers, or a space can be entered but are omitted when registered.

#### 10.2 AUTOMATIC INSERTION OF SEQUENCE NUMBERS

Sequence numbers can be automatically inserted in each block when a program is created using the MDI keys in the EDIT mode. Set the increment for sequence numbers in parameter 3216.

#### Procedure for automatic insertion of sequence numbers Procedure Set 1 for SEQUENCE NO. (see subsection III-11.4.3). 1 Enter the **EDIT** mode. 2 Press **PROG** to display the program screen. 3 Search for or register the number of a program to be edited and move 4 the cursor to the EOB (;) of the block after which automatic insertion of sequence numbers is started. When a program number is registered and an EOB (;) is entered with the INSERT key, sequence numbers are automatically inserted starting with 0. Change the initial value, if required, according to step 10, then skip to step 7. Press address key $|\mathbf{N}|$ and enter the initial value of N. 5 Press INSERT kev. 6 Enter each word of a block. 7 8 Press EOB key.

#### 

9 Press NSERT . The EOB is registered in memory and sequence numbers are automatically inserted. For example, if the initial value of N is 10 and the parameter for the increment is set to 2, N12 inserted and displayed below the line where a new block is specified.

| PROGRAM  | O0040 N00012 |
|--|--------------|
| O0040 ;<br>N10 G92 X0 Y0 Z0 ;<br>N12<br>%  |              |
|  |              |
| >_<br>FDIT **** *** ***  | 13 : 18 : 08 |
| $\left( \underline{\mathbf{PRGRM}} \right) \left( \begin{array}{c} LIB \end{array} \right) \left( \begin{array}{c} \\ \end{array} \right)$ |              |

10

- In the example above, if N12 is not necessary in the next block, pressing the pressing the key after N12 is displayed deletes N12.
- To insert N100 in the next block instead of N12, enter N100 and press ALTER after N12 is displayed. N100 is registered and initial value is changed to 100.

| 10.3          | When the playback option is selected, the <b>TEACH IN JOG</b> mode and      |
|---------------|---|
| CREATING      | <b>TEACH IN HANDLE</b> mode are added. In these modes, a machine position   |
|               | along the X, Z, and Y axes obtained by manual operation is stored in        |
| PROGRAMS IN   | memory as a program position to create a program.                           |
| TEACH IN MODE | The words other than X, Z, and Y, which include O, N, G, R, F, C, M, S,     |
| (PLAYBACK)    | T, P, Q, and EOB, can be stored in memory in the same way as in <b>EDIT</b> |
|               | mode.   |

#### Procedure for Creating Programs in TEACH IN Mode

The procedure described below can be used to store a machine position along the X, Z, and Y axes.

- 1 Select the **TEACH IN JOG** mode or **TEACH IN HANDLE** mode.
- 2 Move the tool to the desired position with jog or handle.
- **3** Press PROG key to display the program screen. Search for or register the number of a program to be edited and move the cursor to the position where the machine position along each axis is to be registered (inserted).
- 4 Key in address X.
- **5** Press the key. Then a machine position along the X axis is stored in memory.

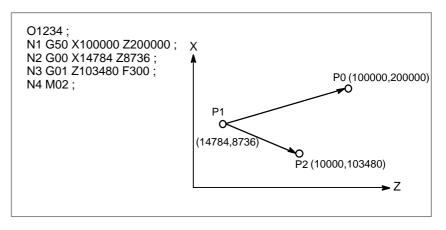
(Example) X10.521 Absolute position (for mm input) X10521 Data stored in memory

6 Similarly, key in [Z], then press the [NSERT] key. Then a machine position along the Z axis is stored in memory. Further, key in [Y], then press the [NSERT] key. Then a machine position along the Y axis is

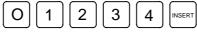
stored in memory.

All coordinates stored using this method are absolute coordinates.

#### **Examples**



- 1 Set the setting data SEQUENCE NO. to 1 (on). (The incremental value parameter (No. 3212) is assumed to be "1".)
- 2 Select the **TEACH IN HANDLE** mode.
- 3 Make positioning at position P0 by the manual pulse generator.
- 4 Select the program screen.
- 5 Enter program number O1234 as follows:



This operation registers program number O1234 in memory. Next, press the following keys:



An EOB (;) is entered after program number O1234. Because no number is specified after N, sequence numbers are automatically inserted for N0 and the first block (N1) is registered in memory.

6 Enter the P0 machine position for data of the first block as follows:



This operation registers G50 X100000 Z200000 ; in memory. The automatic sequence number insertion function registers N2 of the second block in memory.

- 7 Position the tool at P1 with the manual pulse generator.
- 8 Enter the P1 machine position for data of the second block as follows:



This operation registers G00 X14784 Z8736; in memory. The automatic sequence number insertion function registers N3 of the third block in memory.

**9** Position the tool at P2 with the manual pulse generator.

Enter the P2 machine position for data of the third block as follows: 10 INSERT

Ζ



This operation registers G01 Z103480 F300; in memory. The automatic sequence number insertion function registers N4 of the fourth block in memory.

F

3

0

0

**11** Register M02; in memory as follows:

|  | M | 0 | 2 | INSERT | EOB |  |
|--|---|---|---|--------|-----|--|
|--|---|---|---|--------|-----|--|

N5 indicating the fifth block is stored in memory using the automatic sequence number insertion function. Press the DELETE key to delete it.

This completes the registration of the sample program.

#### **Explanations**

• Checking contents of the memory

The contents of memory can be checked in the **TEACH IN** mode by using the same procedure as in **EDIT** mode.

| PROGRAM   |               | O1234 N00004                 |
|---|---------------|------------------------------|
| (RELATIVE)<br>U –85.216<br>W –191.264   | (AB<br>X<br>Z | SOLUTE)<br>14.784<br>8.736   |
| O1234 ;<br>N1 G50 X100000 Y0 Z20000<br>N2 G00 X14784 Z8736 ;<br>N3 G01 Z103480 F300 ;<br>N4 M02 | ,             |                              |
| >_<br>THND **** *** ***<br>( <b>IPRGRM</b> ) ( LIB ) (  | )(            | 14 : 17 : 27<br>) ( (OPRT) ) |

• Registering a position with compensation

When a value is keyed in after keying in address X Ζİ , or then the *INSERT* key is pressed, the value keyed in for a machine position

is added for registration. This operation is useful to correct a machine position by key-in operation.

• Registering commands other than position commands

Commands to be entered before and after a machine position must be entered before and after the machine position is registered, by using the same operation as program editing in **EDIT** mode.

#### 10.4 CONVERSATIONAL PROGRAMMING WITH GRAPHIC FUNCTION

Programs can be created block after block on the conversational screen while displaying the G code menu. Blocks in a program can be modified, inserted, or deleted using the G code

menu and conversational screen.

#### Procedure for Conversational Programming with Graphic Function

Procedure 1 Creating a program

- 1 Enter the **EDIT** mode.
- 2 Press PROG . If no program is registered, the following screen is displayed. If a program is registered, the program currently selected is displayed.

| PROGRAM           | O0000 N00000                                   |
|-------------------|--|
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   |  |
|                   | 44 - 50 - 40                                   |
| EDIT **** *** *** | 11 : 59 : 46                                   |
|                   | $\left( (C.A.P) \right) \left( (OPRT) \right)$ |
|                   |  |

Key in the program number of a program to be registered after keying in address O, then press 
 INSERT . For example, when a program with program number 10 is to be registered, key in O 1 0, then

press INSERT . This registers a new program O0010.

4 Press the **[C.A.P]** soft key. The following G code menu is displayed on the screen.

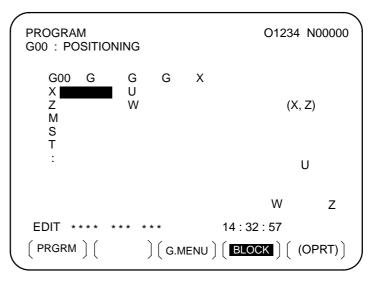
If soft keys different from those shown in step 2 are displayed, press the menu return key  $\frown$  to display the correct soft keys.

| Γ               |   |        |                     |
|-----------------|---|--------|---------------------|
|                 | PROGRAM   | O1234  | N00004              |
|                 | G00 : POSITIONING   |        |                     |
|                 | G01 : LINEAR IPL  |        |                     |
|                 | G02 : CIRCULAR IPL. CW                                    |        |                     |
|                 | G03 : CIRCULAR IPL. CCW                                   |        |                     |
|                 | G04 : DWELL   |        |                     |
|                 | G10 : OFFSET VALUE SETTING                                |        | (0)                 |
|                 | G20 : INCH  |        |                     |
|                 | G21 : METRIC<br>G22 : STORED STROKE CHECK ON              |        | $\langle 0 \rangle$ |
|                 | G22 STORED STROKE CHECK ON<br>G23 STORED STROKE CHECK OFF |        | (0)<br>(0)          |
|                 | G25 : SPINDLE SPEED DETECT OFF                            |        | (0)                 |
|                 | G26 : SPINDLE SPEED DETECT ON                             |        |                     |
|                 | >_  |        |                     |
|                 | EDIT **** *** 14 : 20                                     | 5 : 15 |                     |
|                 |   |        | N                   |
|                 |   | UN     | J J                 |
| $\overline{\ }$ |   |        |                     |

**5** Key in the G code corresponding to a function to be programmed. When the positioning function is desired, for example, the G code menu lists the function with the G code G00. So key in G00. If the screen does not indicate a function to be programmed, press the page

key  $\checkmark$  to display the next G code menu screen. Repeat this operation until a desired function appears. If a desired function is not a G code, key in no data.

6 Press the soft key [**BLOCK**] to display a detailed screen for a keyed in G code. The figure below shows an example of detailed screen for G00.



**OPERATION** 

PROGRAM O0010 N00000 G G G G Х U Ζ W A С F Н Κ L Ρ Q R Μ Т S : EDIT \*\*\*\* \* \* \* 14:41:10 ) ( G.MENU ) ( BLOCK ) ( (OPRT) PRGRM ) [

When no keys are pressed, the standard details screen is displayed.

- 7 Move the cursor to the block to be modified on the program screen. At this time, a data address with the cursor blinks.
- 8 Enter numeric data by pressing the numeric keys and press the **[INPUT]** soft key or **NPUT** key. This completes the input of one data item.
- **9** Repeat this operation until all data required for the entered G code is entered.
- 10 Press the INSERT key. This completes the registration of data of one block in program memory. On the screen, the G code menu screen is displayed, allowing the user to enter data for another block. Repeat the procedure starting with **5** as required.
- **11** After registering all programs, press the **[PRGRM]** soft key. The registered programs are converted to the conversational format and displayed.
- **12** Press the |RESET| key to return to the program head.

| Procedure 2<br>Modifying a block | 1 | Move the cursor to the block to be modified on the program screen<br>and press the <b>[C.A.P]</b> soft key. Or, press the <b>[C.A.P]</b> soft key first to  |
|----------------------------------|---|---|
|                                  |   | display the conversational screen, then press the 📕 or 🕇 page   |
|                                  |   | key until the block to be modified is displayed.  |
|                                  | 2 | When data other than a G code is to be altered, just move the cursor to the data and key in a desired value, then press the <b>[INPUT]</b> soft key or $\boxed{\text{INPUT}}$ key.  |
|                                  | 3 | When a G code is to be altered, press the menu return key $\square$ and the soft key <b>[G.MENU]</b> . Then the G code menu appears. Select a desired G code, then key in the value. For example, to specify a cutting feed, since the G code menu indicates G01, key in G01. Then press the soft key <b>[BLOCK]</b> . The detailed screen of the G code is displayed, so enter the data. |
|                                  | 4 | After data is changed completely, press the ALTER key. This operation   |
|                                  |   | replaces an entire block of a program.  |
| Procedure 3<br>Inserting a block | 1 | On the conversational screen, display the block immediately before a<br>new block is to be inserted, by using the page keys. On the program<br>screen, move the cursor with the page keys and cursor keys to<br>immediately before the point where a new block is to be inserted.   |
|                                  | 2 | Press the soft key <b>[G.MENU]</b> to display the G code menu. Then enter new block data.   |
|                                  | 3 | When input of one block of data is completed in step <b>2</b> , press the Key. This operation inserts a block of data.  |
| Procedure 4<br>Deleting a block  | 1 | On the conversational screen, display the contents of a block to be deleted, then press the $\begin{bmatrix} DELETE \end{bmatrix}$ key.   |
|                                  | 2 | The contents of the block displayed are deleted from program<br>memory. Then the contents of the next block are displayed on the<br>conversational screen.  |



#### SETTING AND DISPLAYING DATA

#### General

To operate a CNC machine tool, various data must be set on the CRT/MDI or LCD/MDI for the CNC. The operator can monitor the state of operation with data displayed during operation.

This chapter describes how to display and set data for each function.

#### **Explanations**

#### Screen transition chart



MDI function keys (Shaded keys ( ) are described in this chapter.) The screen transition for when each function key on the MDI panel is pressed is shown below. The subsections referenced for each screen are also shown. See the appropriate subsection for details of each screen and the setting procedure on the screen. See other chapters for screens not described in this chapter.

See Chapter III–7 for the screen that appears when function key MESSAGE is

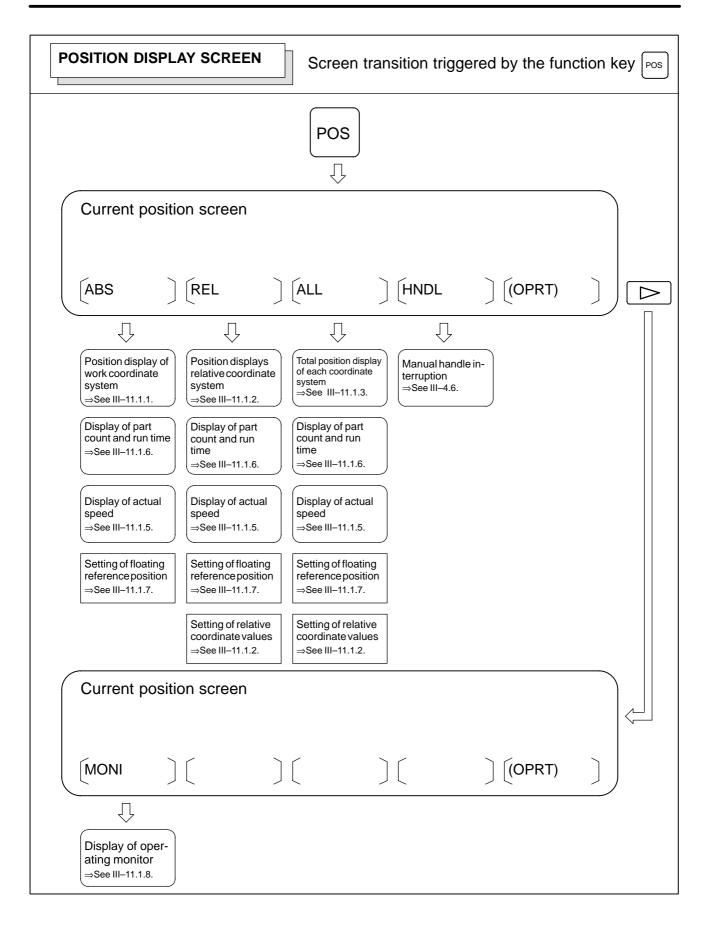
pressed. See Chapter III-12 for the screen that appears when function key

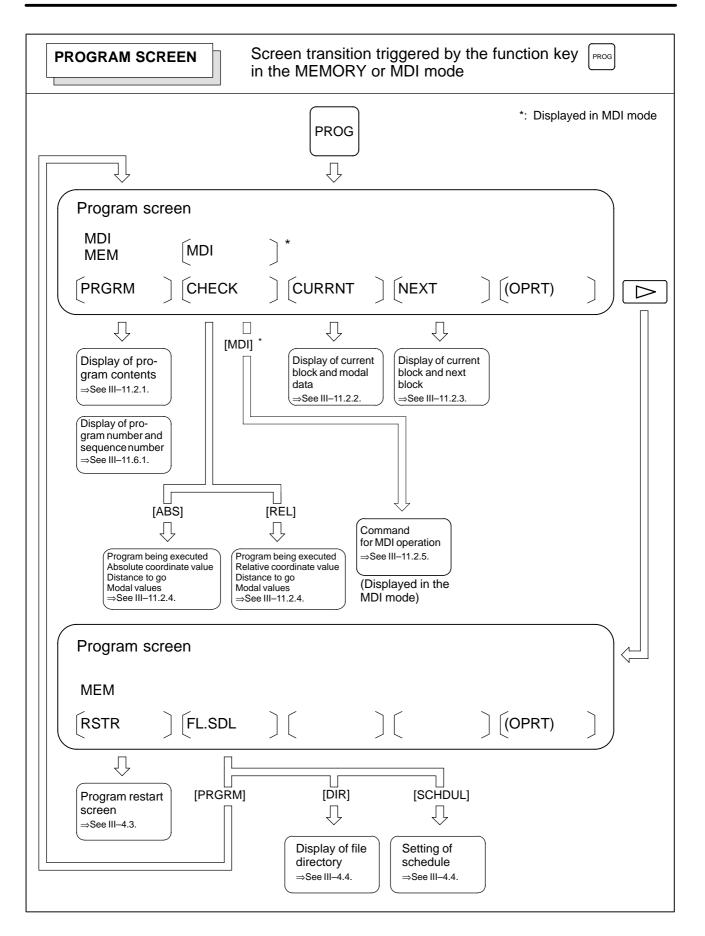
GRADH is pressed. See Chapter III–13 for the screen that appears when

function key HELP is pressed. In general, function key CUSTOM is prepared by the machine tool builder and used for macros. Refer to the manual issued by the machine tool builder for the screen that appears when function key CUSTOM is pressed.

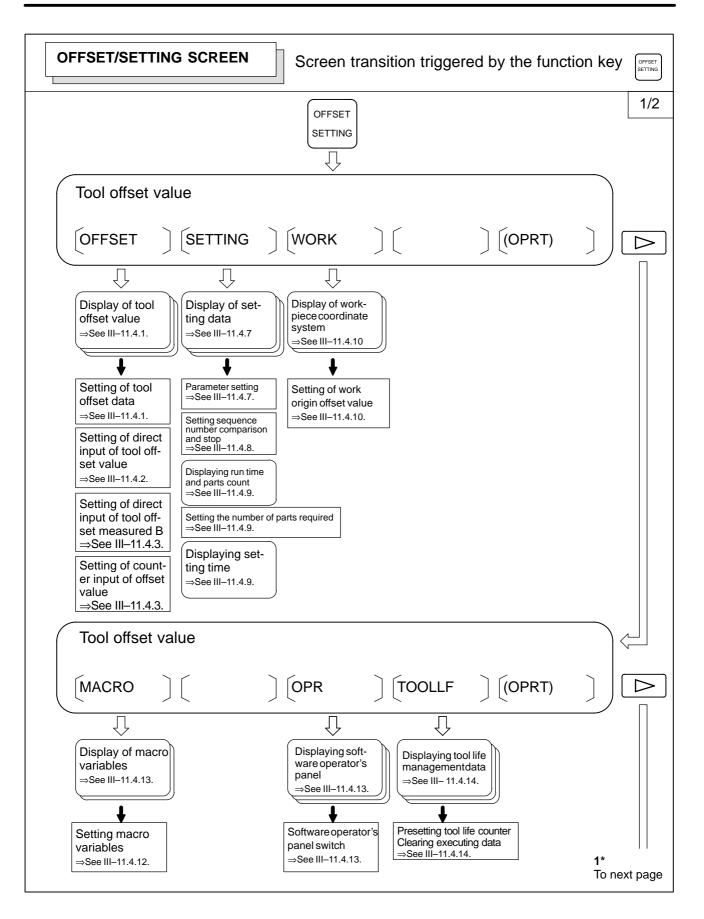
Data protection key

The machine may have a data protection key to protect part programs, tool compensation values, setting data, and custom macro variables. Refer to the manual issued by the machine tool builder for where the data protection key is located and how to use it.

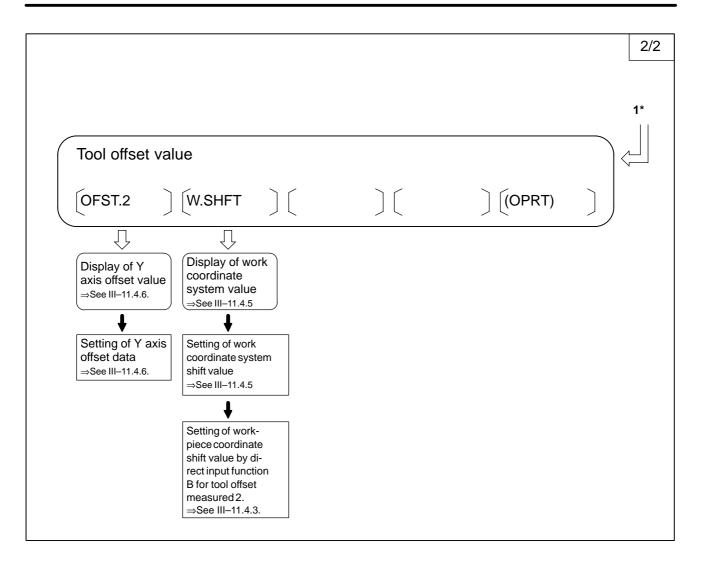




| PROGRAM SCREEN  | Screen transition in the EDIT mo   | on triggered by<br>de                                | the function ke | PROG |
|---|--|--|-----------------|------|
|   | PROG   |  |                 |      |
|   | $\overline{\Box}$  |  |                 |      |
| Program screen  |  |  |                 |      |
| EDIT  |  |  |                 |      |
|   |  | ) (C.A.P.  |                 |      |
| Ū Ū   |  | $\overline{\Box}$                                    |                 |      |
| Program editing<br>screen<br>⇒See III–10<br>⇒See III–11.3 | n di-  | Conversation<br>programming<br>screen<br>⇒See III–10 |                 |      |
|   |  |  |                 |      |
| Program screen  |  |  |                 |      |
| EDIT  |  |  |                 |      |
|   |  |  |                 |      |
| [Pi   | RGRM] [DIR]<br>☐ ↓<br>File directory<br>screen for<br>floppy disks<br>⇒See III–8 | ′  |                 |      |



#### 



| SYSTEM SCREEN Screen transition triggered by the function key   |
|---|
| SYSTEM  |
| Parameter screen  |
| [PARAM]     [DGNOS]     [PMC]     [SYSTEM]     [(OPRT)]   |
| $ \begin{array}{c} \downarrow \\ \hline \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\$  |
| Parameter screen  |
| Image: Description of the second s |
| $   \overrightarrow{\textbf{b}} $ Display of pitch<br>error data<br>$\Rightarrow$ See III-11.5.2.<br>Setting of pitch<br>error data<br>$\Rightarrow$ See III-11.5.2   |

#### • Setting screens

The table below lists the data set on each screen.

#### Table 11. Setting screens and data on them

| No. | Setting screen                                | Contents of setting   | Reference<br>item |
|-----|---|---|-------------------|
| 1   | Tool offset value                             | Tool offset value<br>Tool nose radius compensation value  | Subsec. 11.4.1    |
|     |   | Direct input of tool offset value   | Subsec. 11.4.2    |
|     |   | Direct input of tool offset value measured B  | Subsec. 11.4.3    |
|     |   | Counter input of offset value   | Subsec. 11.4.4    |
|     |   | Y axis offset   | Subsec. 11.4.6    |
| 2   | Workpiece coordinate                          | Workpiece coordinate system shift value   | Subsec. 11.4.5    |
|     | system setting                                | Workpiece origin offset value   | Subsec. 11.4.10   |
| 3   | Setting data (handy)                          | Parameter write<br>TV check<br>Punch code (EIA/ISO)<br>Input unit (mm/inch)<br>I/O channel<br>Automatic insert of Sequence No.<br>Conversion of tape format<br>(F15)  | Subsec. 11.4.7    |
|     |   | Sequence number comparison and stop   | Subsec. 11.4.8    |
| 4   | Setting data (mirror image)                   | Mirror image  | Subsec. 11.4.7    |
| 5   | Setting data (timer)                          | Parts required  | Subsec. 11.4.9    |
| 6   | Macro variables                               | Custom macro common variables<br>(#100 to #149) or (#100 to #199)<br>(#500 to #531) or (#500 to #599)   | Subsec. 11.4.12   |
| 7   | Parameter                                     | Parameter   | Subsec. 11.5.1    |
| 8   | Pitch error                                   | Pitch error compensation data   | Subsec. 11.5.2    |
| 9   | software operator's<br>panel                  | Mode selection<br>Jog feed axis selection<br>Jog rapid traverse<br>Axis selection for Manual pulse<br>generator<br>Multiplication for manual pulse<br>generator<br>Jog feedrate<br>Feedrate override<br>Rapid traverse override<br>Optional block skip<br>Single block<br>Machine lock<br>Dry run<br>Protect key<br>Feed hold | Subsec. 11.4.13   |
| 10  | Tool life data<br>(Tool life manage-<br>ment) | Life count  | Subsec. 11.4.14   |
| 11  | Current position dis-<br>play screen          | Floating reference position   | Subsec. 11.1.7    |

OPERATION

#### 11.1 SCREENS DISPLAYED BY FUNCTION KEY

Press function key POS to display the current position of the tool.

The following three screens are used to display the current position of the tool:

Position display screen for the work coordinate system.
Position display screen for the relative coordinate system.
Overall position display screen.

The above screens can also display the feedrate, run time, and the number of parts. In addition, a floating reference position can be set on these screens.

Function key POS can also be used to display the load on the servo motor

and spindle motor and the rotation speed of the spindle motor (operating monitor display).

Function key POS can also be used to display the screen for displaying

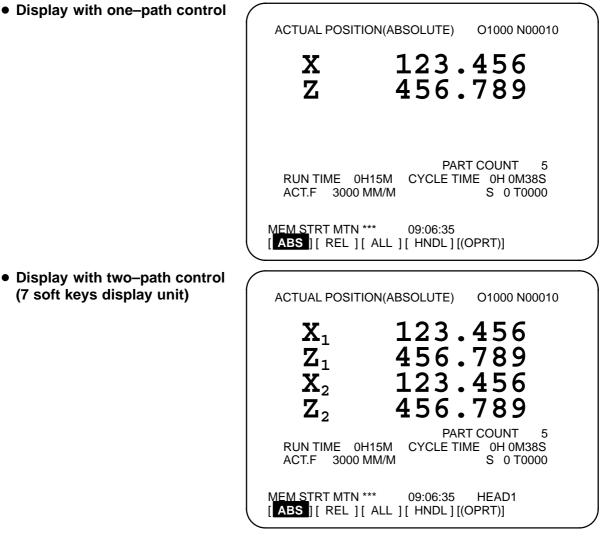
the distance moved by handle interruption. See Section 4.6 for details on this screen.

#### 11.1.1 Position Display in the Workpiece Coordinate System

Displays the current position of the tool in the workpiece coordinate system. The current position changes as the tool moves. The least input increment is used as the unit for numeric values. The title at the top of the screen indicates that absolute coordinates are used.

Display procedure for the current position screen in the workpiece coordinate system

- **1** Press function key POS
- 2 Press soft key **[ABS]**.
- 3 On (7 soft keys display unit), press the **[ABS]** soft key one more time to display the coordinates along axes other than the six standard axes.



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 Two-path lathe control / 7 soft keys display unit

#### NOTE

For the two-path control, the display may not be as shown above. In some cases, only the coordinates along the axes on tool post 1 are displayed due to the number of axes. In that case, press the **[ABS]** soft key one more time to display the coordinates along the axes on tool post 2.

 Display with two-path control (12 soft keys display unit)

|  | 01000 N10010 | 02000 N20010  |
|--|--------------|---|
| (ACTUAL  | 10           | (ACTUAL0  |
| X1 100.000<br>Z1 200.000<br>C1 300.000<br>Y1 400.000   |              | X2 500.000<br>Z2 600.000<br>C2 700.000<br>Y2 800.000                            |
| (ACTUAL SPEED) F :<br>MIN<br>S : ORPM<br>(PARTS COUNT) |              | (ACTUAL SPEED) F : 0 M M ,<br>MIN<br>S : 0RPM<br>(PARTS COUNT) 114              |
| (RUN TIME) 5H<br>(CYCLE TIME)                          |              | (RUN TIME) 5H 3M<br>(CYCLE TIME) 0H 0M 6S<br>MEM STOP *** *** 12:34:56<br>HEAD1 |

#### **Explanations**

- Display including compensation values
- Displaying the sixth and subsequent axes

Bits 6 and 7 of parameter 3104 can be used to select whether the displayed values include tool offset value and tool nose radius compensation.

On 7 soft keys display unit or the shared screen of 12 soft keys display unit, only the coordinates for the first to fifth axes are displayed initially whenever there are six or more controlled axes. Pressing the **[ABS]** soft key displays the coordinates for the sixth and subsequent axes. When six or more controlled axes are used under two–path control, the coordinates for path 1 are displayed initially on 7 soft keys display unit. Pressing the **[ABS]** soft key displays the coordinates for path 2. On the shared screen of 12 soft keys display unit, the tool post selection signal is used to select the display for path 1 or 2.

#### 11.1.2 Position Display in the Relative Coordinate System

Displays the current position of the tool in a relative coordinate system based on the coordinates set by the operator. The current position changes as the tool moves. The increment system is used as the unit for numeric values. The title at the top of the screen indicates that relative coordinates are used.

| Display procedure for the current position screen with the relative coordinate system |   |  |
|---|---|--|
| 1   | Press function key Pos.   |  |
| 2   | Press soft key [REL].   |  |
| 3   | On 7 soft key display unit, press the <b>[REL]</b> soft key one more time to display the coordinates along axes other than the six standard axes. |  |
| <ul> <li>Display with one-path control</li> </ul>                                     |   |  |
|   | ACTUAL POSITION(RELATIVE) O1000 N00010  |  |
|   | U 123.456<br>W 456.789  |  |
|   |   |  |
|   | PART COUNT 5<br>RUN TIME 0H15M CYCLE TIME 0H 0M38S<br>ACT.F 3000 MM/M S 0 T0000   |  |
|   | MEM STRT MTN *** 09:06:35<br>[ ABS ] [ REL ] [ ALL ] [ HNDL ] [ (OPRT) ]  |  |
| <ul> <li>Display with two–path control<br/>(7 soft keys display unit)</li> </ul>      | ACTUAL POSITION(RELATIVE) O1000 N00010  |  |
|   | $\begin{array}{ccccc} U_1 & 100.000 \\ W_1 & 200.000 \\ U_2 & 300.000 \end{array}$  |  |
|   | W <sub>2</sub> 400.000  |  |
|   | PART COUNT 5<br>RUN TIME 0H15M CYCLE TIME 0H 0M38S<br>ACT.F 3000 MM/M S 0 T0000   |  |
|   | MEM STRT MTN *** 09:06:35 HEAD1<br>[ ABS ] [ <b>REL</b> ] [ ALL ] [ HNDL ] [ (OPRT) ]   |  |

#### NOTE

For the two-path lathe control 7 soft keys display unit, the display may not be as shown above. In some cases, only the coordinates along the axes on tool post 1 are displayed due to the number of axes. In that case, press the **[REL]** soft key one more time to display the coordinates along the axes on tool post 2.

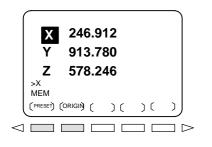
• Display with two-path control (12 soft keys display unit)

| ACTUAL POSITION 01000 N10              | 0010 | 02000 N20010                              |
|--|------|---|
| (RELATIVE)                             |      | (RELATIVE)                                |
| U1 100.000                             |      | U2 500.000                                |
| W1 200.000                             |      | W2 600.000                                |
| H1 300.000<br>V1 400.000               |      | A2 700.000<br>B2 800.000                  |
| 11 1001000                             |      | 22 0001000                                |
|  |      |   |
|  |      |   |
|  |      |   |
|  |      |   |
|  |      |   |
| (ACTUAL SPEED) F : 0                   | мм/  | (ACTUAL SPEED) F : 0 M M                  |
| MIN                                    | ,    | MIN                                       |
| S: ORPM                                |      | S: ORPM                                   |
| (PARTS COUNT) 114                      |      | (PARTS COUNT) 114                         |
| (RUN TIME) 5H 3M<br>(CYCLE TIME) 0H 0M | 6S   | (RUN TIME) 5H 3M<br>(CYCLE TIME) 0H 0M 6S |
| (CICHE IIME) ON ON                     | 0.5  | (CICHE TIME) ON ON 05                     |
|  | '    | MEM STOP *** *** 12:34:56                 |
|  |      | HEAD1                                     |

#### Explanations

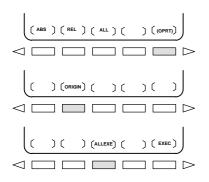
• Setting the relative coordinates The current position of the tool in the relative coordinate system can be reset to 0 or preset to a specified value as follows:

#### Procedure to set the axis coordinate to a specified value



- 1 Enter an axis address (such as X or Z) on the screen for the relative coordinates. The indication for the specified axis blinks and the soft keys change as shown on the left.
- 2 To reset the coordinate to 0, press soft key **[ORIGIN]**. The relative coordinate for the blinking axis is reset to 0.
  - To preset the coordinate to a specified value, enter the value and press soft key [**PRESET**]. The relative coordinate for the blinking axis is set to the entered value.

#### Procedure to reset all axes



- 1 Press soft key [(OPRT)].
- 2 Press soft key [ORIGIN].
- **3** Press soft key **[ALLEXE]**. The relative coordinates for all axes are reset to 0.
- Display including compensation values
- Presetting by setting a coordinate system
- Displaying the sixth and subsequent axes

Bits 4 (DRL) and 5 (DRC) of parameter 3104 can be used to select whether the displayed values include tool offset and tool nose radius compensation.

Bit 3 of parameter 3104 is used to specify whether the displayed positions in the relative coordinate system are preset to the same values as in the workpiece coordinate system when a coordinate system is set by a G50 (G code system A) or a G92 (G code system B or C) command or when the manual reference position return is made.

On 7 soft keys display unit or the shared screen of 12 soft keys display unit, only the coordinates for the first to fifth axes are displayed initially whenever there are six or more controlled axes. Pressing the **[REL]** soft key displays the coordinates for the sixth and subsequent axes. When six or more controlled axes are used under two-path control, the coordinates for path 1 are displayed initially on 7 soft keys display unit. Pressing the **[REL]** soft key displays the coordinates for path 2. On the shared screen of 12 soft key display unit, the tool post selection signal is used to select the display for path 1 or 2.

Ϊ

| 11.1.3<br>Overall Position<br>Display  | Displays the following positions on a screen : Current positions of tool in the workpiece coordinate system, relative coordinate system, machine coordinate system, and the remaining distance. The relation coordinates can also be set on this screen. See subsection III–11.1.2 the procedure.  |  |  |  |  |
|--|--|--|--|--|--|
| Procedure for o  | displaying overall position display screen   |  |  |  |  |
|  | <ol> <li>Press function key POS .</li> <li>Press soft key [ALL].</li> </ol>  |  |  |  |  |
| <ul> <li>Display with one-path control<br/>(7 soft keys display unit)</li> </ul> | ACTUAL POSITION         O1000 N00010           (RELATIVE)         (ABSOLUTE)           U 246.912         X 123.456           W 913.780         Z 456.890   |  |  |  |  |
|  | (MACHINE) (DISTANCE TO<br>X 0.000 GO)<br>Z 0.000 X 0.000<br>Z 0.000<br>PART COUNT 5  |  |  |  |  |
|  | RUN TIME 0H15M       CYCLE TIME 0H 0M38S         ACT.F       3000 MM/M       S 0 T0000         MEM **** *** ***       09:06:35         [ ABS ] [ REL ] [ ALL ] [ HNDL ] [(OPRT)]   |  |  |  |  |
| <ul> <li>Display with two–path contro<br/>(7 soft keys display unit)</li> </ul>  | ACTUAL POSITION       O1000 N00010         (RELATIVE)       (ABSOLUTE)         U1       100.000       X1       100.000         W1       200.000       Z1       200.000         U2       300.000       X2       300.000         W2       400.000       Z2       400.000         (MACHINE)       (DISTANCE TO GO)         X1       100.000       X1       000.000         Z1       200.000       Z1       000.000         Z2       300.000       Z2       000.000         Z2       300.000       Z2       000.000         Z2       400.000       Z2       000.000         Z2       300.000       Z2       000.000         Z2       400.000       Z2       000.000         Z2       400.000       Z2       000.000         Z2       400.000       Z2       000.000         PART COUNT       5       RUN TIME       0H15M         CYCLE TIME       0H 0M38S       ACT.F       3000 MM/M       S 0 T0000         MEM *****       **** ****       09:06:35       HEAD1         [       ABS ] [       REL ] [       ALT ] [       [       (OPRT ) ] |  |  |  |  |

 Display with two-path control (12 soft keys display unit)

| ACT                  | UAL POSITI                               | ON 010                | 00 N10010                                |                      | 02000 N200                               | 10                    |  |
|----------------------|--|-----------------------|--|----------------------|--|-----------------------|--|
| (R                   | ELATIVE)                                 | (Al                   | BSOLUTE)                                 | (R                   | ELATIVE)                                 | (A                    | BSOLUTE)                                 |
| U1<br>W1<br>H1<br>V1 | 100.000<br>100.000<br>300.000<br>400.000 | X1<br>Z1<br>C1<br>Y1  | 100.000<br>100.000<br>300.000<br>400.000 | U2<br>W2<br>A2<br>B2 | 100.000<br>100.000<br>300.000<br>400.000 | X2<br>Z2<br>A2<br>B2  | 100.000<br>100.000<br>300.000<br>400.000 |
|                      | ACHINE)                                  |                       | NCE TO GO)                               |                      | ACHINE)                                  |                       | NCE TO GO)                               |
| X1<br>Z1<br>C1       | 100.000<br>100.000<br>300.000            | X1<br>Z1<br>C1        | 000.000<br>000.000<br>000.000            | X2<br>Z2<br>A2       | 100.000<br>100.000<br>300.000            | X2<br>Z2<br>A2        | 000.000<br>000.000<br>000.000            |
| ¥1                   | 400.000                                  | ¥1                    | 000.000                                  | B2                   | 400.000                                  | В2                    | 000.000                                  |
| •                    | UAL SPEED)                               | s:                    | 0MM/MIN<br>0RPM                          |                      | AL SPEED)F                               | :                     | 0MM/MIN<br>0RPM                          |
| (RUN                 | TS COUNT)<br>TIME)<br>LE TIME)           | 114<br>5H 3M<br>0H 0M | 65                                       | (RUN T               |  | 114<br>5H 3M<br>0H 0M | 65                                       |
|                      |  |                       |  | MEM ST               | TOP *** **                               | * 12                  | :34:56 HEA                               |
|                      |  |                       |  | ABS                  | REL                                      | HNDL                  | (OPRT)                                   |

#### **Explanations**

Coordinate display

The current positions of the tool in the following coordinate systems are displayed at the same time:

- Current position in the relative coordinate system (relative coordinate)
- Current position in the work coordinate system (absolute coordinate)
- Current position in the machine coordinate system (machine coordinate)
- Distance to go (distance to go)

The distance remaining is displayed in the MEMORY or MDI mode. The distance the tool is yet to be moved in the current block is displayed.

The least command increment is used as the unit for values displayed in the machine coordinate system. However, the least input increment can be used by setting bit 0 (MCN) of parameter 3104.

On the overall position display screen, relative coordinates can be reset to 0 or preset to specified values. The procedure is the same as that for resetting the relative coordinates described in III-11.1.2.

On the shared screen of 12 soft keys display unit, only the coordinates for the first to fifth axes are displayed initially whenever there are six or more controlled axes. Pressing the [ALL] soft keys displays the coordinates for the sixth and subsequent axes. On the shared screen of 12 soft keys display unit, the tool post selection signal is used to select the display for path 1 or 2.

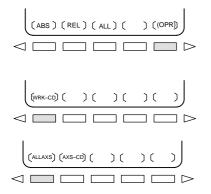
• Displaying the fifth and On 7 soft keys display unit, relative coordinates cannot be displayed subsequent axes together with absolute coordinates when there are five or more controlled axes (when the total number of controlled axes is five or more, for two-path control). Pressing the [ALL] soft key toggles the display between absolute and relative coordinates.

- Distance to go
- Machine coordinate system
- Resetting relative coordinates
- Displaying the sixth and subsequent axes

#### **11.1.4 Presetting the Workpiece Coordinate System A** workpiece coordinate system shifted by an operation such as manual intervention can be preset using MDI operations to a pre–shift workpiece coordinate system. The latter coordinate system is displaced from the machine zero point by a workpiece zero point offset value. A command (G92.1) can be programmed to preset a workpiece coordinate system. (See Subsec. III–8.2.4.)

#### Procedure for Presetting the Workpiece Coordinate System

**1** Press function key POS



- 2 Press soft key [(OPRT)].
- 3 When **[WRK-CD]** is not displayed, press the continuous menu key [□].
- 4 Press soft key [WRK-CD].
- **5** Press soft key **[ALLAXS]** to preset all axes.
- 6 To preset a particular axis in step 5, enter the axis name (X, Y, Y, ...) and 0, then press soft key [AXS-CD].

#### **Explanations**

- Operation mode
- Presetting relative coordinates
- This function can be executed when the reset state or automatic operation stop state is entered, regardless of the operation mode.
- As with absolute coordinates, bit 3 (PPD) of parameter No. 3104 is used to specify whether to preset relative coordinates (RELATIVE).

| 11.1.5<br>Actual Feedrate<br>Display | The actual feedrate on the machine (per minute) can be displayed on a current position display screen or program check screen by setting bit 0 (DPF) of parameter 3015. On 12 soft keys display unit, the actual feedrate is always displayed. |
|--------------------------------------|--|
|--------------------------------------|--|

#### Display procedure for the actual feedrate on the current position display screen

Press function key POS to display a current position display screen. 1 ACTUAL POSITION (ABSOLUTE) 01000 N00010 123.456 456.789 Х  $\mathbf{Z}$ PART COUNT 5 0H15M CYCLE TIME 0H 0M38S RUN TIME ACT.F 3000 MM/M 0 T0000 S MEM STRT MTN \*\*\* 09:06:35 [ ABS ] [ REL ] [ ALL ] [ HNDL ] [ OPRT

Actual feedrate is displayed after ACT.F.

The actual feedrate is displayed in units of millimeter/min or inch/min (depending on the specified least input increment) under the display of the current position.

#### **Explanations**

Actual feedrate value

The actual rate is calculated by the following expression:

$$Fact = \sqrt{\sum_{i=1}^{n} (fi)^2}$$

where

- $n \ : \ Number \ of \ axes$
- fi : Cutting feed rate in the tangential direction of each axis or rapid traverse rate

Fact : Actual feedrate displayed

The display unit: mm/min (metric input).

inch/min (Inch input, Two digits below the decimal point are displayed.)

The feedrate along the PMC axis can be omitted by setting bit 1 (PCF) of parameter 3105.

| B-63004EN/02   | OPERATION                   | 11. SETTING AND DISPLAYING DATA  |
|--|-----------------------------|--|
| <ul> <li>Actual feedrate display<br/>of feed per revolution</li> </ul> |                             | volution and thread cutting, the actual feedrate ninute rather than feed per revolution.   |
| <ul> <li>Actual feedrate display<br/>of rotary axis</li> </ul>         | deg/min but is displayed or | of rotary axis, the speed is displayed in units of<br>in the screen in units of input system at that time.<br>ary axis moves at 50 deg/min, the following is |
| <ul> <li>Actual feedrate display<br/>on the other screen</li> </ul>    | The program check screer    | also displays the actual feedrate.   |

#### 11.1.6 Display of Run Time and Parts Count

The run time, cycle time, and the number of machined parts are displayed on the current position display screens.

**1** Press function key POS to display a current position display screen.

#### Procedure for displaying run time and parts count on the current position display screen

ACTUAL POSITION (RELATIVE) 01000 N00010 123.456 456.789 X 7 PART COUNT 5 RUN TIME 0H15M CYCLE TIME 0H 0M38S 0 T0000 ACT.F 3000 MM/M S MEM STRT MTN \*\*\* 09:06:35 ABS ] [ REL ] [ ALL ] [ HNDL ] [ OPRT ] Г

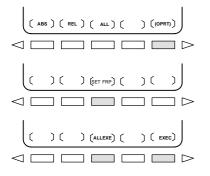
The number of machined parts (PART COUNT), run time (RUN TIME), and cycle time (CYCLE TIME) are displayed under the current position.

#### **Explanations**

| • PART COUNT  | Indicates the number of machined parts. The number is incremented each time M02, M30, or an M code specified by parameter 6710 is executed.   |
|---|---|
| • RUN TIME  | Indicates the total run time during automatic operation, excluding the stop and feed hold time.   |
| • CYCLE TIME  | Indicates the run time of one automatic operation, excluding the stop and feed hold time. This is automatically preset to 0 when a cycle start is performed at reset state. It is preset to 0 even when power is removed.                           |
| <ul> <li>Display on the other<br/>screen</li> </ul>               | Details of the run time and the number of machined parts are displayed<br>on the setting screen. See subsection III–11.4.9.   |
| • Parameter setting   | The number of machined parts and run time cannot be set on current position display screens. They can be set by parameters 6711, 6751, and 6752 or on the setting screen.   |
| <ul> <li>Incrementing the number<br/>of machined parts</li> </ul> | Bit 0 (PCM) of parameter 6700 is used to specify whether the number of machined parts is incremented each time M02, M30, or an M code specified by parameter 6710 is executed, or only each time an M code specified by parameter 6710 is executed. |

### **11.1.7**To perform floating reference position return with a G30.1 command, the<br/>floating reference position must be set beforehand.**Setting the Floating**<br/>**Reference Position**To perform floating reference position must be set beforehand.

#### Procedure for setting the floating reference position



- 1 Press function key POS to display a screen used for displaying the current position. Any of the following three screens may be selected: The screen for displaying the current position in the relative coordinate system, screen for displaying the current position in the workpiece coordinate system, and screen for displaying the current positions in four different coordinate systems.
- 2 Move the tool to the floating reference position by jogging.
- 3 Press soft key [(OPRT)].
- 4 Press soft key [SET FRP].
- **5** To register the floating reference positions for all axes, press soft key **[ALLEXE]**.

To register the floating reference position of a specific axis, enter the name of the axis (X, etc.), then press soft key **[EXEC]**. Two or

X

Y

Ζ

more names can be entered consecutively (e.g.,

#### **[EXEC]**).

The above operation stores the floating reference position. It can be checked with parameter (No. 1244).

6 In step 4, the floating reference position along a specified axis can also be stored by entering the axis name (such as X) and pressing soft key [SET FRP].

#### **Explanations**

• Presetting the relative coordinate system

By parameter FPC (bit 3 of parameter 1201), the relative position can be preset to 0 when a floating reference position is registered.

## **11.1.8** The reading on the load meter can be displayed for each servo axis and the serial spindle by setting bit 5 (OPM) of parameter 3111 to 1. The reading on the speedometer can also be displayed for the serial spindle.

#### Procedure for displaying the operating monitor

- **1** Press function key POS to display a current position display screen.
- 2 Press the continuous-menu key  $\square$ .
- **3** Press soft key [MONI].

| x  | :   |     |     | * | *   | *    | 80% | <b>S</b> 1 | :      |       | 201% |
|----|-----|-----|-----|---|-----|------|-----|------------|--------|-------|------|
| z  | :   | *   | *   | * | *   | *    | 0%  |            | (SPEED | METER | RPM) |
| С  | :   | *   | *   | * | *   | *    | 0%  | <b>S</b> 1 | :      | * *   | *    |
| 15 | 500 |     |     |   |     |      | P   | ART        | COUNT  | 5     | 5    |
|    | R   | UN  | TIM | Œ | C   | )н15 | M C | YCLE       | TIME   | он ом | 138S |
|    | А   | CT. | F   |   | 300 | 00 M | м/м |            |        |       |      |

#### Explanations

Display of the servo axes

 The reading on the load meter can be displayed for up to three servo axes by setting parameters 3151 to 3158. When all these parameters are set to 0, data is displayed only for the basic axes.
 Display of the spindle axes
 When serial spindles are used, the reading on the load meter and speedometer can be displayed only for the main serial spindle.

 Unit of graph

 The bar graph for the load meter shows load up to 200% (only a value is displayed for load exceeding 200%). The bar graph for the speedometer shows the ratio of the current spindle speed to the maximum spindle speed (100%).

- Load meter
- Speed meter

The reading on the load meter depends on servo parameter 2086 and spindle parameter 4127.

Although the speedometer normally indicates the speed of the spindle motor, it can also be used to indicate the speed of the spindle by setting bit 6 (OPS) of parameter 3111 to 1.

The spindle speed to be displayed during operation monitoring is calculated from the speed of the spindle motor (see the formula below). The spindle speed can therefore be displayed, during operation monitoring, even when no position coder is used. To display the correct spindle speed, however, the maximum spindle speed for each gear (spindle speed at each gear ratio when the spindle motor rotates at the maximum speed) must be set in parameters No. 3741 to 3744.

The input of the clutch and gear signals for the first serial spindle is used to determine the gear which is currently selected. Control the input of the CTH1A and CTH2A signals according to the gear selection, by referring to the table below.

(Formula for calculating the spindle speed to be displayed)

| Spindle speed<br>displayed during = | Speed of spindle motor         | X | Maximum spindle speed with the |
|-------------------------------------|--------------------------------|---|--------------------------------|
| operation monitoring                | Maximum speed of spindle motor | ~ | gear being used                |

The following table lists the correspondence between clutch and gear selection signals CTH1A and CTH2A <G070#3, #2>, used to determine the gear being used, and parameters:

| СТН1А | CTH2A | Parameter                                       | Serial spindle specification |
|-------|-------|---|------------------------------|
| 0     | 0     | =No.3741<br>(Maximum spindle speed with gear 1) | HIGH                         |
| 0     | 1     | =No.3742<br>(Maximum spindle speed with gear 2) | MEDIUM HIGH                  |
| 1     | 0     | =No.3743<br>(Maximum spindle speed with gear 3) | MEDIUM LOW                   |
| 1     | 1     | =No.3744<br>(Maximum spindle speed with gear 4) | LOW                          |

The speed of the spindle motor and spindle can be displayed, during operation monitoring, only for the first serial spindle and the spindle switching axis for the first serial spindle. It cannot be displayed for the second spindle.

• Color of graph

On a color CRT, if the value of a load meter exceeds 100%, the bar graph turns purple.

#### 11. SETTING AND DISPLAYING DATA

11.2 SCREENS DISPLAYED BY FUNCTION KEY PROG (IN MEMORY MODE OR MDI MODE) This section describes the screens displayed by pressing function key

**PROG** in MEMORY or MDI mode. The first four of the following screens

display the execution state for the program currently being executed in MEMORY or MDI mode and the last screen displays the command values for MDI operation in the MDI mode:

11.2.1 Program contents display screen

11.2.2 Current block display screen

11.2.3 Next block display screen

11.2.4 Program check screen

11.2.5 Program screen for MDI operation

11.2.6 Stamping the maching time

11.2.7 Displaying the B-axis operation state

Function key PROG can also be pressed in MEMORY mode to display the

program restart screen and scheduling screen.

See Section III–4.3 for the program restart screen.

See Section III–4.4 for the scheduling screen.

# 11.2.1 Displays the program currently being executed in MEMORY or MDI mode. Program Contents mode.

#### Procedure for displaying the program contents

- **1** Press function key **PROG** to display a program screen.
- 2 Press chapter selection soft key [PRGRM]. The cursor is positioned at the block currently being executed.

```
02000 N00130
   PROGRAM
   02000;
   N100 G50 X0 Z0. ;
   N110 G91 G00 X-70. ;
   N120 Z-70. ;
   N130 G01 X-60 ;
   N140 G41 G03 X-17.5 Z17.5 R17.5 ;
   N150 G01 X-25. ;
   N160 G02 X27.5 Z27.5 R27.5
   N170 G01 X20. ;
   N180 G02 X45. Z45. R45. ;
                               s
                                   0 T0000
>
                       16:05:59
MEM STRT
            * * *
[ PRGRM ] [ CHECK ] [ CURRNT ] [ NEXT ] [ (OPRT) ]
```

#### Explanations

• 12 soft keys display unit

On 12 soft keys display unit, the contents of the program are displayed on the right half of the screen or on the entire screen (switched each time soft key **[PRGRM]** is pressed).

| PROGRAM                      | 00006 N00000              |
|------------------------------|---------------------------|
|                              |                           |
| 00003 ;                      | G65 H01 P#100 O#3901 ;    |
| G65 H01 P#2001 O0 ;          | G65 H01 P#101 O#3902 ;    |
| G65 H01 P#2014 O0 ;          | G65 H01 P#3901 O#102 ;    |
| G65 H01 P#2110 O0 ;          | G65 H01 P#3902 O#103 ;    |
| G04 P2000 ;                  | G04 P5000 ;               |
| G04 P2000 ;                  | G04 P5000 ;               |
| G04 P2000 ;                  | G04 ;                     |
| G65 H01 P#2001 O50000 ;      | G65 H01 P#100 O#4001 ;    |
|                              | G65 H01 P#101 O#4002 ;    |
| G65 H01 P#2110 O30000 ;      | / G65 H01 P#102 O#4003 ;  |
| G04 P2000 ;                  | G65 H01 P#103 O#4004 ;    |
| G04 P2000 ;                  | G65 H01 P#104 O#4005 ;    |
| G04 P2000 ;                  | G65 H01 P#105 O#4006 ;    |
| G65 H02 P#2001 O#2001 R3 ;   |                           |
| G65 H03 P#2014 O15000 R#2014 |                           |
| ;                            | G65 H01 P#108 O#4009 ;    |
| G65 H04 P#2110 O3 R#2110 ;   |                           |
|                              | MEM **** *** *** 07:12:55 |
|                              |                           |
|                              |                           |
|                              |                           |
|                              |                           |
|                              | O SRH SRH↑ SRH↓ REWIND    |
|                              |                           |

#### 11.2.2 Current Block Display Screen

Displays the block currently being executed and modal data in the MEMORY or MDI mode.

#### Procedure for displaying the current block display screen

- **1** Press function key PROG .
- 2 Press chapter selection soft key **[CURRNT]**. The block currently being executed and modal data are displayed. The screen displays up to 22 modal G codes and up to 11 G codes specified in the current block.

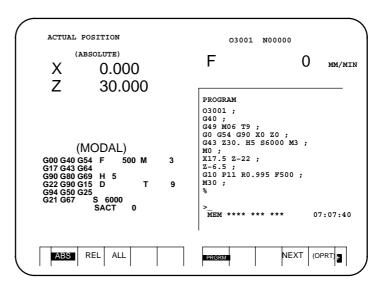
| PROGRAM             |                 | 02000   | N00130   |
|---------------------|-----------------|---------|----------|
| (CURRNT)            | (MODAL)         | 02000   | 100130   |
| (CORRNI)            | (MODAL)         |         |          |
| G01 ·X 100.         | 500 G18 G00     | F       |          |
| •F 50.              | 000 G50.2G97    |         |          |
|                     | G13.1G69        |         |          |
|                     | G99             |         |          |
|                     | G21             | т       |          |
|                     | G40             | S       |          |
|                     | G25             |         |          |
|                     | G22             |         |          |
|                     | G80             |         |          |
|                     | G67             | SACT    | 0        |
|                     | G54             |         |          |
| > _                 |                 | s (     | ) T0000  |
| MEM STRT ***        | 16:05:59        |         |          |
| [ PRGRM ] [ CHECK ] | [ CURRNT ] [ NE | EXT ] [ | (OPRT) ] |

#### **Explanations**

• 12 soft keys display unit

The current block display screen is not provided for 12 soft keys display unit. Press soft key **[PRGRM]** to display the contents of the program on the right half of the screen. The block currently being executed is indicated by the cursor. Modal data is displayed on the left half of the screen.

The screen displays up to 18 modal G codes.



# **11.2.3**Displays the block currently being executed and the block to be executed<br/>next in the MEMORY or MDI mode.**Next Block DisplayMEMORYScreenScreen**

#### Procedure for displaying the next block display screen

- **1** Press function key **PROG**.
- 2 Press chapter selection soft key **[NEXT]**. The block currently being executed and the block to be executed next are displayed.

The screen displays up to 11 G codes specified in the current block and up to 11 G codes specified in the next block.

| PROGRAM     |      |            |        |     | 00000 M00100   |
|-------------|------|------------|--------|-----|----------------|
| PROGRAM     |      |            |        |     | 02000 N00130   |
|             | CURE | NT)        |        | (NE | XT)            |
| G01         | х    | 17.500     | G39    | I   | -17.500        |
| G17         | F    | 2000       | G42    |     |                |
| G41         | н    | 2          |        |     |                |
| G80         |      |            |        |     |                |
|             |      |            |        |     |                |
|             |      |            |        |     |                |
|             |      |            |        |     |                |
|             |      |            |        |     |                |
|             |      |            |        |     |                |
| >           |      |            |        | S   | 0 T0000        |
| MEM STRT    | **   | * 1        | 6:05:5 | 59  |                |
| [ PRGRM ] [ | CHE  | CK ] [ CUR | RNT ]  | NEX | T ] [ (OPRT) ] |
|             |      |            |        |     |                |

— 701 —

# **11.2.4**Displays the program currently<br/>tool, and modal data in the MEN

Displays the program currently being executed, current position of the tool, and modal data in the MEMORY mode.

#### Procedure for displaying the program check screen

- **1** Press function key PROG .
- 2 Press chapter selection soft key [CHECK]. The program currently being executed, current position of the tool, and modal data are displayed.
- Display with one-path control

PROGRAM 02000 N00130 00010 G92 G90 X100. Z50. ; G00 X0 Z0 ; G01 Z250. F1000 ; (ABSOLUTE) (DIST TO GO) G00 G94 G80 0.000 X 0.000 G17 G21 G98 х  $\mathbf{Z}$ 0.000 Z 0.000 G90 G40 G50 G22 G67 в м н т D F s 0 т0000 > S MEM STRT 16:05:59 \* \* \* [ PRGRM ] [ CHECK ] [ CURRNT ] [ NEXT ] [ (OPRT) ]

• Display with two-path control (7 soft keys display unit)

| PROGRAM          |          |        | 02   | 2000 N00130        |
|------------------|----------|--------|------|--------------------|
| 00010            |          |        |      |                    |
| 392 G90 X100. Z5 | 50.;     |        |      |                    |
| 300 X0 Z0 ;      |          |        |      |                    |
| 301 Z250. F1000  | ;        |        |      |                    |
| (ABSOLUTE) (DIST | TO GO)   | G00    | G94  | G80                |
| x 0.000 x        | 0.000    | G17    | G21  | G98                |
| z 0.000 z        | 0.000    | G90    | G40  | G50                |
|                  |          | G22    |      | G67                |
|                  |          |        | в    |                    |
|                  |          | н      | м    |                    |
| Т                |          | D      |      |                    |
| F                | S        |        |      |                    |
| _                |          |        | S    | 0 T0000            |
| M STRT ***       | 1        | 6:05:  | 59   | HEAD1              |
| PRGRM ] [ CHECK  | ] [ CURR | NT ] [ | NEXT | <b>[</b> ][ (OPRT) |

 Display with two path control (12 soft keys display unit)

| (  |  |
|--|--|
| PROGRAM CHECK 01000 N01010   | PROGRAM CHECK 02000 N02010   |
| :01000 G90 X100. 2100.;<br>N01010 G01 X50. 250. F2000. ;<br>N01020 X30. ;<br>N01030 X50. Z-40. ;<br>N01040 Z-60. ;   | N02010 G90 X200. Z200.;<br>N02020 G01 X50. Z50. F3000. ;<br>N02030 G01 X50 ;<br>N02040 Z-50. ;<br>N02050 X0 Z0 A0 B0 ;   |
| (RELATIVE) (ABSOLUTE) (DIST TO GO)<br>Ul 100.000 X1 100.000 X1 0.000<br>W1 200.000 Z1 200.000 Z1 0.000<br>H1 300.000 C1 300.000 C1 0.000<br>V1 400.000 Y1 400.000 Y1 0.000 | (RELATIVE)         (ABSOLUTE)         (DIST TO GO)           U2         500.000         X2         500.000         X2         0.000           W2         600.000         X2         600.000         X2         0.000           A2         700.000         A2         700.000         A2         0.000           B2         800.000         B2         800.000         B2         0.000 |
| (MODAL)  | (MODAL)  |
| G00 G98 G25 G67 M  | G00 G98 G25 G67 M  |
| G97 G21 G22 G54 M  | G97 G21 G22 G54 M  |
| G69 G40 G90 G18 M  | G69 G40 G90 G18 M  |
| T<br>F 3000.000 (ACT.F)  | T<br>F 3000.000 (ACT.F) 0MM/MIN  |
| OMM/MIN  | S 1000 (ACT.S) 0RPM  |
| S 1000 (ACT.S) 0RPM  | S 0 T0000  |
| >_   | MEM STOP *** *** 14:00:00 HEAD1  |
|  | PRGRM CHECK NEXT (OPRT)  |

#### **Explanations**

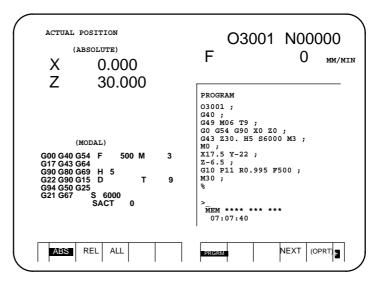
• **Program display** The screen displays up to four blocks (five blocks on 12 soft keys display unit when two-path control is being used) of the current program, starting from the block currently being executed. The block currently being executed is displayed in reverse video. During DNC operation, however, only three blocks can be displayed.

• Current position display The position in the workpiece coordinate system or relative coordinate system and the remaining distance are displayed. The absolute positions and relative positions are switched by soft keys [ABS] and [REL]. On 7 soft keys display unit when there are six or more controlled axes, pressing the [ABS] soft key toggles the display between the absolute coordinates for the first to fifth axes and those for the sixth to eighth axes. Pressing the [REL] soft key toggles the relative coordinate display in the same way.

- Modal G codes Up to 12 modal G codes are displayed. (12 G codes for each path, on 12 soft keys display unit when two-path control is being used)
- Displaying during automatic operation During automatic operation, the actual speed, SCAT, and repeat count are displayed. The key input prompt (>\_) is displayed otherwise.

#### 12 soft keys display unit with one-path control

The program check screen is not provided for 12 soft keys display unit with one-path control. Press soft key **[PRGRM]** to display the contents of the program on the right half of the screen. The block currently being executed is indicated by the cursor. The current position of the tool and modal data are displayed on the left half of the screen. Up to 18 modal G codes are displayed.

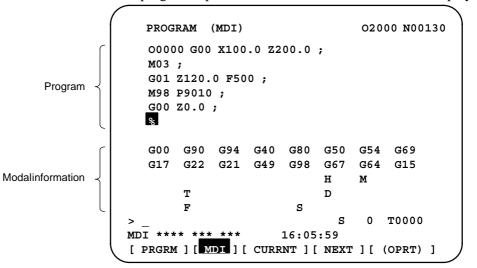


### 11.2.5 **Program Screen for MDI** Operation

Displays the program input from the MDI and modal data in the MDI mode.

#### Procedure for displaying the program screen for MDI operation

- Press function key PROG 1
- Press chapter selection soft key [MDI]. 2 The program input from the MDI and modal data are displayed.



#### **Explanations**

- MDI operation
- Modal information

See Section II-4.2 for MDI operation.

The modal data is displayed when bit 7 (MDL) of parameter 3107 is set to 1. Up to 16 modal G codes are displayed. On 12 soft keys display unit, however, the contents of the program are displayed on the right half of the screen and the modal data is displayed on the left half of the screen, regardless of this parameter. • Displaying during During automatic operation, the actual speed, SCAT, and repeat count are

automatic operation

displayed. The key input prompt (>) is displayed otherwise.

# **11.2.6**When a machining program is executed, the machining time of the main<br/>program is displayed on the program machining time display screen. The<br/>machining times of up to ten main programs are displayed in<br/>hours/minutes/seconds. When more than ten programs are executed, data<br/>for the oldest programs is discarded.

#### **Procedure for Stamping Machining Time**

Procedure 1 Machining time calculation and display

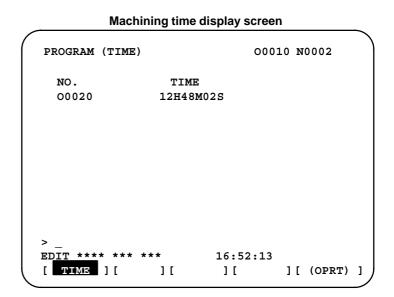
**1** Select the memory operation mode, then press the RESET key.

- 2 Select the program screen, then select a program whose machining time is to be calculated.
- **3** Execute the program to perform actual machining.

4 When the RESET key is pressed, or M02 or M30 is executed, the machining time count operation stops. When the machining time display screen is selected, the program number of the stopped main program and its machining time are displayed.

To display the machining time display screen, use the procedure below. (Machining time data can be displayed in any mode and during background editing.)

- Press the function key PROG .
- Press the rightmost soft key once or twice to display soft key **[TIME]**.
- Press soft key **[TIME]**. The machining time display screen appears.



**5** To calculate the machining times of additional programs, repeat the above procedure. The machining time display screen displays the executed main program numbers and their machining times sequentially.

Note, that machining time data cannot be displayed for more than ten main programs. When more than ten programs are executed, data for the oldest programs is discarded. The screens below show how the screen display changes from the initial state where the machining times of ten main programs (O0020, O0040, ..., and O0200) are displayed to the state where the machining time of the main program O0220 is calculated.

| PROGRAM (TIM  | 2)    |          | 000 | 00 N00 | 00 |
|---------------|-------|----------|-----|--------|----|
| NO.           | TIM   | Œ        |     |        |    |
| 00020         | 12H48 | M01S     |     |        |    |
| 00040         | 0H48  | M01S     |     |        |    |
| 00060         | 4H16  | M01S     |     |        |    |
| 00080         | 0H16  | M01S     |     |        |    |
| 00100         | 1H20  | M01S     |     |        |    |
| 00120         | 2H08  | M02S     |     |        |    |
| 00140         | 2H32  | M01S     |     |        |    |
| 00160         | 0H51  | M01S     |     |        |    |
| 00180         | 15H04 | M01S     |     |        |    |
| 00200         | 0H56  | M01S     |     |        |    |
| >_            |       |          |     |        |    |
| EDIT **** *** | * * * | 16:52:13 |     |        |    |
| [ TIME ] [    | ][    | ][       | ][  | (OPRT) | 1  |
|               |       |          |     |        |    |
|               |       | Π        |     |        |    |
|               |       | 47       |     |        |    |

| PROGRAM   | (TIME)  |          | 00000 | моооои |
|-----------|---------|----------|-------|--------|
| NO.       | т       | IME      |       |        |
| 00040     | 0H4     | 18M01S   |       |        |
| 00060     | 4H1     | L6M01S   |       |        |
| 00080     | 0H1     | L6M01S   |       |        |
| 00100     | 1H2     | 20M01S   |       |        |
| 00120     | 2H0     | 8M02S    |       |        |
| 00140     | 2H3     | 32M01S   |       |        |
| 00160     | 0H5     | 51M01S   |       |        |
| 00180     | 15H0    | 04M01S   |       |        |
| 00200     | 0H5     | 56M01S   |       |        |
| 00220     | 0H0     | 3M01S    |       |        |
| >_        |         |          |       |        |
| EDIT **** | *** *** | 16:52:20 | )     |        |
| [ TIME ]  | [ ][    | ][       | ][ (0 | PRT) ] |
|           |         |          |       |        |

# Procedure 2 Stamping machining time

- 1 To insert the calculated machining time of a program in a program as a comment, the machining time of the program must be displayed on the machining time display screen. Before stamping the machining time of the program, check that the machining time display screen shows the program number
- 2 Set the part program storage and edit mode or background edit state and select the program screen. Then select the program whose machining time is to be inserted.
- 3 Suppose that the machining time of O0100 is displayed on the machining time display screen. Press soft key [(OPRT)] to display the operation soft keys. Then, hold down the rightmost soft key until soft key [INS-TM] appears. When soft key [INS-TM] is pressed, the cursor moves to the start of the program, and the machining time of the program is inserted after the program number.

```
PROGRAM
                                      00100 N0000
 00100 ;
 N10 G92 X100. Z10. ;
 N20 S1500 M03 ;
 N30 G00 X20.5 Z5. T0101 ;
 N40 G01 X-10. F25. ;
 N50 G02 X-16.5 Z-12. R2. ;
 N60 G01 X40. ;
 N70 X42. Z-13. ;
  N80 Z-50. ;
 N90 X44. Z-51. ;
 N100 X80. ;
       *** *** *** ***
                           16:05:59
EDIT
[ INS-TM ][
                      ][
                                ][
                                           ][
                                                    1
                         ₽
PROGRAM
                                     00100 N0000
 00100 (001H20M01S) ;
 N10 G92 X100. Z10. ;
 N20 S1500 M03 ;
 N30 G00 X20.5 Z5. T0101 ;
 N40 G01 Z-10. F25. ;
 N50 G02 X16.5 Z-12. R2. ;
 N60 G01 X40. ;
 N70 X42. Z-13. ;
 N80 Z-50. ;
 N90 X44. Z-51. ;
 N100 X80. ;
EDIT
       *** *** *** ***
                           16:05:59
```

][

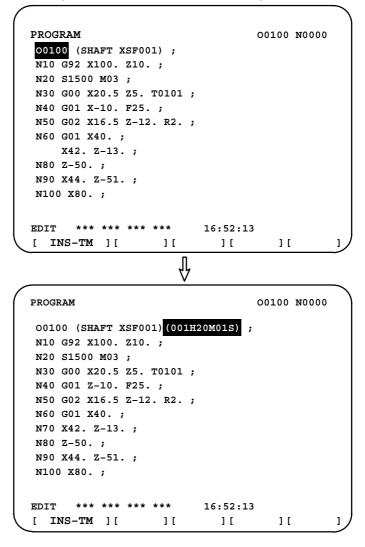
][

][

1

[ INS-TM ][

**4** If a comment already exists in the block containing the program number of a program whose machining time is to be inserted, the machining time is inserted after the existing comment.



**5** The machining time of a program inserted as a comment can be displayed after an existing program comment on the program directory screen.

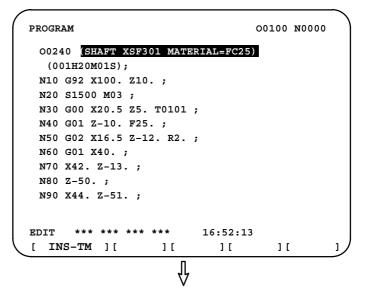
```
PROGRAM DIRECTORY
                               00001 N00010
         PROGRAM(NUM.)
                           MEMORY (CHAR.)
     USED:
                 60
                                  3321
     FREE:
                  2
                                   429
  O0020 (GEAR XGR001 ): (012H48M01S)
  O0002 (GEAR XGR002 ): (000H48M01S)
  O0010 (BOLT YBT001 ): (004H16M01S)
  O0020 (BOLT YBT002 ): (000H16M01S)
  O0040 (SHAFT XSF001 ): (001H20M01S)
  O0050 (SHAFT XSF002 ): (002H08M01S)
  O0100 (SHAFT XSF011 ):(002H32M02S)
  O0200 (PLATE XPL100 ):(000H51M01S)
EDIT **** *** ***
                     14:46:09
[ PRGRM ] [ DIR ] [
                              ][ (OPRT) ]
                      ][
```

### Explanations

| <ul> <li>Machining time</li> </ul>              | Machining time is counted from the initial start after a reset in memory operation mode to the next reset. If a reset does not occur during operation, machining time is counted from the start to M03 (or M30). However, note that the time during which operation is held is not counted, but the time used to wait for completion of M, S, T, and/or B functions is counted. |
|---|---|
| <ul> <li>Stamping the machining time</li> </ul> | The displayed machining time can be inserted (stamped) as a comment<br>in a program stored in memory. Machining time is inserted as a comment<br>after the program number.  |
| <ul> <li>Program directory</li> </ul>           | The machining time inserted after a program number can be displayed on<br>the program directory screen by setting bit 0 (NAM) of parameter No.<br>3107 to 1. This lets the user know the machining time of each program.<br>This information is useful as reference data when planning processing.  |
| Restrictions                                    |   |
| • Alarm   | When program execution is terminated by an alarm during the machining time count, the machining time until the alarm is released is counted.  |
| • M02   | If the user specifies that M02 does not reset the CNC but returns completion signal FIN to the CNC to restart the program from the beginning successively (with bit 5 (M02) of parameter No. 3404 set to 0), the machining time count stops when M02 returns completion signal FIN.   |
| <ul> <li>Stamping the machining time</li> </ul> | When the machining time of a program to be stamped is not displayed on the machining time display screen, the machining time cannot be inserted into the program even if soft key <b>[INS-TM]</b> is pressed.   |

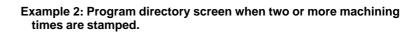
• **Program directory** When the machining time inserted into a program is displayed on the program directory screen and the comment after the program number consists of only machining time data, the machining time is displayed in both the program name display field and machining time display field. If machining time data is inserted into a program as shown below, the program directory screen does not display the data or displays only part of the data.

# Example 1: Program directory screen when a program name longer than 16 characters



All characters after the first 16 characters of the program comment are discarded and the machining time display field is left blank.

| PROGRAM DIREC  | TORY      |          | 00001 N000   | 010 |
|----------------|-----------|----------|--------------|-----|
| PROGR          | AM (NUM.) | ) MI     | EMORY (CHAR. | )   |
| USED:          | 60        |          | 3321         |     |
| FREE:          | 2         |          | 429          |     |
| 00240 (SHAFT   | XSF301    | ):(      | )            |     |
|                |           |          |              |     |
|                |           |          |              |     |
|                |           |          |              |     |
|                |           |          |              |     |
| >_             |           |          |              |     |
| EDIT **** ***  | * * *     | 16:52:13 |              |     |
| [ PRGRM ] [ D] | IR ][     | ][       | ][ (OPRT)    | ]   |



| PROGRAM                           | 00260 | лоооо |
|-----------------------------------|-------|-------|
| 00260 (SHAFT XSF302) (001H15M59S) |       |       |
| (001H20M01S) ;                    |       |       |
| N10 G92 X100. Z10. ;              |       |       |
| N20 S1500 M03 ;                   |       |       |
| N30 G00 X20.5 Z5. T0101 ;         |       |       |
| N40 G01 Z-10. F25. ;              |       |       |
| N50 G02 X16.5 Z-12. R2. ;         |       |       |
| N60 G01 X40. ;                    |       |       |
| N70 X42. Z-13. ;                  |       |       |
| N80 Z-50. ;                       |       |       |
| N90 X44. Z-51. ;                  |       |       |
|                                   |       |       |
| EDIT *** *** *** *** 16:52:13     | 5     |       |
|                                   | ][    | IJ    |
|                                   |       |       |
| Ϋ́                                |       |       |

Only the first machining time is displayed.

| PROGRAM  | DIRECTO  | RY     |        | 00001 N000  | 10 |
|----------|----------|--------|--------|-------------|----|
|          | PROGRAM  | (NUM.) | ME     | MORY (CHAR. | )  |
| USE      | D:       | 60     |        | 3321        |    |
| FRE      | Е:       | 2      |        | 429         |    |
| 00260    | (SHAFT   | XSF302 | ):(003 | LH15M59S)   |    |
|          |          |        |        |             |    |
| >_       |          |        |        |             |    |
| EDIT *** | * *** ** | * 16   | :52:13 |             |    |
| [ PRGRM  | ][ DIR   | ][     | ][     | ][ (OPRT)   | 1  |

Example 3: Program directory screen when inserted machining time data does not conform to the format hhhHmmMssS (3–digit number followed by H, 2–digit number followed by M, and 2–digit number followed by S, in this order)

| PROGRAM                     | 00280  | N0000 |    |
|-----------------------------|--------|-------|----|
| 00280 (SHAFT XSF303) (1H10M | 598)   |       |    |
| N10 G92 X100. Z10. ;        |        |       |    |
| N20 S1500 M03 ;             |        |       |    |
| N30 G00 X20.5 Z5. T0101 ;   |        |       |    |
| N40 G01 Z-10. F25. ;        |        |       |    |
| N50 G02 X16.5 Z-12. R2. ;   |        |       |    |
| N60 G01 X40. ;              |        |       |    |
| N70 X42. Z-13. ;            |        |       |    |
| N80 Z-50. ;                 |        |       |    |
| N90 X44. Z-51. ;            |        |       |    |
| N100 X80. ;                 |        |       |    |
|                             |        |       |    |
| EDIT *** *** *** *** 16     | :52:13 |       |    |
| [ INS-TM ][ ][              | ][     | ][    | IJ |
| Π                           |        |       | -  |
| 4                           |        |       |    |

The machining time display field is blank.

| ( PI | PROGRAM DIRECTORY |         |       |     | 00001 N0001     |      |          |   |  |
|------|-------------------|---------|-------|-----|-----------------|------|----------|---|--|
|      |                   | PROGRAM | (NUM. | )   | ME              | EMOR | Y (CHAR. | ) |  |
|      | USE               | D:      | 60    |     |                 |      | 3321     |   |  |
|      | FRE               | Е:      | 2     |     |                 |      | 429      |   |  |
|      | 00260             | (SHAFT  | XSF30 | 2   | ):(00           | 1H15 | 5M59S)   |   |  |
|      | 00280             | (SHAFT  | XSF30 | )3  | ):(             | )    |          |   |  |
|      |                   |         |       |     |                 |      |          |   |  |
|      |                   |         |       |     |                 |      |          |   |  |
|      |                   |         |       |     |                 |      |          |   |  |
|      |                   |         |       |     |                 |      |          |   |  |
|      |                   |         |       |     |                 |      |          |   |  |
| >_   | _                 |         |       |     |                 |      |          |   |  |
| ED   | TT ***            | * *** * | * *   | 16: | :52 <b>:</b> 13 |      |          |   |  |
| ( L  | PRGRM             | ][ DIR  | ][    |     | ][              | ][   | (OPRT)   | ] |  |

# • Correcting the machining time

If an incorrect machining time is calculated (such as when a reset occurs during program execution), reexecute the program to calculate the correct machining time. If the machining time display screen displays multiple programs with the same program number, select the machining time of the latest program number for insertion into the program.

## 11.2.7 Displaying the B–axis Operation State

#### Displaying the B-axis operation state

- **1** Press the **PROG** function key.
- 2 Press the [CHECK] chapter selection soft key.
- **3** Press the **[B–DSP]** chapter selection soft key. Then, the B–axis operation state is displayed on the program check screen. The command currently being executed and the next command are displayed.

| PROGRAM CHECK            | 00001 N00001  |
|--------------------------|---------------|
| M102 ;                   |               |
| G00 X10. Z20. ;          |               |
| G01 X20. Z30. F1000 ;    |               |
| G04 P1000 ;              |               |
| (ABSOLUTE) (B-AXIS) G00  | G95 G22       |
| X 40.000 G01(CURR) G97   | G21 G80       |
| Z 40.000 B -200.000 G90  | G40 G50       |
| Y 0.000 F 0.1500 G69     | G25 G67       |
| B -125.994 G00(NEXT)     |               |
| в 250.000                | M 102         |
| Т                        |               |
| F 0.1000 S               |               |
| ACT.F 0 SCAT (           | DS 0 T0000    |
| MEM STRT *** FIN 21:20:0 | 05            |
| [ ABS ][ REL ][ B.DSP    | ][ ][ (OPRT)] |

# 11.3 SCREENS DISPLAYED BY FUNCTION KEY PROG (IN THE EDIT MODE)

This section describes the screens displayed by pressing function key PROG in the EDIT mode. Function key PROG in the EDIT mode can display the program editing screen and the program display screen (displays memory used and a list of programs). Pressing function key PROG in the EDIT mode can also display the conversational graphics programming screen and the floppy file directory screen. See Chapter 9, 10 for the program editing screen and conversational graphics programming screen. See Chapter 8 for the floppy file directory screen.

# **11.3.1**Displays the number of registered programs, memory used, and a list of<br/>registered programs.**Displaying Memory**<br/>**Used and a List of**<br/>**Programs**Displays the number of registered programs.

#### Procedure for displaying memory used and a list of programs

- Select the EDIT mode.
   For the two-path control, select the tool post for which a program is to be displayed with the tool post selection switch.
- 2 Press function key PROG .
- **3** Press chapter selection soft key **[LIB]**.

| PROGRAM DIRECT                               | ORY          | 00001 N00010  |  |
|--|--------------|---|--|
| USED:<br>FREE:<br>00010 00001<br>00062 00004 |              | MEMORY (CHAR.)<br>3321<br>429<br>2 00555 00999<br>L 00969 06666 |  |
| ><br>MDI **** *** *<br>[ PRGRM ][ DI         | s<br>*** 16: | 0 T0000<br>05:59<br>][ ][ (OPRT)]                               |  |

#### **Explanations** • Details of memory used **PROGRAM NO. USED PROGRAM NO. USED** : The number of the programs registered (including the subprograms) The number of programs which can be FREE : registered additionally. **MEMORY AREA USED** MEMORY AREA USED : The capacity of the program memory in which data is registered (indicated by the number of characters). The capacity of the program memory which FREE : can be used additionally (indicated by the number of characters). • Program library list Program Nos. registered are indicated.

Also, the program name can be displayed in the program table by setting parameter NAM (No. 3107#0) to 1.

|         |           |          |             |        |       | · · · · |
|---------|-----------|----------|-------------|--------|-------|---------|
| PROGRAM | DIRECTOR  | ΥY       | 000         | 01 N   | 00010 |         |
|         | PROGRAM   | NUM.)    | MEMOR       | Y (CHA | R.)   |         |
| USI     | ED:       | 60       |             | 3321   |       |         |
| FRI     | 3E:       | 2        |             | 429    |       |         |
| 00001   | (MACRO-GC | ODE.MAIN | )           |        |       |         |
| 00002   | (MACRO-GC | ODE.SUB1 | )           |        |       |         |
| 00010   | (TEST-PRO | GRAM.ART | HMETIC NO.1 | )      |       |         |
| 00020   | (TEST-PRO | GRAM.F10 | -MACRO)     |        |       |         |
| 00040   | (TEST-PRO | GRAM.OFF | SET)        |        |       |         |
| 00050   |           |          |             |        |       |         |
| 00100   | (INCH/MM  | CONVERT  | CHECK NO.1) |        |       |         |
| 00200   | (MACRO-MC | ODE.MAIN | )           |        |       |         |
| > _     |           |          |             |        |       |         |
| EDIT ** | ** *** ** | * 16     | 5:05:59     |        |       |         |
| [ PRGRM | ][ DIR    | ][       | ][          | ][ (   | OPRT) | ]       |

Fig. 11.3.1 (a)

| ROGRAM  | DIREC | TORY       | 0      | 0001 N00010 |   |
|---------|-------|------------|--------|-------------|---|
|         | PROGR | AM(NUM.)   | MEMO   | RY (CHAR.)  |   |
| USE     | D:    | 17         |        | 4320        |   |
| FRE     | Е:    | 46         |        | 3960        |   |
| 00001   | 360   | 1966-06-12 | 14:40  |             |   |
| 00002   | 240   | 1966-06-12 | 14:55  |             |   |
| 00010   | 420   | 1966-07-01 | 11:02  |             |   |
| 00020   | 180   | 1966-08-14 | 09:40  |             |   |
| 00040   | 1140  | 1966-03-25 | 28:40  |             |   |
| 00050   | 60    | 1966-08-26 | 16:40  |             |   |
| 00100   | 120   | 1966-04-30 | 13:11  |             |   |
|         |       |            |        |             |   |
| DIT *** | * *** | *** 16     | :52:13 |             |   |
| PRGRM   | 1 [ D | IR ][      | 11     | ][ (OPRT)   | 1 |

Fig. 11.3.1 (b)

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• **Program name** Always enter a program name between the control out and control in codes immediately after the program number. Up to 31 characters can be used for naming a program within the parentheses. If 31 characters are exceeded, the exceeded characters are not displayed.

Only program number is displayed for the program without any program name.



Program number Program name (up to 31 characters)

- Software series
- Order in which programs are displayed in the program library list
- Order in which programs are registered

Software series of the system is displayed. It is used for maintenance ; user is not required this information.

Programs are displayed in the same order that they are registered in the program library list. However, if bit 4 (SOR) of parameter 3107 is set to 1, programs are displayed in the order of program number starting from the smallest one.

Immediately after all programs are cleared (by turning on the power while

pressing the  $\begin{bmatrix} DELETE \end{bmatrix}$  key), each program is registered after the last program in the list.

If some programs in the list were deleted, then a new program is registered, the new program is inserted in the empty location in the list created by the deleted programs.

Example) When bit 4 (SOR) of parameter 3107 is 0

- 1. After clearing all programs, register programs O0001, O0002, O0003, O0004, and O0005 in this order. The program library list displays the programs in the following order: O0001, O0002, O0003, O0004, O0005
- 2. Delete O0002 and O0004. The program library list displays the programs in the following order: O0001, O0003, O0005
- 3. Register O0009. The program library list displays the programs in the following order: O0001, O0009, O0003, O0005

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# **11.3.2**In two-path control, the programs for both tool posts can be displayed and<br/>edited on the same screen when bit 0 (DHD) of parameter No. 3106 is set<br/>to 1.<br/>The name of each tool post is displayed above the corresponding program.

#### Procedure for Two-path Simultaneous Editing on the Program Screen

- 1 Specify **EDIT** mode for both tool posts.
- 2 Press function **PROG** key.

Shared screen (7 soft keys display unit)

> PROGRAM 01357 N00120 02468 N00130 (HEAD2) (HEAD1) 01357 (HEAD-1 MAIN PROGRAM); 02468 (HEAD-2 MAIN PROGRAM); N010 G90 G00 X200.0 Z220.0 N010 G90 G00 X200.0 Z220.0 N020 T0101 ; N020 T0101 ; N030 S30000 M03 ; N030 S30000 M03 ; N040 G40 G00 X40.0 Z180.0 ; N040 G41 G00 X40.0 Z180.0 ; N050 G01 Z140.0 F1000.0 ; N050 G01 Z140.0 F1000.0 ; N060 X60.0 Z110.0 ; N060 X60.0 Z110.0 ; N070 Z90.0 ; N080 X100.0 Z80.0 ; N070 Z90.0 ; N080 X100.0 Z80.0 ; N090 Z60.0 ; N090 Z60.0 ; N100 X140.0 Z40.0 ; N110 X200.0 Z220.0 ; N100 X140.0 Z40.0 ; N110 X200.0 Z220.0 ; N120 T0100 ; N130 T0102 ; N120 S0 M05 N140 S1000 N150 G41 G00 X40.0 Z180.0 ; >N130T0100;M30; EDIT \*\*\*\* \*\*\* \*\*\* 16:05:59 HEAD1 [ BG-EDT ] [ O SRH ] [ SRH + ] [ SRH - ] [ REWIND ]

Shared screen (12 soft keys display unit)

| PROGRAM   | 01234 N00010 |  | 02345 N00100 |
|---|--------------|--|--------------|
| (HEAD1)   |              | (HEAD2)  |              |
| O1234 ;<br>N10 G00 ;<br>N20 X100.0 ;<br>N30 X200.0 ;<br>N40 X300.0 23<br>N50 X400.0 ;<br>N60 X500.0 ;<br>N70 M02 ;<br>% | 300.0 ;      | 02345;<br>N100 G00 ;<br>N200 X0 ;<br>N300 X50.0 ;<br>N400 M02 ;<br>% |              |
| >_  |              |  |              |

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#### Explanations

• Shared screen and individual screen

When the selected tool post is in **EDIT** mode, pressing the **[PRGRM]** soft key displays a shared screen which shows the program for the first tool post on the left and that for the second tool post on the right. However, if the tool post that is not selected fails to satisfy any of the conditions described below, only the individual screen for the selected tool post is displayed.

<Conditions>

- Bit 0 (DHD) of parameter No. 3106 is set to 1.
- The program screen for the selected tool post is the 12 soft keys display unit

(when the 12 soft keys display unit is being used).

- Both tool posts are set to **EDIT** mode.
- Background editing is not specified for either tool post.

When the mode for the tool post that is not selected is changed from **EDIT** mode on the shared screen, the individual screen (12 soft keys display unit when 12 soft keys display unit is being used) for the selected tool post is displayed.

On the 12 soft keys display unit, pressing the **[PRGRM]** soft key toggles between the individual screen (7 soft keys display unit) and the shared screen.

#### Individual screen (7 soft keys display unit)

| /  |                     |   |       |             | · /        |
|--|---------------------|---|-------|-------------|------------|
| PROGRAM  | 01234 N00010        |   | 02    | 2345 N00100 | › <b>)</b> |
| (HEAD1)  |                     | (HEAD2)   |       |             |            |
| 01234;<br>N10 G00;<br>N20 X100.0<br>N30 X200.0<br>N40 X300.0<br>N50 X400.0<br>N50 X500.0<br>N70 M02; | ;<br>Z300.0 ;<br>;  | O2345;<br>N100 G00 ;<br>N200 X0 ;<br>N300 X50.0 ;<br>N400 M02 ; |       |             |            |
|  |                     |   |       |             |            |
| >_<br>די דידי פיז  | TRT MIN FIN ALM 17: | 25.01 HEAD1   |       |             |            |
|  |                     | PRGRM] [ LIB ] [  | ][][( | OPR)][ ]    | J          |
| <b>\</b>   |                     |   |       |             |            |

Individual screen (12 soft keys display unit)

| PROGRAM   |               |                   | 01234 N00010 |
|-----------|---------------|-------------------|--------------|
| 01234 ;   |               |                   |              |
| N10 G00 ; |               |                   |              |
| N20 X100. | 0;            |                   |              |
| N30 X200. | 0;            |                   |              |
| N40 X300. | 0 Z300.0 ;    |                   |              |
| N50 X400. | 0;            |                   |              |
| N60 X500. | 0;            |                   |              |
| N70 M02 ; |               |                   |              |
| 26        |               |                   |              |
|           |               |                   |              |
|           |               |                   |              |
|           |               |                   |              |
| EDIT STRT | MIN FIN ALM 3 | 17:25:01 HEAD1    |              |
|           | [ ][ ][ ]     | [PRGRM] [ LIB ] [ | ][ ][(OPR)][ |

Individual screen

| ACTUAL POSIT                               | ION                              | O1234N00010  |
|--|----------------------------------|--|
| (ABSOLUTE)<br>X 0.000<br>Y 0.000           | (RELATIVE)<br>X 0.000<br>Y 0.000 | F 1000 mm/m  |
| Z 0.000<br>A 0.000<br>B 0.000              | Z 0.000<br>A 0.000<br>B 0.000    | PROGRAM 01234 N00010<br>01234 ;<br>N10 G00 ;                             |
| (MACHINE)<br>X 0.000<br>Y 0.000<br>Z 0.000 |                                  | N20 X100.;<br>N30 X200.;<br>N40 X300. Z300.;<br>N50 X400.;<br>N50 X500.; |
| A 0.000<br>B 0.000                         |                                  | N70 M02;<br>%  |
| G00 G25<br>G97 G22<br>G67 G80<br>G99 G67   |                                  | >_   |
| G21 G54<br>G40 G18 SCA                     |                                  |  |
|  | IN FIN ALM 17:<br>][ALL][][]     | :25:01 HEAD1<br> [PRGRM][ LIB ][ ][ ][(OPR)][ ]                          |

- Editing operation
- 7 soft keys display unit shared screen

Editing is enabled only for the program for the selected tool post. The program for the first or second tool post can be edited on the same screen by selecting either tool post with the tool post selection signal.

On 7 soft keys display unit, the shared screen consists of 80 digits x 25 lines. If the tool post name specified with parameter No. 3131 contains a character other than alphanumeric and special characters ("#\$ % & ' () \* + , - . / : ; < = > ? @ [¥] ^ \_ and space), the character ! will not be displayed correctly. In such a case, operation soft keys [SRH  $\uparrow$ ] and [SRH  $\downarrow$ ] are displayed as [SRH +] and [SRH –].

#### Limitations

This function cannot be used for background editing.

| 11.3.3<br>Displaying a Program<br>List for a Specified | In addition to the normal listing of the numbers and names of CNC programs stored in memory, programs can be listed in units of groups, according to the product to be machined, for example. |
|--|---|
| Group  | To assign CNC programs to the same group, assign names to those programs, beginning each name with the same character string.   |

By searching through the program names for a specified character string, the program numbers and names of all the programs having names including that string are listed.

#### Procedure for Displaying a Program List for a Specified Group

Procedure

1 Enter EDIT or background editing mode.

- **2** Press the |PROG| function key.
- **3** Press the PROG function key or **[DIR]** soft key to display the program list.

| PROGRA    |             |             |        | 0001 N0001 | -   |
|-----------|-------------|-------------|--------|------------|-----|
|           |             | AM (NUM.)   |        |            | )   |
| USED      |             | 60          |        | 3321       |     |
| FREE      |             | 2           |        | 429        |     |
| O0020     | (GEAR-      | 1000 MAIN)  |        |            |     |
|           | ·           | 1000 SUB-1  | )      |            |     |
| O0060     | (SHAFT-     | -2000 MAIN) | )<br>) |            |     |
|           |             | -2000 SUB-  |        |            |     |
|           |             | 1000 SUB-2  |        |            |     |
| O1000     | (FRANG      | E-3000 MAI  | N)     |            |     |
|           |             | 1000 SUB-3  |        |            |     |
| 03000     | (SHAFT-     | -2000 SUB-  | 2)     |            |     |
| >         |             |             |        |            |     |
| EDIT **** | *** *** *** | 16:52:13    |        |            |     |
| [ PRGRM   | ] [ DIR     | ] [         | ][     | ] [ (OPR]  | Г)] |
|           |             |             |        |            |     |

- 4 Press the [(OPRT)] operation soft key.
- 5 Press the **[GROUP]** operation soft key.
- 6 Press the **[NAME]** operation soft key.
- 7 Enter the character string corresponding to the group for which a search is to be made, using the MDI keys. No restrictions are imposed on the length of a program name. Note, however, that search is made based on only the first 32 characters.
  - Example: To search for those CNC programs having names that begin with character string "GEAR–1000," enter the following: >GEAR–1000\*\_

| ₿G-EDĴ | (o-srh) ( | )(        | )    | GROL | ₽ |
|--------|-----------|-----------|------|------|---|
| ()     | ( ) ((NAM | /E) (PR-0 | GRP) | (    | ) |

- ()()()(Exec)
- 8 Pressing the **[EXEC]** operation soft key displays the group–unit program list screen, listing all those programs whose name includes the specified character string.

| PROGRAM DIRECTORY (GROU<br>PROGRAM (NUM.)<br>USED: 60<br>FREE: 2  | ,                |
|---|------------------|
| O0020 (GEAR-1000 MAIN)<br>O0040 (GEAR-1000 SUB-1)<br>O0200 (GEAR-1000 SUB-2)<br>O2000 (GEAR-1000 SUB-3) |                  |
| > _<br>EDIT **** *** *** *** 16:52:25<br>[PRGRM] [ <b>DIR</b> ] [                                       | ] [ ] [ (OPRT) ] |

[Group–unit program list screen displayed when a search is made for "GEAR–1000\*"]

When the program list consists of two or more pages, the pages can be changed by using a page key.

#### **Explanations**

• \* and ?

In the above example, the asterisk (\*) must not be omitted. The asterisk indicates an arbitrary character string (wild card specification).

"GEAR-1000\*" indicates that the first nine characters of the target program names must be "GEAR-1000," followed by an arbitrary character string. If only "GEAR-1000" is entered, a search is made only for those CNC programs having the nine-character name "GEAR-1000."

A question mark (?) can be used to specify a single arbitrary character. For example, entering "???-1000" enables a search to be made for programs having names which start with four arbitrary characters, followed by "-1000".

#### [Example of using wild cards]

|                            | -   |
|----------------------------|---|
| (Entered character string) | (Group for which the search will be made) |
| (a) "*"                    | CNC programs having any name              |
| (b) "*ABC"                 | CNC programs having names which end       |
|                            | with "ABC"                                |
| (c) "ABC*"                 | CNC programs having names which start     |
|                            | with "ABC"                                |
| (d) "*ABC*"                | CNC programs having names which           |
|                            | include "ABC"                             |
| (e) "?A?C"                 | CNC programs having four-character        |
|                            | names, the second and fourth characters   |
|                            | of which are A and C, respectively        |
| (f) "??A?C"                | CNC programs having five-character        |
|                            | names, the third and fifth characters of  |
|                            | which are A and C, respectively           |
| (g) "123*456"              | CNC programs having names which start     |
|                            | with "123" and which end with "456"       |

- When the specified character string cannot be found
- Holding the group for which a search is made
- Group for which previous search was made

#### Examples

If no program is located as a result of a search for an entered character string, warning message "DATA NOT FOUND" is displayed on the program list screen.

A group–unit program list, generated by a search, is held until the power is turned off or until another search is performed.

After changing the screen from the group–unit program list to another screen, pressing the **[PR–GRP]** operation soft key (displayed in step 6) redisplays the group–unit program list screen, on which the program names for the previously searched group are listed. Using this soft key eliminates the need to enter the relevant character string again to redisplay the search results after changing the screen.

Assume that the main programs and subprograms for machining gear part number 1000 all have names which include character string "GEAR–1000." The numbers and names of those programs can be listed by searching through the names of all CNC programs for character string "GEAR–1000." This function facilitates the management of the CNC programs stored in large–capacity memory. OPERATION

#### 11. SETTING AND DISPLAYING DATA

# 11.4 SCREENS DISPLAYED BY FUNCTION KEY

Press function key USETTING to display or set tool compensation values and

### other data.

This section describes how to display or set the following data:

- 1. Tool offset value
- 2. Settings
- 3. Run time and part count
- 4. Workpiece origin offset value or workpiece coordinate system shift value
- 5. Custom macro common variables
- 6. Software operator's panel
- 7. Tool life management data

This section also describes following functions.

- Direct input of tool offset value
- Direct input of tool offset value measured B
- Counter input of offset value
- Direct input of workpiece coordinate system shift
- Y axis offset
- Sequence number comparison and stop function

The following functions depend on the specifications of the machine tool builder. See the manual issued by the machine tool builder for details.

- Direct input of tool offset value
- Direct input of tool offset value measured B
- Software operator's panel
- Tool life management data

OPERATION

### 11.4.1 **Setting and Displaying** the Tool Offset Value

Dedicated screens are provided for displaying and setting tool offset values and tool nose radius compensation values.

#### Procedure for setting and displaying the tool offset value and the tool nose radius compensation value

1 Press function key

For the two-path control, select the tool post for which tool compensation values are to be displayed with the tool post selection switch.

2 Press chapter selection soft key [OFFSET] or press several

times until the tool compensation screen is displayed. Different screens are displayed depending on whether tool geometry offset, wear offset, or neither is applied.

| OFFSET   |                 |          | 00001 N00000 | ט |
|----------|-----------------|----------|--------------|---|
| NO.      | x               | z.       | R            | т |
| 001      | 0.000           | 10.000   | 0.000        | 0 |
| 002      | 0.000           | 0.000    | 0.000        | 0 |
| 003      | 0.000           | 0.000    | 0.000        | 0 |
| 004      | 40.000          | -40.000  | 0.000        | 0 |
| 005      | 0.000           | 0.000    | 0.000        | 0 |
| 006      | 0.000           | 0.000    | 0.000        | 0 |
| 007      | 0.000           | 0.000    | 0.000        | 0 |
| 008      | 0.000           | 0.000    | 0.000        | 0 |
| ACTUAL   | POSITION (RELAT | TIVE)    |              |   |
| υ        | 101.000         | W        | 202.094      |   |
| > _      |                 |          |              |   |
| MDI **** | *** ***         | 16:05:59 |              |   |
| OFFSET   | ][ SETING ][    | WORK ][  | ][ (OPRT)    | ] |



| OFT | SET/0  | EOMETRY  |       |        |     | 00001 N00 | 000   |
|-----|--------|----------|-------|--------|-----|-----------|-------|
| •   | NO.    |          | x     | z.     |     | R         | т     |
| G   | 001    | 0        | .000  | 1.0    | 000 | 0.000     | 0     |
| G   | 002    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| G   | 003    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| G   | 004    | 1        | .486  | 0.0    | 000 | 0.000     | 0     |
| G   | 005    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| G   | 006    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| G   | 007    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| G   | 008    | 1        | .486  | -49.5  | 561 | 0.000     | 0     |
| ACT | TUAL E | POSITION | (RELA | TIVE)  |     |           |       |
|     | υ      | 101.000  |       |        | W   | 202.094   |       |
| >   |        |          |       |        |     |           |       |
| MDI | ****   | *** **   | *     | 16:05: | 59  |           |       |
| [ W | EAR    | ][ GE0   | ][ MC | WORK ] | [   | ][ (OPI   | RT) ] |

With tool geometry offset

| OFFSET/W | EAR            |         | 00001 N0000 | 00 |
|----------|----------------|---------|-------------|----|
| NO.      | х              | z.      | R           | т  |
| W 001    | 0.000          | 1.000   | 0.000       | 0  |
| W 002    | 1.486          | -49.561 | 0.000       | 0  |
| W 003    | 1.486          | -49.561 | 0.000       | 0  |
| W 004    | 1.486          | 0.000   | 0.000       | 0  |
| W 005    | 1.486          | -49.561 | 0.000       | 0  |
| W 006    | 1.486          | -49.561 | 0.000       | 0  |
| W 007    | 1.486          | -49.561 | 0.000       | 0  |
| W 008    | 1.486          | -49.561 | 0.000       | 0  |
| ACTUAL P | OSITION (RELAT | TIVE)   |             |    |
| ט נ      | 101.000        | W       | 202.094     |    |
| _        |                |         |             |    |

With tool wear offset

- 3 Move the cursor to the compensation value to be set or changed using page keys and cursor keys, or enter the compensation number for the compensation value to be set or changed and press soft key **[NO.SRH]**.
- 4 To set a compensation value, enter a value and press soft key [INPUT]. To change the compensation value, enter a value to add to the current value (a negative value to reduce the current value) and press soft key [+INPUT]. Or, enter a new value and press soft key [INPUT]. TIP is the number of the virtual tool tip (see Programming). TIP may be specified on the geometry compensation screen or on the wear compensation screen.

compensation or wear compensation can be selected for each group.

#### **Explanations**

- **Decimal point input** A decimal point can be used when entering a compensation value.
- Other method An external input/output device can be used to input or output a cutter compensation value. See Chapter III–8. Tool length compensation values can be set using the following functions described in subsequent subsections: direct input of tool offset value, direct–input function B for tool offset measured, and counter input of
- Tool offset memory
   16 groups are provided for tool compensation. The number of groups can be optionally extended to 32, 64, or 99. For the two–path control, the above number of groups can be used for each tool post. Tool geometry

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| <ul> <li>Disabling entry of<br/>compensation values</li> </ul>                | In some cases, tool wear compensation or tool geometry compensation values cannot be input because of the settings in bits 0 (WOF) and 1 (GOF) of parameter 3290. The input of tool compensation values from the MDI can be inhibited for a specified range of offset numbers. The first offset number for which the input of a value is inhibited is set in parameter No. 3294. The number of offset numbers, starting from the specified first number for which the input of a value is inhibited is get in parameter No. |  |  |  |  |  |
|---|---|--|--|--|--|--|
|   | number, for which the input of a value is inhibited is set in parameter No. 3295.<br>Consecutive input values are set as follows:   |  |  |  |  |  |
|   | 1) When values are input for offset numbers, starting from one for which<br>input is not inhibited to one for which input is inhibited, a warning is<br>issued and values are set only for those offset numbers for which input<br>is not inhibited.  |  |  |  |  |  |
|   | 2) When values are input for offset numbers, starting from one for which input is inhibited to one for which input is not inhibited, a warning is issued and no values are set.   |  |  |  |  |  |
| <ul> <li>Displaying radius and<br/>TIP</li> </ul>                             | The radius and TIP are not displayed if the tool tip radius compensation option is not displayed.   |  |  |  |  |  |
| <ul> <li>Changing offset values<br/>during automatic<br/>operation</li> </ul> | When offset values have been changed during automatic operation, bit 4 (LGT) and bit 6 (LWM) of parameter 5002 can be used for specifying whether new offset values become valid in the next move command or in the next T code command.  |  |  |  |  |  |
|   | When geometry compensa-<br>tion values and wear com-<br>tion values and wear com-   |  |  |  |  |  |

| LGT | LWM | When geometry compensa-<br>tion values and wear com-<br>pensation values are sepa-<br>rately specified | When geometry compensa-<br>tion values and wear com-<br>pensation values are not<br>separately specified |
|-----|-----|--|--|
| 0   | 0   | Become valid in the next T<br>code block   | Become valid in the next T code block  |
| 1   | 0   | Become valid in the next T code block  | Become valid in the next T code block  |
| 0   | 1   | Become valid in the next T code block  | Become valid in the next move command  |
| 1   | 1   | Become valid in the next move command  | Become valid in the next move command  |

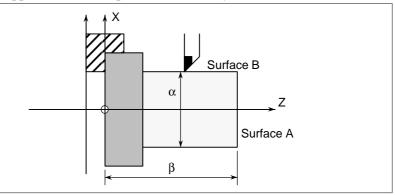
## 11.4.2 Direct Input of Tool Offset Value

To set the difference between the tool reference position used in programming (the nose of the standard tool, turret center, etc.) and the tool tip position of a tool actually used as an offset value

#### Procedure for direct input of tool offset value

• Setting of Z axis offset value

1 Cut surface A in manual mode with an actual tool. Suppose that a workpiece coordinate system has been set.



- 2 Release the tool in X-axis direction only, without moving Z-axis and stop the spindle.
- 3 Measure distance  $\beta$  from the zero point in the workpiece coordinate system to surface A.

Set this value as the measured value along the Z-axis for the desired offset number, using the following procedure:

| OFI   | SET/ | GEOMETRY        |         | 00001 N0000 | 0 |  |  |  |
|---|------|-----------------|---------|-------------|---|--|--|--|
|   | NO.  | X               | Ζ.      | R           | т |  |  |  |
| G   | 001  | 0.000           | 1.000   | 0.000       | 0 |  |  |  |
| G   | 002  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| G   | 003  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| G   | 004  | 1.486           | 0.000   | 0.000       | 0 |  |  |  |
| G   | 005  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| G   | 006  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| G   | 007  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| G   | 008  | 1.486           | -49.561 | 0.000       | 0 |  |  |  |
| ACT   | TUAL | POSITION (RELAT | IVE)    |             |   |  |  |  |
|   | υ    | 0.000           | W       | 0.000       |   |  |  |  |
|   | v    | 0.000           | н       | 0.000       |   |  |  |  |
| >MZ1  | 20.  | _               |         |             |   |  |  |  |
| MDI **** *** 16:05:59                               |      |                 |         |             |   |  |  |  |
| [NO,SRH] [ MEASUR ] [ INP.C. ] [ +INPUT ] [ INPUT ] |      |                 |         |             |   |  |  |  |

3–1 Press the function key of the soft key [OFFSET] to display

the tool compensation screen. If geometry compensation values and wear compensation values are separately specified, display the screen for either of them.

- 3–2 Move the cursor to the set offset number using cursor keys.
- **3–3** Press the address key | Z | to be set.

- Setting of X axis offset value
- **3–4** Key in the measured value ( $\beta$ ).
- **3–5** Press the soft key **[MESURE]**. The difference between measured value  $\beta$  and the coordinate is set as the offset value.
- 4 Cut surface B in manual mode.
- 5 Release the tool in the Z-axis direction without moving the X-axis and stop the spindle.
- 6 Measure the diameter  $\alpha$  of surface B. Set this value as the measured value along the X-axis for the desired offset number in the same way as when setting the value along the Z-axis.
- 7 Repeat above procedure the same time as the number of the necessary tools. The offset value is automatically calculated and set. For example, in case  $\alpha$ =69.0 when the coordinate value of surface B in the diagram above is 70.0, set 69.0 **[MEASURE]** at offset No. 2. In this case, 1.0 is set as the X-axis offset value to offset No. 2.

#### **Explanations**

 Compensation values for Enter diameter values for the compensation values for axes for which a program created in diameter programming is used. diameter programming Tool geometry offset If measured values are set on the tool geometry compensation screen, all value and tool wear compensation values become geometry compensation values and all wear offset value compensation values are set to 0. If measured values are set on the tool wear compensation screen, the differences between the measured compensation values and the current wear compensation values become the new compensation values. Retracting along two If a record button is provided on the machine, the tool can retract along axes two axes when bit 2 (PRC) of parameter 5005 is set and the record signal is used. Refer to the appropriate manual issued by the machine tool

builder.

OPERATION 11. SETTING AND DISPLAYING DATA

# **11.4.3**The direct input function B for tool offset measured is used to set tool<br/>compensation values and workpiece coordinate system shift values.**0ffset measured B**

#### Procedure for setting the tool offset value

Tool position offset values can be automatically set by manually moving the tool until it touches the sensor. Refer to the appropriate manual issued by the machine tool builder for actual operation.

| Execute manual reference position return.                           |
|---|
| By executing manual reference position return, a machine coordinate |
| system is established.  |
| The tool offset value is computed on the machine coordinate system. |
|   |

2 Set the offset writing mode signal GOQSM to HIGH. (Refer to the appropriate manual issued by the machine tool builder for actual operation.) The CRT display is automatically changed to the tool offset screen (geometry), and the "OFST" indicator starts blinking in the status indication area in the bottom of the screen, which informs that the

**3** Select a tool to be measured.

offset writing mode is ready.

4 When the cursor is not coincided with the tool offset number desired to be set, move the cursor to the desired offset number by page key and cursor key.

Besides the cursor can also be coincided with the tool offset number desired to set automatically by the tool offset number input signals (when parameter QNI(No. 5005#5)=1).

In this case, the position of the cursor cannot be changed on the tool compensation screen using page keys or cursor keys.

- 5 Near the tool to the sensor by manual operation.
- 6 Place the tool edge to a contacting surface of the sensor by manual handle feed.

Bring the tool edge in contact with the sensor. This causes the offset writing signals (+MIT1, -MIT1, +MIT2 or -MIT2) to input to CNC.

The offset writing signal is set to HIGH, and the :

- The axis is interlocked in this direction and its feeding is stopped.
- The tool offset value extracted by the tool offset memory (tool geometry offset value) which corresponds to the offset number shown by the cursor is set up.
- 7 For both X-axis and Z-axis, their offset value are set by the operations 5 and 6.
- 8 Repeat operations 3 to 7 for necessary tools.

**9** Set the offset writing signal mode GOQSM to LOW. The writing mode is canceled and the blinking "OFST" indicator light goes off.

#### Procedure for setting the work coordinate system shift amount

Tool position offset values can be automatically set by manually moving the tool until it touches the sensor.

Refer to the appropriate manual issued by the machine tool builder for actual operation.

- **1** The tool compensation values are then calculated based on the machine coordinates of the tool.
- Execute manual reference position return.
   By executing manual reference position return, the machine coordinate system is established.
   The workpiece coordinate system shifting amount is computed based on the machine coordinate system of the tool.
- 3 Set the workpiece coordinate system shifting amount writing signal mode WOQSM to HIGH.

(Refer to the appropriate manual issued by the machine tool builder for actual operation.)

The CRT display is automatically switches to the workpiece shifting screen, the "WFST" indicator starts blinking at the status indicator area in the bottom of the screen, which inform that the workpiece coordinate system shifting amount writing mode is ready.

- 4 Select a tool to be measured.
- **5** Check tool offset numbers.

The tool offset number corresponding to the tool required for measurement, shall be set in the parameter (No. 5020) in advance. Besides the tool offset number can be set automatically by setting the tool offset number input signal (with parameter QNI (No. 5005#5)=1).

Refer to the appropriate manual issued by the machine tool builder for details.

- 6 Manually approach the tool to an end face of the workpiece.
- 7 Place the tool edge to the end face (sensor) of the workpiece by manual handle feed.The workpiece coordinate system shifting amount on the Z-axis is automatically set.
- 8 Feed the tool.
- **9** Set the workpiece coordinate system shifting amount writing signal mode WOQSM to LOW.

The writing mode is canceled and the blinking "WSFT" indicator light goes off.

(Refer to the appropriate manual issued by the machine tool builder for actual operation.)

## 11.4.4 Counter Input of Offset value

By moving the tool until it reaches the desired reference position, the corresponding tool offset value can be set.

#### Procedure for counter input of offset value

- 1 Manually move the reference tool to the reference position.
- **2** Reset the relative coordinates along the axes to 0 (see subsec. III-11.1.2).
- **3** Move the tool for which offset values are to be set to the reference position.
- 4 Select the tool compensation screen. Move the cursor to the offset value to be set using cursor keys.

| OFI  | -      | GEOMETRY        |          | 00001 N0000 | 00 |  |  |  |
|--|--------|-----------------|----------|-------------|----|--|--|--|
|  | NO.    | Х               | z.       | R           | т  |  |  |  |
| G  | 001    | 0.000           | 1.000    | 0.000       | 0  |  |  |  |
| G  | 002    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| G  | 003    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| G  | 004    | 1.486           | 0.000    | 0.000       | 0  |  |  |  |
| G  | 005    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| G  | 006    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| G  | 007    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| G  | 008    | 1.486           | -49.561  | 0.000       | 0  |  |  |  |
| AC   | TUAL I | POSITION (RELAT | IVE)     |             |    |  |  |  |
|  | υ      | 0.000           | W        | 0.000       |    |  |  |  |
|  | v      | 0.000           | н        | 0.000       |    |  |  |  |
| >X   |        |                 |          |             |    |  |  |  |
| IND  | ****   | *** ***         | 16:05:59 |             |    |  |  |  |
| HND **** *** 16:05:59<br>[NO,SRH] [ MEASUR ] [ INP.C. ] [ +INPUT ] [ INPUT ] |        |                 |          |             |    |  |  |  |

5 Press address key  $\begin{bmatrix} X \end{bmatrix}$  (or  $\begin{bmatrix} Z \end{bmatrix}$ ) and the soft key **[INP.C.]**.

#### **Explanations**

• Geometry offset and wear offset

When the above operations are performed on the tool geometry compensation screen, tool geometry compensation values are input and tool wear compensation values do not change.

When the above operations are performed on the tool wear compensation screen, tool wear compensation values are input and tool geometry compensation values do not change.

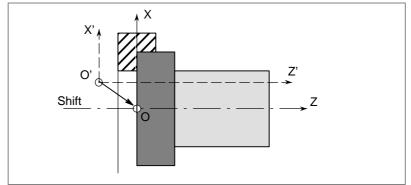
#### **11.4.5** Setting the Workpiece Coordinate System Shifting Amount The set coordinate system can be shifted when the coordinate system which has been set by a G50 command (or G92 command for G code system B or C) or automatic coordinate system setting is different from the workpiece coordinate system assumed at programming.

#### Procedure for setting the workpiece coordinate system shifting amount

- 1 Press function key OFFSET SETTING
- 2 Press the continuous menu key ▷ several times until the screen with soft key [WK.SHFT] is displayed.

| WORK SHIFT        |      |            | 00001 | N0 | 0000  |
|-------------------|------|------------|-------|----|-------|
| (SHIFT VALUE)     | (ME  | ASUREMENT) |       |    |       |
| x 0.000           | х    | 0.000      |       |    |       |
| z 0.000           | Z    | 0.000      |       |    |       |
|                   |      |            |       |    |       |
|                   |      |            |       |    |       |
|                   |      |            |       |    |       |
|                   |      |            |       |    |       |
| ACTUAL POSITION ( | RELA | TIVE)      |       |    |       |
| U 0.000           |      | W          | 0.00  | 00 |       |
|                   |      |            |       |    |       |
| > MZ100           |      |            | S     | 0  | т0000 |
| MDI **** *** ***  |      | 16:05:59   |       |    |       |
| [ ][ WK.SHFT      | ][   | ][ +INPU   | JT ][ | IN | PUT ] |

- 3 Press soft key [WK.SHFT].
- 4 Move the cursor using cursor keys to the axis along which the coordinate system is to be shifted.
- 5 Enter the shift value and press soft key [INPUT].



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#### **Explanations**

- When shift values become valid
- Shift values and coordinate system setting command
- Shift values and coordinate system setting
- Diameter or radius value

#### **Examples**

Shift values become valid immediately after they are set.

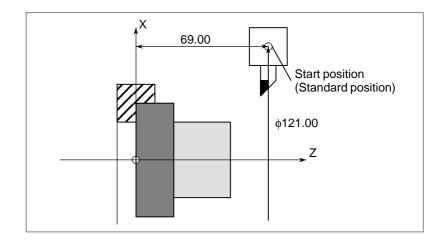
Setting a command (G50 or G92) for setting a coordinate system disables the set shift values.

**Example** When G50 X100.0 Z80.0; is specified, the coordinate system is set so that the current tool reference position is X = 100.0, Z = 80.0 regardless of the shift values.

If the automatic coordinate system setting is performed by manual reference position return after shift amount setting, the coordinate system is shifted instantly.

Whether the shift amount on the X-axis is diameter or radius value depends on that specified in program.

When the actual position of the reference point is X = 121.0 (diameter), Z = 69.0 with respect to the workpiece origin but it should be X = 120.0, Z = 70.0, set the following shift values: X = 1.0, Z = -1.0



#### Procedure for setting the tool offset value of the Y axis

- 1 Press function key
- 2 Press the continuous menu key  $\triangleright$  several times until the screen with soft key **[OFST.2]** is displayed.
- 3 Press soft key [OFST.2]. The Y axis offset screen is displayed.

|                |          |        |      |         | 0.01 |        | )  |
|----------------|----------|--------|------|---------|------|--------|----|
| OFFSET         |          |        |      | 00      | 001  | N00000 |    |
| NO.            | Y        |        |      |         |      |        |    |
| 01             | 10.000   |        |      |         |      |        |    |
| 02             | 0.000    |        |      |         |      |        |    |
| 03             | 0.000    |        |      |         |      |        |    |
| 04             | 40.000   |        |      |         |      |        |    |
| 05             | 0.000    |        |      |         |      |        |    |
| 06             | 0.000    |        |      |         |      |        |    |
| 07             | 0.000    |        |      |         |      |        |    |
| 08             | 0.000    |        |      |         |      |        |    |
| ACTUAL         | POSITION | (RELAT | IVE) |         |      |        |    |
| υ              | 100.000  |        | W    | 100.000 |      |        |    |
|                |          |        |      |         |      |        |    |
| >_             |          |        |      |         |      |        |    |
| <u>MDI ***</u> | * *** ** | *      | 16:  | 05:59   |      |        |    |
| [ OFST.2       | ][ W.SH  | FT ][  |      | ][      | ][   | (OPRT) | ], |
| 、              | _        |        |      |         |      |        |    |

**3–1** Press soft key **[GEOM]** to display the tool geometry compensation values along the Y–axis.

| (   |                 |      |           |        |      |         |      |          |   |
|-----|-----------------|------|-----------|--------|------|---------|------|----------|---|
|     | OFFSET/GEOMETRY |      |           |        |      | (       | 0001 | N00000   |   |
|     |                 | NO.  | Y         | -      |      |         |      |          |   |
|     | G               | 01   | 10.000    |        |      |         |      |          |   |
|     | G               | 02   | 0.000     |        |      |         |      |          |   |
|     | G               | 03   | 0.000     |        |      |         |      |          |   |
|     | G               | 04   | 40.000    |        |      |         |      |          |   |
|     | G               | 05   | 0.000     |        |      |         |      |          |   |
|     | G               | 06   | 0.000     |        |      |         |      |          |   |
|     | G               | 07   | 0.000     |        |      |         |      |          |   |
|     | G               | 80   | 0.000     |        |      |         |      |          |   |
|     | ACT             | TUAL | POSITION  | (RELAT | IVE) |         |      |          |   |
|     |                 | υ    | 100.000   |        | W    | 100.000 | D    |          |   |
|     |                 |      |           |        |      |         |      |          |   |
| >   | _<br>мрт        |      | ** *** ** | +      | 16.  | 05:59   |      |          |   |
|     | MD I            |      |           |        | T0:  | 05:59   |      |          |   |
| ( [ | W               | EAR  | ] [ GEO   | M ][   |      | ][      | ] [  | [ (OPRT) | Ŋ |

**3–2** Press soft key **[WEAR]** to display the tool wear compensation values along the Y–axis.

| (            |             |       |             |        |      |               |       |       |          |    |
|--------------|-------------|-------|-------------|--------|------|---------------|-------|-------|----------|----|
| c            | OFFSET/WEAR |       |             |        |      |               |       | 00001 | N00000   |    |
|              |             | NO.   | _           | Y      |      |               |       |       |          |    |
|              | W           | 01    | 1           | 0.000  |      |               |       |       |          |    |
|              | W           | 02    |             | 0.000  |      |               |       |       |          |    |
|              | W           | 03    |             | 0.000  |      |               |       |       |          |    |
|              | W           | 04    | 4           | 0.000  |      |               |       |       |          |    |
|              | W           | 05    |             | 0.000  |      |               |       |       |          |    |
|              | W           | 06    |             | 0.000  |      |               |       |       |          |    |
|              | W           | 07    |             | 0.000  |      |               |       |       |          |    |
|              | W           | 08    |             | 0.000  |      |               |       |       |          |    |
| Z            | CI          | UAL   | POSI        | TION ( | RELA | <b>FIVE</b> ) |       |       |          |    |
|              |             | υ     | 100         | .000   |      | W             | 100.0 | 00    |          |    |
| >            |             |       |             |        |      |               |       |       |          |    |
| <br>м        | т           | ***   | * * *       | * ***  |      | 16.           | 05:59 |       |          |    |
| г            |             | EAR   | <b>1</b> 11 | GEOM   | 11   | ±0.           | 1[    | 1     | (OPRT)   | 1  |
| \ ' <b>-</b> | WV.         | -7-4N |             | GROW   | 11   |               | J L   | 1     | L (OPRI) | ') |

- 4 Position the cursor at the offset number to be changed by using either of the following methods:
  - Move the cursor to the offset number to be changed using page keys and cursor keys.
  - Type the offset number and press soft key [NO.SRH].
- **5** Type the offset value.
- 6 Press soft key [WEAR]. The offset value is set and displayed.

| (   |     |      |            |           |    |     |        |    |       |   |
|-----|-----|------|------------|-----------|----|-----|--------|----|-------|---|
|     | OF  | SET, | /WEAR      |           |    |     | 00001  | N0 | 0000  |   |
|     |     | NO.  | Y          |           |    |     |        |    |       |   |
|     | W   | 01   | 10.000     |           |    |     |        |    |       |   |
|     | W   | 02   | 0.000      |           |    |     |        |    |       |   |
|     | W   | 03   | 0.000      |           |    |     |        |    |       |   |
|     | W   | 04   | 40.000     |           |    |     |        |    |       |   |
|     | W   | 05   | 0.000      |           |    |     |        |    |       |   |
|     | W   | 06   | 0.000      |           |    |     |        |    |       |   |
|     | W   | 07   | 0.000      |           |    |     |        |    |       |   |
|     | W   | 08   | 0.000      |           |    |     |        |    |       |   |
|     | ACT | TUAL | POSITION   | (RELATIVE | 3) |     |        |    |       |   |
|     |     | υ    | 100.000    | ν         | 7  | 100 | .000   |    |       |   |
| >_  |     |      |            |           |    |     |        |    |       |   |
|     |     |      |            |           |    |     |        |    |       |   |
| [ N | 0.8 | SRH  | ] [ MEASUR | ][ INP.   | c. | ][  | +INPUT | ][ | INPUT | ] |
|     |     |      |            |           |    |     |        |    |       |   |

### Procedure for counter input of the offset value

To set relative coordinates along the Y-axis as offset values:

- **1** Move the reference tool to the reference point.
- **2** Reset relative coordinate Y to 0 (see subsec. III–11.1.2).
- **3** Move the tool for which offset values are to be set to the reference point.
- 4 Move the cursor to the value for the offset number to be set, press  $\boxed{Y}$ , then press soft key [INP.C.].

Relative coordinate Y (or V) is now set as the offset value.

| 11.4.7<br>Displaying and<br>Entering Setting Data | <ul> <li>Data such as the TV check flag and punch code is set on the setting data screen. On this screen, the operator can also enable/disable parameter writing, enable/disable the automatic insertion of sequence numbers in program editing, and perform settings for the sequence number comparison and stop function.</li> <li>See Chapter III–10 for automatic insertion of sequence numbers.</li> <li>See subsection III–11.4.8 for the sequence number comparison and stop</li> </ul> |
|---|--|

### Procedure for setting the setting data

- 1 Select the MDI mode.
- 2 Press function key OFFSET SETTING
- **3** Press soft key **[SETING]** to display the setting data screen. This screen consists of several pages.

function. This subsection describes how to set data.

Press page key  $\begin{bmatrix} \bullet \\ \bullet \end{bmatrix}$  or  $\begin{bmatrix} \bullet \\ \bullet \end{bmatrix}$  until the desired screen is displayed.

An example of the setting data screen is shown below.

```
SETTING (HANDY)
                                        00001 N00000
    PARAMETER WRITE = 1 (0:DISABLE 1:ENABLE)
    TV CHECK = 0 (0:OFF 1:ON)
                     1 (0:EIA 1:ISO)
    PUNCH CODE =
    INPUT UNIT =
                      0 (0:MM 1:INCH)
    I/O CHANNEL = 0 (0-3:CHANNEL NO.)
    SEQUENCE NO. = 0 (0:OFF 1:ON)
    TAPE FORMAT = 0 (0:NO CNV 1:F
SEQUENCE STOP = 0 (PROGRAM NO.)
SEQUENCE STOP = 0 (SEQUENCE NO.)
                       0 (0:NO CNV 1:F15)
>
MDI **** ***<u>*</u>***
                          16:05:59
[ OFFSET ] [ SETING ] [ WORK ] [
                                        ][ (OPRT) ]
  SETTING (HANDY)
                                        00001 N00000
    MIRROR IMAGE X = 0 (0:OFF
                                 1:0N)
    MIRROR IMAGE Z = 0 (0:OFF
                                 1:0N)
>
MDI **** ***<u>*</u>***
                          16:05:59
[ OFFSET ] [ SETING ] [ WORK ] [
                                        ][ (OPRT) ]
```

11. SETTING AND DISPLAYING DATA

|                                   | <ul> <li>4 Move the cursor to the item to be changed by pressing cursor keys</li> <li> ↑ </li> <li> ↑ </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •  </li> <li> •   </li> </ul> |
|-----------------------------------|--|
|                                   | 5 Enter a new value and press soft key <b>[INPUT]</b> .  |
| Contents of settings              |  |
| • PARAMETER WRITE                 | Setting whether parameter writing is enabled or disabled.<br>0: Disabled<br>1: Enabled   |
| • TV CHECK                        | Setting to perform TV check.<br>0 : No TV check<br>1 : Perform TV check  |
| PUNCH CODE                        | Setting code when data is output through reader puncher interface.<br>0 : EIA code output<br>1 : ISO code output   |
| • INPUT UNIT                      | Setting a program input unit, inch or metric system<br>0 : Metric<br>1 : Inch  |
| • I/O CHANNEL                     | Using channel of reader/puncher interface.<br>0 : Channel 0<br>1 : Channel 1<br>2 : Channel 2<br>3 : Channel 3   |
| <ul> <li>SEQUENCE STOP</li> </ul> | <ul> <li>Setting of whether to perform automatic insertion of the sequence number or not at program edit in the EDIT mode.</li> <li>0 : Does not perform automatic sequence number insertion.</li> <li>1 : Perform automatic sequence number insertion.</li> </ul>   |
| • TAPE FORMAT                     | <ul><li>Setting the F15 tape format conversion.</li><li>0: Tape format is not converted.</li><li>1: Tape format is converted.</li><li>See PROGRAMMING for the F15 tape format.</li></ul>   |
| SEQUENCE STOP                     | Setting the sequence number with which the operation stops for the<br>sequence number comparison and stop function and the number of the<br>program to which the sequence number belongs   |
| • MIRROR IMAGE                    | Setting of mirror image ON/OFF for each axes.<br>0: Mirror image off<br>1: Mirror image on   |
| Others                            | Page key $\mathbf{r}_{PAGE}$ or $\mathbf{r}_{PAGE}$ can also be pressed to display the SETTING (TIMER) screen. See subsection III–11.4.9 for this screen.  |

# 11.4.8 Sequence Number Comparison and Stop

If a block containing a specified sequence number appears in the program being executed, operation enters single block mode after the block is executed.

### Procedure for sequence number comparison and stop

- 1 Select the **MDI** mode.
- 2 Press function key OFFSET SETTING
- **3** Press chapter selection soft key **[SETING]**.
- 4 Press page key or several times until the following screen is displayed.

```
SETTING (HANDY)
                                  00001 N00000
  PARAMETER WRITE = 1 (0:DISABLE 1:ENABLE)
  TV CHECK = 0 (0:OFF 1:ON)
  PUNCH CODE
                 = 1 (0:EIA 1:ISO)
                            1:INCH)
  INPUT UNIT
                 = 0 (0:MM)
  I/O CHANNEL
                 = 0 (0-3:CHANNEL NO.)
  SEQUENCE NO.
                 = 0 (0:OFF 1:ON)
                 = 0 (0:NO CNV 1:F10/11)
  TAPE FORMAT
                 = 0 (PROGRAM NO.)
  SEQUENCE STOP
                 = 11 (SEQUENCE NO.)
  SEQUENCE STOP
MDI **** *** ***
                      16:05:59
[ OFFSET ] [ SETING ] [ WORK ] [
                                   ][ (OPRT) ]
```

- **5** Enter in (PROGRAM NO.) for SEQUENCE STOP the number (1 to 9999) of the program containing the sequence number with which operation stops.
- 6 Enter in (SEQUENCE NO.) for SEQUENCE STOP (with five or less digits) the sequence number with which operation is stopped.
- 7 When automatic operation is executed, operation enters single block mode at the block containing the sequence number which has been set.

### 11. SETTING AND DISPLAYING DATA

OPERATION

# Explanations

| <ul> <li>Sequence number after<br/>the program is executed</li> </ul>                               | After the specified sequence number is found during the execution of the program, the sequence number set for sequence number compensation and stop is decremented by one. When the power is turned on, the setting of the sequence number is 0.  |
|---|---|
| • Exceptional blocks  | If the predetermined sequence number is found in a block in which all<br>commands are those to be processed within the CNC control unit, the<br>execution does not stop at that block.<br><b>Example</b><br>N1 #1=1 ;<br>N2 IF [#1 EQ 1] GOTO 08 ;<br>N3 GOTO 09 ;<br>N4 M98 P1000 ;<br>N5 M99 ;<br>In the example shown above, if the predetermined sequence number is<br>found, the execution of the program does not stop. |
| <ul> <li>Stop in the canned cycle</li> </ul>  | If the predetermined sequence number is found in a block which has a canned–cycle command, the execution of the program stops after the return operation is completed.  |
| <ul> <li>When the same<br/>sequence number is<br/>found several times in<br/>the program</li> </ul> | If the predetermined sequence number appears twice or more in a<br>program, the execution of the program stops after the block in which the<br>predetermined sequence number is found for the first time is executed.   |
| <ul> <li>Block to be repeated a<br/>specified number of<br/>times</li> </ul>                        | If the predetermined sequence number is found in a block which is to be<br>executed repeatedly, the execution of the program stops after the block is<br>executed specified times.  |

This screen can also display the clock time. The time can be set on the screen.

### Procedure for Displaying and Setting Run Time, Parts Count and Time

- 1 Select the MDI mode.
- 2 Press function key OFFSET
- **3** Press chapter selection soft key **[SETING]**.
- 4 Press page key or several times until the following screen is displayed.

| SETTING (TIMER)     |     |         |     | 0000 | 1 | N00000 |        |
|---------------------|-----|---------|-----|------|---|--------|--------|
| PARTS TOTAL         | =   | 1       | 4   |      |   |        |        |
| PARTS REQUIRED      | =   |         | 0   |      |   |        |        |
| PARTS COUNT         | =   | 2       | 3   |      |   |        |        |
| POWER ON            | =   | 4H      | 31M |      |   |        |        |
| OPERATING TIME      | =   | 0н      | 0M  | 05   |   |        |        |
| CUTTING TIME        | =   | 0H      | 37M | 55   |   |        |        |
| FREE PURPOSE        | =   | 0н      | 0M  | 05   |   |        |        |
| CYCLE TIME          | =   | 0н      | 0М  | 05   |   |        |        |
| DATE                | =   | 1993/07 | /05 |      |   |        |        |
| TIME                | =   | 11:32   | :52 |      |   |        |        |
| >                   |     |         |     | S    | 0 | T0000  | )      |
| MDI **** *** ***    |     | 16:05   | :59 |      |   |        |        |
| [ OFFSET ] [ SETING | ] [ | WORK ]  | [   | ] [  |   | (OPRT) | )<br>J |

- **5** To set the number of parts required, move the cursor to PARTS REQUIRED and enter the number of parts to be machined.
- **6** To set the clock, move the cursor to DATE or TIME, enter a new date or time, then press soft key **[INPUT]**.

### **Display items**

- PARTS TOTAL
- PARTS REQUIRED

This value is incremented by one when M02, M30, or an M code specified by parameter 6710 is executed. This value cannot be set on this screen. Set the value in parameter 6712.

It is used for setting the number of machined parts required. When the "0" is set to it, there is no limitation to the number of parts. Also, its setting can be made by the parameter (No. 6713). 11. SETTING AND DISPLAYING DATA

| • PARTS COUNT    | This value is incremented by one when M02, M30, or an M code specified by parameter 6710 is executed. The value can also be set by parameter 6711. In general, this value is reset when it reaches the number of parts required. Refer to the manual issued by the machine tool builder for details.   |
|------------------|--|
| • POWER ON       | Displays the total time which the power is on. This value cannot be set<br>on this screen but can be preset in parameter 6750.   |
| • OPERATING TIME | Indicates the total run time during automatic operation, excluding the stop<br>and feed hold time.<br>This value can be preset in parameter 6751 or 6752.  |
| • CUTTING TIME   | Displays the total time taken by cutting that involves cutting feed such as linear interpolation (G01) and circular interpolation (G02 or G03). This value can be preset in parameter 6753 or 6754.  |
| • FREE PURPOSE   | This value can be used, for example, as the total time during which coolant flows. Refer to the manual issued by the machine tool builder for details.   |
| • CYCLE TIME     | Indicates the run time of one automatic operation, excluding the stop and feed hold time. This is automatically preset to 0 when a cycle start is performed at reset state. It is preset to 0 even when power is removed.  |
| • DATA and TIME  | Displays the current date and time. The date and time can be set on this screen.   |
| Explanations     |  |
| • Usage          | When the command of M02 or M30 is executed, the total number of machined parts and the number of machined parts are incremented by one. Therefore, create the program so that M02 or M30 is executed every time the processing of one part is completed. Furthermore, if an M code set to the parameter (No. 6710) is executed, counting is made in the similar manner. Also, it is possible to disable counting even if M02 or M30 is executed (parameter PCM (No. 6700#0) is set to 1). For details, see the manual issued by machine tool builders. |

# Restrictions

• Run time and part count settings Negative value cannot be set. Also, the setting of "M" and "S" of run time is valid from 0 to 59. Negative value may not be set to the total number of machined parts.

Regarive value may not be set to the total number of h

• Time settings

Neither negative value nor the value exceeding the value in the following table can be set.

| ltem  | Maximum value | Item   | Maximum value |
|-------|---------------|--------|---------------|
| Year  | 2085          | Hour   | 23            |
| Month | 12            | Minute | 59            |
| Day   | 31            | Second | 59            |

# 11.4.10 Displaying and Setting the Workpiece Origin Offset Value

Displays the workpiece origin offset for each workpiece coordinate system (G54 to G59) and external workpiece origin offset. The workpiece origin offset and external workpiece origin offset can be set on this screen.

### Procedure for Displaying and Setting the Workpiece Origin Offset Value

- 1 Press function key OFFSET SETTING
- 2 Press chapter selection soft key **[WORK]**. The workpiece coordinate system setting screen is displayed.

| WORK COORDINATES    | 00001 N00000        |
|---------------------|---------------------|
| NO. DATA            | NO. DATA            |
| 00 X 0.000          | 02 X 152.580        |
| (EXT) Z 0.000       | (G55) Z 234.000     |
| 01 X 20.000         | 03 X 300.000        |
| (G54) Z 50.000      | (G56) Z 200.000     |
| > _                 | S 0 T0000           |
| MDI **** *** ***    | 16:05:59            |
| [ OFFSET ] [ SETING | ][WORK][ ][ (OPRT)] |

**3** The screen for displaying the workpiece origin offset values consists of two or more pages. Display a desired page in either of the following two ways:

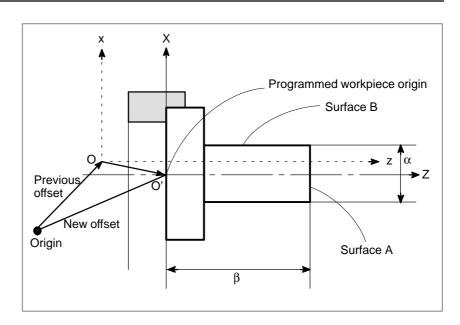
|                   |   |              | PAGE | 1    |
|-------------------|---|--------------|------|------|
| Press the page up | T | or page down |      | key. |

Enter the workpiece coordinate system number (0: external workpiece origin offset, 1 to 6: workpiece coordinate systems G54 to G59) and press operation selection soft key **[NO.SRH]**.

- **4** Turn off the data protection key to enable writing.
- 5 Move the cursor to the workpiece origin offset to be changed.
- 6 Enter a desired value by pressing numeric keys, then press soft key **[INPUT]**. The entered value is specified in the the workpiece origin offset value. Or, by entering a desired value with numeric keys and pressing soft key **[+INPUT]**, the entered value can be added to the previous offset value.
- 7 Repeat 5 and 6 to change other offset values.
- 8 Turn on the data protection key to disable writing.

| 11.4.11<br>Direct Input of<br>Measured Workpiece<br>Origin Offsets | This function is used to compensate for the difference between the programmed workpiece coordinate system and the actual workpiece coordinate system. The measured offset for the origin of the workpiece coordinate system can be input on the screen such that the command values match the actual dimensions. Selecting the new coordinate system matches the programmed coordinate |
|--|--|
|  | system with the actual coordinate system.  |

### Procedure for Inputting of Measured Workpiece Origin Offsets



- **1** When the workpiece is shaped as shown above, cut surface A manually.
- 2 Move the tool along the X axis without changing the Z coordinate then stop the spindle.
- 3 Measure distance  $\beta$  between surface A and the programmed origin of the workpiece coordinate system as shown above.
- 4 Press function key OFFSET

**5** To display the workpiece origin offset setting screen, press the chapter selection soft key **[WORK]**.

| WORK COORDINATES         01234 N56'           (G54)         NO. DATA         NO. DATA           00 X 0.000         02 X 0.000           (EXT) Z 0.000         (G55) Z 0.000 | )     |
|---|-------|
| 00       X       0.000       02       X       0.000         (EXT)       Z       0.000       (G55)       Z       0.000   | 789   |
| (EXT) Z 0.000 (G55)Z 0.000  |       |
|   |       |
|   |       |
| 01 X 0.000 03 X 0.000   |       |
| (G54) Z 0.000 (G56) Z 0.000   |       |
|   |       |
|   | 0000  |
| MDI **** *** *** 16:05:59   |       |
| [ NO.SRH ] [ MEASUR ] [ ] [ +INPUT ] [ INF  | PUT ] |

- 6 Position the cursor to the workpiece origin offset value to be set.
- 7 Press the address key for the axis along which the offset is to be set (Z-axis in this example).
- **8** Enter the measured value ( $\alpha$ ) then press the **[MEASUR]** soft key.
- **9** Cut surface B manually.
- **10** Move the tool along the Z axis without changing the X coordinate then stop the spindle.
- 11 Measure the diameter of surface A ( $\alpha$ ) then enter the diameter at X.

### Restrictions

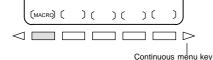
| <ul> <li>Consecutive input</li> </ul>             | Offsets for two or more axes cannot be input at the same time.  |
|---|---|
| <ul> <li>During program<br/>execution</li> </ul>  | This function cannot be used while a program is being executed.   |
| <ul> <li>Effect from other shift value</li> </ul> | Any shift specified for the workpiece coordinate system or external offset<br>remains effective when this function is used. |

# 11.4.12 Displaying and Setting Custom Macro Common Variables

Displays common variables (#100 to #149 or #100 to #199, and #500 to #531 or #500 to #999) on the CRT. When the absolute value for a common variable exceeds 99999999, \*\*\*\*\*\*\* is displayed. The values for variables can be set on this screen. Relative coordinates can also be set to variables.

### Procedure for displaying and setting custom macro common variables

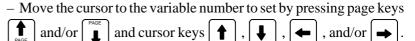
1 Press function key OFFSET



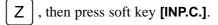
2 Press the continuous menu key >, then press chapter selection soft key [MACRO]. The following screen is displayed:

|        |             |           |          | )        |
|--------|-------------|-----------|----------|----------|
| VARIAB | LE          |           | 0000     | 1 N00000 |
| NO.    | DATA        | NO.       | DATA     |          |
| 100    | 1000.000    | 108       | 0.00     | 00       |
| 101    | 0.000       | 109       | 40000.00 | 00       |
| 102    | -50000.000  | 110       | 153020.0 | 00       |
| 103    | 0.000       | 111       | 0001.00  | 0        |
| 104    | 1238501.0   | 112       | 0.00     | 0        |
| 105    | 0.000       | 113       | 20000.00 | 0        |
| 106    | 0.000       | 114       | 0.00     | 0        |
| 107    | 0.000       | 115       | 0.00     | 0        |
| ACTUAI | DOSITION (1 | RELATIVE) |          |          |
| U      | 0.000       | W         | 0.000    |          |
| > _    |             |           | S 0      | T0000    |
| MDI ** | ** *** ***  | 16:       | 05:59    |          |
| NO.S   | RH ] [ ]    | [ INP.C.  | ][]]     | INPUT ]  |

- **3** Move the cursor to the variable number to set using either of the following methods:
  - Enter the variable number and press soft key [NO.SRH].



- 4 Enter data with numeric keys and press soft key [INPUT].
- 5 To set a relative coordinate in a variable, press address key | X | or



**6** To set a blank in a variable, just press soft key **[INPUT]**. The value field for the variable becomes blank.

— 748 —

# 11.4.13 Displaying and Setting the Software Operator's Panel

With this function, functions of the switches on the machine operator's panel can be controlled from the MDI panel. Jog feed can be performed using numeric keys.

### Procedure for displaying and setting the software operator's panel

1 Press function key OFFSET SETTING

key [OPR].



Continuous menu key

**3** The screen consists of several pages.

Press page key  $\begin{bmatrix} \bullet \\ \bullet \end{bmatrix}$  or  $\begin{bmatrix} \mathsf{PAGE} \\ \bullet \end{bmatrix}$  until the desired screen is displayed.

2 Press the continuous menu key  $[\square]$ , then press chapter selection soft

|  |                  |         | <u>۱</u> |
|--|------------------|---------|----------|
| OPERATOR'S PANEL                           | 00000            | N00000  |          |
| MODE : MDI MEM EDIT<br>HANDLE AXIS : HX HZ | нс ну            | F       |          |
| STEP MULTI.: 1 *10                         | _                |         |          |
| RAPID OVRD.: 100% 50%                      | 5 25% <b>F</b> 0 |         |          |
| JOG OVRD : 2.0%                            |                  |         |          |
|  | *****            |         |          |
| FEED OVRD. : 100%                          | ***              |         |          |
|  |                  |         |          |
| ACTUAL POSITION (ABSOLUT<br>X 0.000 Z      |                  |         |          |
| x 0.000 Z                                  | 0.000            |         |          |
| >_   |                  |         |          |
| REF **** *** *** 16:0                      |                  |         |          |
| [ MACRO ] [ MEMu ] [ OF                    | PR ][            | ][      | ]        |
|  |                  |         |          |
|  |                  |         |          |
| OPERATOR'S PANEL                           | 00000            | N00000  |          |
| BLOCK SKIP                                 | OFF 🔳 ON         |         |          |
| SINGLE BLOCK :                             | OFF ON           |         |          |
| MACHINE LOCK :                             | off 🔳 on         |         |          |
| PROTECT KEY :                              | PROTECT          | RELEASE |          |
| FEED HOLD :                                | ■ OFF            |         |          |
| ACTUAL POSITION (ABSOLUT                   | E.)              |         |          |
|  | 0.000            |         |          |
|  |                  |         |          |
|  |                  |         |          |
|  |                  |         |          |
|  |                  |         |          |
| MDI **** *** *** 16:                       |                  |         |          |
| [ MACRO ] [ MENU ] [                       | PR 1             | 11      | 11       |

- 4 Move the cursor to the desired switch by pressing cursor key  $\uparrow$  or
  - **↓**.

- 5 Push the cursor move key ← or → to match the mark to an arbitrary position and set the desired condition.
- 6 Press one of the following arrow keys to perform jog feed. Press the 5<sup>th</sup> key together with an arrow key to perform manual continuous rapid traverse.



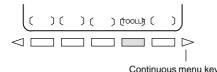
# Explanations

| <ul> <li>Valid operations</li> </ul>                       | The valid operations on the software operator's panel are shown below.<br>Whether to use the CRT or machine operator's panel for each group of<br>operations can be selected by parameter 7200.   |  |  |  |  |
|--|---|--|--|--|--|
|  | <ul> <li>Group1 : Mode selection</li> <li>Group2 : Selection of jog feed axis, manual continuous rapid traverse</li> <li>Group3 : Selection of manual pulse generator feed axis, selection of manual pulse magnification x1, x10, x100</li> <li>Group4 : Jog federate, federate override, rapid traverse override</li> <li>Group5 : Optional block skip, single block, machine lock, dry run</li> <li>Group6 : Protect key</li> <li>Group7 : Feed hold</li> </ul> |  |  |  |  |
| <ul> <li>Display</li> </ul>                                | The groups for which the machine operator's panel is selected by parameter 7200 are not displayed on the software operator's panel.   |  |  |  |  |
| <ul> <li>Screens on which jog<br/>feed is valid</li> </ul> | When the CRT indicates other than the software operator's panel screen<br>and diagnostic screen, jog feed is not conducted even if the arrow key is<br>pushed.  |  |  |  |  |
| <ul> <li>Jog feed and arrow keys</li> </ul>                | The feed axis and direction corresponding to the arrow keys can be set with parameters (Nos. 7210 to 7217).   |  |  |  |  |
| <ul> <li>General purpose<br/>switches</li> </ul>           | Eight optionally definable switches are added as an extended function of<br>the software operator's panel. The name of these switches can be set by<br>parameters as character strings of max. 8 characters. For the meanings of<br>these switches, refer to the manual issued by machine tool builder.   |  |  |  |  |

# 11.4.14 Displaying and Setting Tool Life Management Data

Tool life data can be displayed to inform the operator of the current state of tool life management. Groups which require tool changes are also displayed. The tool life counter for each group can be preset to an arbitrary value. Tool data (execution data) can be reset or cleared. To register or modify tool life management data, a program must be created and executed. See Explanations in this section for details.

### Procedure for display and setting the tool life management data



- 1 Press function key OFFSET SETTING
- 2 Press the continuous menu key 🗁 to display chapter selection soft key **[TOOLLF]**.
- **3** Press soft key **[TOOLLF]**.
- 4 One page displays data on two groups. Pressing page key **1** or

 $\begin{bmatrix} 1 \\ PAGE \end{bmatrix}$  successively displays data on the following groups. Up to four

group Nos., for which the Tool Change signal is being issued, are displayed at the bottom of each page. An arrow shown in the figure is displayed for five or more groups, if exists.

| / |                               | )                  |
|---|-------------------------------|--------------------|
|   | TOOL LIFE DATA :              | O3000 N00060       |
|   | SELECTED GRC                  | OUP 000            |
|   | GROUP 001 : LIFE 0150 CO      | UNT 0000           |
|   | 0034 0078 0012 0056           |                    |
|   | 0090 0035 0026 0061           |                    |
|   | 0000 0000 0000 0000           |                    |
|   | 0000 0000 0000 0000           |                    |
|   |                               |                    |
|   | GROUP 002 : LIFE 1400 CO      | UNT 0000           |
|   | 0062 0024 0044 0074           |                    |
|   | 0000 0000 0000 0000           |                    |
|   | 0000 0000 0000 0000           |                    |
|   | 0000 0000 0000 0000           |                    |
|   | TO BE CHANGED : 003 004 005   | 006>               |
|   | >_                            |                    |
|   | MEM **** *** 16:05:59         |                    |
|   | [MACRO][ ][ OPR ][ <u>TOO</u> | LLF ] [ (OPRT) ] / |

**5** To display the page containing the data for a group, enter the group number and press soft key **[NO.SRH]**.

The cursor can be moved to an arbitrary group by pressing cursor key  $\uparrow$  or  $\downarrow$ .

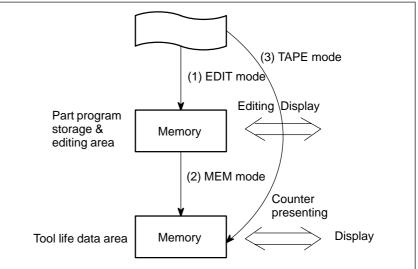
6 To change the value in the life counter for a group, move the cursor to the group, enter a new value (four digits), and press **[INPUT]**. The life counter for the group indicated by the cursor is preset to the entered value. Other data for the group is not changed.

7 To reset the tool data, move the cursor on the group to reset, then press the [(OPRT)], [CLEAR], and [EXEC] soft keys in this order.All execution data for the group indicated by the cursor is cleared together with the marks (@, #, or \*).

### **Explanations**

• Registering tool life management data

The tool life management data must be executed to register it in the CNC memory.



- (1) Load the program for tool life management in the EDIT mode, as with an ordinary CNC tape. The program will be registered in the part program memory and will be made ready for display and editing.
- (2) Perform a cycle start operation in the MEM mode to run the program. The data will be stored in the tool life data area of the memory; at the same time, the already existing tool life data of all groups will be cancelled and the life counters will be cleared. Data once stored is not erased by turning the power off.
- (3) Executing a cycle start operation in the TAPE mode instead of the operation of (1), stores the program contents directly onto the tool life data area. In this case, however, display and editing cannot be done as in (1). TAPE mode is not always prepared according to the machine tool builders.

### • Display contents

| TOOL LT      | FE DATA       |       |           | 03000 1 |      |
|--------------|---------------|-------|-----------|---------|------|
|              |               | SELI  | ECTED GRO | UP 000  |      |
| GROUP        | 001           | : 1   | LIFE 0150 | COUNT   | 0007 |
|              | *0034         | #0078 | @0012     | 0056    |      |
|              | 0090          | 0035  | 0026      | 0061    |      |
|              | 0000          | 0000  | 0000      | 0000    |      |
|              | 0000          | 0000  | 0000      | 0000    |      |
| GROUP        | 002           | : 1   | LIFE 1400 | COUNT   | 0000 |
|              | 0062          | 0024  | 0044      | 0074    |      |
|              | 0000          | 0000  | 0000      | 0000    |      |
|              | 0000          | 0000  | 0000      | 0000    |      |
|              | 0000          | 0000  | 0000      | 0000    |      |
| TO BE        | CHANGED       | :     | 003 004   | 005 006 | >    |
| <br>(EM **** | * * * * * * * | 1     | 6:05:59   |         |      |

• The first line is the title line.

**OPERATION** 

• In the second line the group number of the current command is displayed.

When there is no group number of the current command, 0 is displayed.

• In lines 3 to 7 the tool life data of the group is displayed.

The third line displays group number, life and the count used. The life count is chosen by parameter LTM (No. 6800#2) as either minutes(or hours) or number of times used.

In lines 4 to 7, tool numbers are displayed. In this case, the tool is selected in the order,  $0034 \rightarrow 0078 \rightarrow 0012 \rightarrow 056 \rightarrow 0090 \dots$ 

The meaning of each mark before the tool numbers is:

- \* : Shows the life has finished.
- # : Shows that the skip command has been accepted.
- @ : Shows that the tool is currently being used.

The life counter counts for tool with @.

"\*" is displayed when the next command is issued by the group to which it belongs.

- Lines 8 to 12 are next group life data to the group displayed in lines 3 to 7.
- In the thirteenth line the group number when the tool change signal is being emitted is displayed. The group number display appears in ascending order. When it cannot be completely displayed, "——>" is displayed.

# 11.4.15 Setting and Displaying B–axis Tool Compensation

### Setting and displaying B-axis tool compensation

- **1** Press the **OFFSET** function key.
- 2 Press the 🗁 continuous menu key several times. Then, press the **[OFST.B]** chapter selection key.
  - When the option for tool geometry and wear compensation is not provided,

| (        |            | )             |
|----------|------------|---------------|
| OFFSET   | (B-AXIS)   | 00200 N00000  |
| No.      | DATA       |               |
| 51       | -999.999   |               |
| 52       | -999.999   |               |
| 53       | -999.999   |               |
| 54       | -999.999   |               |
| 55       | -999.999   |               |
| 56       | -999.999   |               |
| 57       | -999.999   |               |
| 58       | -999.999   |               |
| 59       | -999.999   |               |
|          |            |               |
|          |            |               |
| >_       |            | S 0 T0000     |
| MDI ***  | ** *** *** | 15:29:51      |
| [ OFST.E | 3][]]      | ( ) ( ) ( ) ) |
|          |            |               |

• When the option for tool geometry and wear compensation is provided,

| $\left( \right)$ | OFFSET   | (B-AXIS)   |   |           | о | 0200 | ) 1 | 100000 | $\mathcal{A}$ |
|------------------|----------|------------|---|-----------|---|------|-----|--------|---------------|
|                  | NO.      | (WEAR)     | ( | GEOMETRY) |   |      |     |        |               |
|                  | 51       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 52       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 53       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 54       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 55       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 56       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 57       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 58       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  | 59       | -999.999   |   | -999.999  |   |      |     |        |               |
|                  |          |            |   |           |   |      |     |        |               |
|                  |          |            |   |           |   |      |     |        |               |
|                  |          |            |   |           |   |      |     |        |               |
|                  | >_       |            |   |           | S | 0    | ) [ | 0000   |               |
|                  | MDI ***  | ** *** *** |   | 15:29:51  |   |      |     |        |               |
| $\langle$        | [ OFST.E | 3][]]      | [ | ] [       |   | ] [  |     | 1      | Ϊ             |

**3** Position the cursor to the item to be set or modified, using the cursor keys.

4 Enter the value, then press the INPUT key.

### **Explanations**

The offset can be set to a value in the following valid data ranges.

| Offset | Metric input          | Inch input           |
|--------|-----------------------|----------------------|
| IS–B   | -999.999 to 999.999   | -99.9999 to 99.9999  |
| IS–C   | -999.9999 to 999.9999 | -99.99999 to 99.9999 |

Special B-axis offsets are input or output together with usual offsets. When the option for tool geometry and wear compensation is provided, wear offsets and geometry offsets can be specified separately. A tool offset consists of both the specified wear offset and geometry offset. In two-path control, tool offsets can be specified for each tool post or both tool posts, depending on the setting of COF, bit 0 of parameter No. 8242.

# 11.5 SCREENS DISPLAYED BY FUNCTION KEY

When the CNC and machine are connected, parameters must be set to determine the specifications and functions of the machine in order to fully utilize the characteristics of the servo motor or other parts.

This chapter describes how to set parameters on the MDI panel. Parameters can also be set with external input/output devices such as the Handy File (see Chapter III–9).

In addition, pitch error compensation data used for improving the precision in positioning with the ball screw on the machine can be set or

displayed by the operations under function key SYSTEM .

See Chapter III–7 for the diagnostic screens displayed by pressing function key system.

Normally, the user need not change parameter setting.

### Procedure for displaying and setting parameters

- 1 Set 1 for **PARAMETER WRITE** to enable writing. See the procedure for enabling/disabling parameter writing described below.
- 2 Press function key SYSTEM
- **3** Press chapter selection soft key **[PARAM]** to display the parameter screen.

| TVC | ISO | INI |   |   |   | SEQ   |       | 0000 |
|-----|-----|-----|---|---|---|-------|-------|------|
|     | 0   | 0   | 0 | 0 | 0 | 0     | 0     |      |
|     | FCV |     |   |   |   |       |       | 0001 |
| 0   | 0   | 0   | 0 | 0 | 0 | 0     | 0     |      |
| MIR |     |     |   |   |   |       |       | 0012 |
| 0   | 0   | 0   | 0 | 0 | 0 | 0     | 0     | Х    |
| 0   | 0   | 0   | 0 | 0 | 0 | 0     | 0     | Y    |
| 0   | 0   | 0   | 0 | 0 | 0 | 0     | 0     | Z    |
| 0   |     |     |   |   | Ъ | HANNE | I/0 C | 0020 |
| 0   |     |     |   |   |   |       |       | 0022 |
|     |     |     |   |   |   |       |       | >    |

- 4 Move the cursor to the parameter number to be set or displayed in either of the following ways:
- Enter the parameter number and press soft key [NO.SRH] .
- Move the cursor to the parameter number using the page keys,



- **5** To set the parameter, enter a new value with numeric keys and press soft key **[INPUT]** in the MDI mode. The parameter is set to the entered value and the value is displayed.
- 6 Set 0 for **PARAMETER WRITE** to disable writing.

### Procedure for enabling/displaying parameter writing

- 1 Select the **MDI** mode or enter state emergency stop.
- 2 Press function key OFFSET SETTING
- **3** Press soft key **[SETING]** to display the setting screen.

| SETTING (HANDY)          | 00001 N00000             |
|--------------------------|--------------------------|
| PARAMETER WRITE          | = 1 (0:DISABLE 1:ENABLE) |
| TV CHECK                 | = 0 (0:OFF 1:ON)         |
| PUNCH CODE               | = 1 (0:EIA 1:ISO)        |
| INPUT UNIT               | = 0 (0:MM 1:INCH)        |
| I/O CHANNEL              | = 0 (0-3:CHANNEL NO.)    |
| SEQUENCE NO.             | = 0 (0:OFF 1:ON)         |
| TAPE FORMAT              | = 0 (0:NO CNV 1:F10/11)  |
| SEQUENCE STOP            | = 0 (PROGRAM NO.)        |
| SEQUENCE STOP            | = 11 (SEQUENCE NO.)      |
|                          |                          |
| >                        | S 0 T0000                |
| MDI **** ** <u>* ***</u> | 16:05:59                 |
| [ OFFSET ] [ SETIN       | G][WORK][][(OPRT)]       |

- 4 Move the cursor to **PARAMETER WRITE** using cursor keys.
- **5** Press soft key **[(OPRT)]**, then press **[1: ON]** to enable parameter writing.

At this time, the CNC enters the P/S alarm state (No. 100).

- 6 After setting parameters, return to the setting screen. Move the cursor to PARAMETER WRITE and press soft key [(OPRT)], then press [0: OFF].
- 7 Depress the |RESET| key to release the alarm condition. If P/S alarm No.

000 has occurred, however, turn off the power supply and then turn it on, otherwise the P/S alarm is not released.

### **Explanations**

- Setting parameters with external input/output devices
- Parameters that require turning off the power
- Parameter list
- Setting data

See Chapter 8 for setting parameters with external input/output devices such as the Handy File.

Some parameters are not effective until the power is turned off and on again after they are set. Setting such parameters causes alarm 000. In this case, turn off the power, then turn it on again.

Refer to the FANUC Series 16*i*/18*i*/160*i*/180*i*–MODEL A Parameter Manual (B–63010EN) for the parameter list.

Some parameters can be set on the setting screen if the parameter list indicates "Setting entry is acceptable". Setting 1 for **PARAMETER WRITE** is not necessary when three parameters are set on the setting screen.

# 11.5.2 Displaying and Setting Pitch Error Compensation Data

If pitch error compensation data is specified, pitch errors of each axis can be compensated in detection unit per axis.

Pitch error compensation data is set for each compensation point at the intervals specified for each axis. The origin of compensation is the reference position to which the tool is returned.

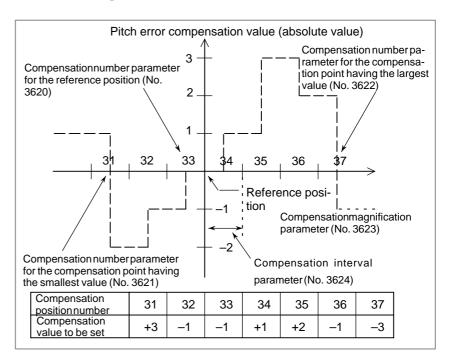
The pitch error compensation data is set according to the characteristics of the machine connected to the NC. The content of this data varies according to the machine model. If it is changed, the machine accuracy is reduced.

In principle, the end user must not alter this data.

Pitch error compensation data can be set with external devices such as the Handy File (see Chapter III–9). Compensation data can also be written directly with the MDI panel.

The following parameters must be set for pitch error compensation. Set the pitch error compensation value for each pitch error compensation point number set by these parameters.

In the following example, 33 is set for the pitch error compensation point at the reference position.



- Number of the pitch error compensation point at the reference position (for each axis): Parameter 3620
- Number of the pitch error compensation point having the smallest value (for each axis): Parameter 3621
- Number of the pitch error compensation point having the largest value (for each axis): Parameter 3622
- Pitch error compensation magnification (for each axis): Parameter 3623
- Interval of the pitch error compensation points (for each axis): Parameter 3624

#### Procedure for displaying and setting the pitch error compensation data **1** Set the following parameters: • Number of the pitch error compensation point at the reference position (for each axis): Parameter 3620 • Number of the pitch error compensation point having the smallest value (for each axis): Parameter 3621 • Number of the pitch error compensation point having the largest value (for each axis): Parameter 3622 • Pitch error compensation magnification (for each axis): Parameter 3623 • Interval of the pitch error compensation points (for each axis): Parameter 3624 Press function key SYSTEM . 2 3 Press the continuous menu key $[\square]$ , then press chapter selection soft ) (PITCH) ( ) ( ) ( key [PITCH]. The following screen is displayed: Continuous menu kev 00000 N00000 PIT-ERROR SETTING NO.DATA NO.DATA NO.DATA 00000 0010 0 0020 0 0001 0 0011 0 0021 0 0002 0 0012 0 0022 0 0003 0 0013 0 0023 0 (X) 0004 0 0014 0 0024 0 0005 0 0015 0 0025 0 0006 0 0016 0 0026 0 0007 0 0017 0 0027 0 0008 0 0018 0 0028 0 0009 0 0019 0 0029 0 <u>MEM</u> \*\*\*\* \*\*\* \*\*\* 16:05:59 [ NO.SRH ] [ ON:1 ] [ OFF:0 ] [ +INPUT ] [ -INPUT ] 4 Move the cursor to the compensation point number to be set in either of the following ways: • Enter the compensation point number and press the [NO.SRH] soft

- Enter the compensation point number and press the [NO.SRH] soft key.
- 5 Enter a value with numeric keys and press the **[INPUT]** soft key.

# 11.6 DISPLAYING THE PROGRAM NUMBER, SEQUENCE NUMBER, AND STATUS, AND WARNING MESSAGES FOR DATA SETTING OR INPUT/OUTPUT OPERATION

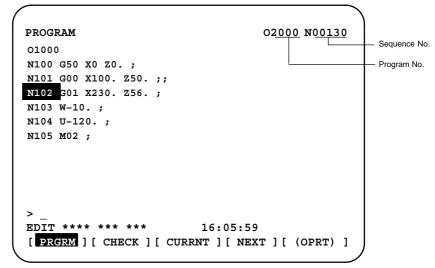
### 11.6.1

Displaying the Program Number and Sequence Number The program number, sequence number, and current CNC status are always displayed on the screen except when the power is turned on, a system alarm occurs, or the PMC screen is displayed.

If data setting or the input/output operation is incorrect, the CNC does not accept the operation and displays a warning message.

This section describes the display of the program number, sequence number, and status, and warning messages displayed for incorrect data setting or input/output operation.

The program number and sequence number are displayed at the top right on the screen as shown below.



# The program number and sequence number displayed depend on the screen and are given below:

On the program screen in the EDIT mode on Background edit screen: The program No. being edited and the sequence number just prior to the cursor are indicated.

### Other than above screens :

The program No. and the sequence No. executed last are indicated.

# Immediately after program number search or sequence number search :

Immediately after the program No. search and sequence No. search, the program No. and the sequence No. searched are indicated.

— 761 —

| 11.6.2                               | The current mode, automatic operation state, alarm state, and program   |
|--------------------------------------|---|
| Displaying the Status                | editing state are displayed on the next to last line on the CRT screen  |
| and Warning for Data                 | allowing the operator to readily understand the operation condition of the  |
| Setting or Input/Output<br>Operation | system.<br>If data setting or the input/output operation is incorrect, the CNC does not<br>accept the operation and a warning message is displayed on the next to last<br>line of the CRT screen. This prevents invalid data setting and input/output |

errors.

### **Explanations**

 Description of each display

| (9) Data is out of range.<br>(Note) Actually, this is displayed in the area starting |             |  |            |            |                         | starting      |
|--|-------------|--|------------|------------|-------------------------|---------------|
| from (2).  |             | (5) (Note) Actually, 5 is disp<br><b>EMG</b> in the area for (3) and (4) |            |            | s displayed<br>and (4). |               |
| (1)<br>EDIT  | (2)<br>STOP | (3)<br>MTN   | (4)<br>FIN | (6)<br>ALM | (7)<br>hh:mm:ss         | (8)<br>INPUT  |
|  |             | (Display soft keys)  |            |            |                         | (10)<br>HEAD1 |

Note) Actually, (10) is displayed at the position where (8) is now displayed.

• (1) Current mode

• (2) Automatic operation

status

- (3) Axis moving status/dwell status
- (4) State in which an auxiliary function is being executed
- (5) Emergency stop or reset status

- MDI : Manual data input, MDI operation
  - MEM : Automatic operation (Memory operation)
  - RMT : Automatic operation (DNC operation)
  - EDIT : Memory editing
  - HND : Manual handle feed
  - JOG : Jog feed
  - TJOG : TEACH IN JOG
  - THND : TEACH IN HANDLE
  - INC : Manual incremental feed
  - REF : Manual reference position return
  - \*\*\*\* : Reset (When the power is turned on or the state in which program execution has terminated and automatic operation has terminated.
  - STOP : Automatic operation stop (The state in which one block has been executed and automatic operation is stopped.)
  - HOLD : Feed hold (The state in which execution of one block has been interrupted and automatic operation is stopped.)
  - STRT : Automatic operation start-up (The state in which the system operates automatically)
  - MTN : Indicates that the axis is moving.
  - DWL : Indicates the dwell state.
  - \*\*\* : Indicates a state other than the above.
  - FIN : Indicates the state in which an auxiliary function is being executed. (Waiting for the complete signal from the PMC)
  - \*\*\* : Indicates a state other than the above.

EMG— : Indicates emergency stop.(Blinks in reversed display.)
 —RESET— : Indicates that the reset signal is being received.

- (6) Alarm status
- (7) Current time
- (8) Program editing status

• (9) Warning for data setting or input/ output operation ALM : Indicates that an alarm is issued. (Blinks in reversed display.)
BAT : Indicates that the battery is low. (Blinks in reversed display.)
Space : Indicates a state other than the above.

- hh:mm:ss Hours, minutes, and seconds
- **INPUT** : Indicates that data is being input.
- OUTPUT : Indicates that data is being output.
- SRCH : Indicates that a search is being performed.
- EDIT : Indicates that another editing operation is being performed (insertion, modification, etc.)
- LSK : Indicates that labels are skipped when data is input.
- RSTR : Indicates that the program is being restarted
- Space : Indicates that no editing operation is being performed.

When invalid data is entered (wrong format, value out of range, etc.), when input is disabled (wrong mode, write disabled, etc.), or when input/output operation is incorrect (wrong mode, etc.), a warning message is displayed. In this case, the CNC does not accept the setting or input/output operation.

The following are examples of warning messages:

#### Example 1)

When a parameter is entered



### Example 2)

When a parameter is entered



### Example 3)

When a parameter is output to an external input/output device



• (10) Tool post name (for the two-path control) HEAD1: Tool post 1 is selected.

HEAD2 : Tool post 2 is selected.

Other names can be used depending on the settings of parameters 3141 to 3147.

The tool post name is displayed at the position where (8) is now displayed. While the program is edited, (8) is displayed.

# 11.7Image: Constraint of the second seco

By pressing the MESSAGE function key, data such as alarms, alarm history data, and external messages can be displayed. For information relating to alarm display, see Section III.7.1. For information relating to alarm history display, see Section III.7.2. For information relating to external message display, see the relevant manual supplied by the machine tool builder.

# 11.7.1 External Operator Message History Display

External operator messages can be preserved as history data. Preserved history data can be displayed on the external operator message history screen.

### Procedure for external operator message history display

1

### Procedure

Press the MESSAGE function key.

2 Press the continuous menu key  $\square$ , then press the chapter selection soft key **[MSGHIS]**. The screen shown below appears.

| Continuous menu key Date and Page number> Message nuumber> | MESSAGE HISTORY<br>94/01/01 17:25:00<br>NO. **** | 00000 N00000<br>PAGE:1 |
|--|--|------------------------|
| Display range<br>(Up to 255 characters)                    |  |                        |
|  | MEM STRT MIN FIN ALM 09:36:48 [ ][ MSGHIS ][ ][  | ][ (OPRT) ]            |

### NOTE

Up to 255 characters can be specified for an external operator message. By setting MS1 and MS0 (bits 7 and 6 of parameter No. 3113), however, the number of characters that can be preserved as external operator message history data can be restricted, and the number of history data items selected.

### Explanations

| <ul> <li>Updating external<br/>operator message<br/>history data</li> </ul> | When an external operator message number is specified, updating of the external operator message history data is started; this updating is continued until a new external operator message number is specified or deletion of the external operator message history data is specified.   |
|---|--|
| <ul> <li>Clearing external<br/>operator message<br/>history data</li> </ul> | To clear external operator message history data, press the [CLEAR] soft<br>key. This clears all external operator message history data. (Set MSGCR<br>(bit 0 of parameter No. 3113) to 1.)<br>Note that when MS1 and MS0 (bits 7 and 6 of parameter No. 3113), used<br>to specify the number of external operator message history data items to<br>be displayed, are changed, all existing external operator message history<br>data is cleared. |
| Limitations   |  |
| <ul> <li>Two–path control</li> </ul>  | When two-path control is exercised, the external operator messages for system 1 are displayed. (The external operator messages for system 2 are  |

• **Option** Before this function can be used, the external data input function or optional external message function must be selected.

not displayed.)

| 11.8<br>CLEARING THE<br>SCREEN           | When screen indication isn't necessary, the life of the back light for LCD can be put off by turning off the back light.<br>The screen can be cleared by pressing specific keys. It is also possible to specify the automatic clearing of the screen if no keys are pressed during a period specified with a parameter.<br>But, the life of the back light may be contracted all the more when the clearing of screen and re–indication of screen are repeated beyond the necessity. This effect can be expected when a screen is cleared for more than one hour. |  |  |
|--|---|--|--|
| 11.8.1<br>Erase CRT Screen<br>Display    | Holding down the $\bigcirc$ key and pressing an arbitrary function key clears the screen.   |  |  |
| Procedure for Erase CRT Screen Display   |   |  |  |
| Procedure                                |   |  |  |
| <ul> <li>Clearing the screen</li> </ul>  | Hold down the CAN key and press an arbitrary function key (such as  |  |  |
|  | POS and $PROG$ ).   |  |  |
| <ul> <li>Restoring the screen</li> </ul> | Press an arbitrary function key.  |  |  |

OPERATION 11. SETTING AND DISPLAYING DATA

# **11.8.2**<br/>Automatic Erase CNC<br/>Screen DisplayThe CNC screen is automatically cleared if no keys are pressed during the<br/>period (in minutes) specified with a parameter. The screen is restored by<br/>pressing any key.

### Procedure for Automatic Erase CRT Screen Display

• Clearing the screen The CNC screen is cleared once the period (minutes) specified with parameter No. 3123 has elapsed, provided the following conditions are satisfied:

### Conditions for clearing the CNC screen

- Parameter No. 3123 is set to other than 0.
- None of the following keys have been pressed: MDI keys Soft keys External input keys
- No alarm has been issued.

• **Restoring the screen** The cleared CNC screen is restored once at least one of the following conditions is satisfied:

### Conditions for restoring the CNC screen

- Any of the following keys has been pressed: MDI keys Soft keys Externally input keys
- An alarm has been issued.

Some machines feature a special key for restoring the screen. For an explanation of the location and use of this key, refer to the corresponding manual, supplied by the machine tool builder.

### Explanations

- Clearing the screen using CAN + function key
- Specified period
- Alarm for another path

If parameter No. 3123 is set to 0, clearing of the screen using the CAN key

and a function key (III–11.8.1) is disabled.

The period specified with parameter No. 3123 is valid only for tool post 1.

The screen is not cleared if an alarm is issued for tool post 1 or 2 or the loader before the specified period elapses.

| <b>CAUTION</b><br>Pressing any key while the screen is being cleared re | estores |  |  |  |
|---|---------|--|--|--|
| the screen. In such a case, however, the function assigned              |         |  |  |  |
| to the pressed key is initiated. Do not press the                       | DELET , |  |  |  |
| INSERT, or ALTER key to restore the screen, therefore.                  |         |  |  |  |

# **GRAPHICS FUNCTION**

The graphic function indicates how the tool moves during automatic operation or manual operation.

| 12.1             | It is possible to draw the programmed tool path on the screen, which      |
|------------------|---|
| GRAPHICS DISPLAY | makes it possible to check the progress of machining, while observing the |
|                  | path on the screen.   |
|                  | In addition, it is also possible to enlarge/reduce the screen.            |
|                  | The drawing coordinates (parameter) and graphic parameters must be set    |
|                  | before a tool path can be displayed.                                      |
|                  | With two-path control, the tool paths of two tool posts are displayed on  |
|                  | the same screen, one on the right and the other on the left.              |
|                  |   |

### Graphics display procedure

### Procedure

Set the drawing coordinates with parameter No. 6510 before starting drawing. See "Drawing Coordinate System" for the settings and corresponding coordinates.

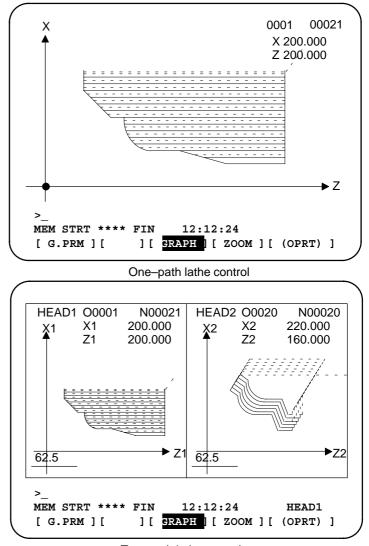
For the two-path control, parameter GRL (bit 0 of No. 6500) specifies which tool post is displayed on which side (tool post 1 on the right or tool post 2 on the right).

1 Press function key GRAPH . Press CUSTOM for a small MDI unit.

The graphic parameter screen shown below appears. (If this screen does not appear, press soft key **[G.PRM]**.)

| GRAPHIC PARAMETER       | O0001 N00020   |                 |  |
|-------------------------|----------------|-----------------|--|
| WORK LENGTH             | W=             | 130000          |  |
| WORK DIAMETER           | D=             | 130000          |  |
| PROGRAM STOP            | N=             | 0               |  |
| AUTO ERASE              | A=             | 1               |  |
| LIMIT                   | L=             | 0               |  |
| GRAPHIC CENTER          | X=             | 61655           |  |
|                         | $\mathbf{Z} =$ | 90711           |  |
| SCALE                   | S=             | 32              |  |
| GRAPHIC MODE            | M=             | 0               |  |
|                         |                | S 0 T0000       |  |
| >_<br>MEM STRT **** FIN | 12.12.2/       | HEAD1           |  |
|                         |                | OM ] [ (OPRT) ] |  |
|                         | APR J[ 20      | OM J (OPRI) J   |  |

- 2 For the two-path control, determine for which tool post the data is specified, using a tool post select signal. Specify the PROGRAM STOP (N), AUTO ERASE (A), and GRAPHIC CENTER (X,Y) parameters separately for each tool post. The other parameters are common to both tool posts. It does not matter for which tool post they are specified first.
- 3 Move the cursor with the cursor keys to a parameter to set.
- 4 Enter data, then press the INPUT key.
- **5** Repeat steps 3 and 4 until all required parameters are specified.
- 6 Press soft key [GRAPH].
- 7 Automatic or manual operation is started and machine movement is drawn on the screen.

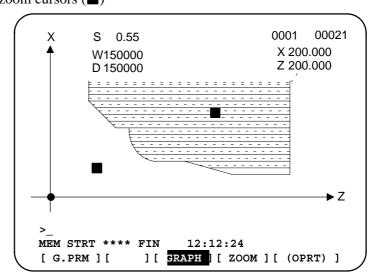


Two-path lathe control

Magnifying drawings

Part of a drawing on the screen can be magnified.

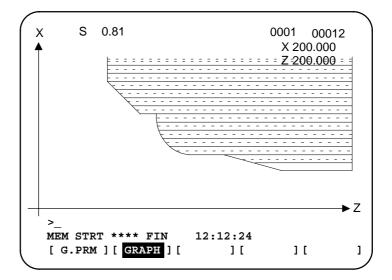
8 Press the GRAPH function key, then the [ZOOM] soft key to display a magnified drawing. The magnified–drawing screen contains two zoom cursors (■)



A rectangle that has one of its diagonals defined by the two zoom cursors is magnified to the full size of the screen.

For the two-path control, the zoom cursors are indicated for the selected tool post. Use the tool post select switch to select the tool post corresponding to the drawing to be magnified.

- 9 Using the cursor keys ↓ ↑ → ↓ , move the zoom cursors to specify a diagonal for the new screen. Pressing the [HI / LO] soft key toggles the zoom cursor to be moved.
- 10 To make the original drawing disappear, press **[EXEC]**.
- **11** Resume the previous operation. The part of the drawing specified with the zoom cursors will be magnified.

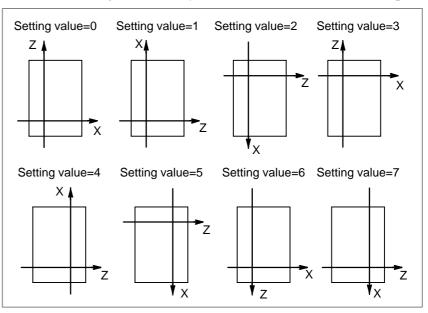


**12** To display the original drawing, press the **[NORMAL]** soft key, then start automatic operation.

### Explanation

• Setting drawing coordinate systems

Parameter No. 6510 is used to set a drawing coordinate system for using the graphic function. The relationships between setting values and drawing coordinate systems are indicated below. With two–path control, a different drawing coordinate system can be selected for each tool post.



• Graphics parameter

### WORK LENGTH (W), WORK DIAMETER (D)

Specify work length and work diameter. The table below lists the input unit and valid data range.

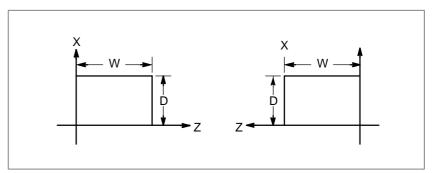


Table 12.1 Unit and Range of Drawing Data

| Increment system | Uı        | Valid range  |                 |  |
|------------------|-----------|--------------|-----------------|--|
| increment system | mm input  | Inch input   | Valid range     |  |
| IS–B             | 0.001 mm  | 0.0001 inch  | - 0 to 99999999 |  |
| IS–C             | 0.0001 mm | 0,00001 inch |                 |  |

### **GRAPHIC CENTER (X, Z), SCALE (S)**

A screen center coordinate and drawing scale are displayed. A scale screen center coordinate are automatically calculated so that a figure set in WORK LENGTH (a) and WORK DIAMETER (b) can be fully displayed on the screen. So, the user need not set these parameters usually.

A screen center coordinate is defined in the workpiece coordinate system. Table 12. 3. 2 indicates the unit and range. The unit of SCALE is 0.001%.

### PROGRAM STOP (N)

Set the sequence number of an end block when part of the program is to be drawn. A value set in this parameter is automatically cancelled (cleared to 0) once a drawing is provided.

### AUTO ERASE (A)

If 1 is set, the previous drawing is automatically erased when automatic operation is stated from the reset state. Then, drawing is started.

### LIMIT (L)

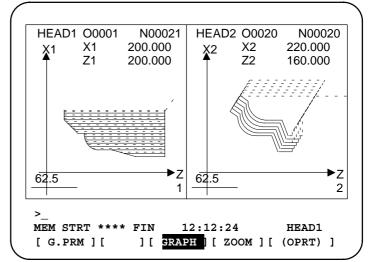
If 1 is set, the area of stored stroke limit 1 is drawn with double-dot-and-dash lines.

### NOTE

The parameter values for drawing are preserved even if power is turned off.

• Executing drawing only Since the graphic drawing is done when coordinate value is renewed during automatic operation, etc., it is necessary to start the program by automatic operation. To execute drawing without moving the machine, therefore, enter the machine lock state. • Deleting the previous Pressing the **[REVIEW]** soft key on the graphic screen deletes tool paths drawing on it. Setting the graphic parameter as AUTO ERASE (A) = 1 specifies that when automatic operation is started at reset, program execution begins after the previous drawing is erased automatically (AUTO ERASE = 1). Drawing a part of a When necessary to display a part of a program, search the starting block to be drawn by the sequence number search, and set the sequence number program of the end block to the PROGRAM STOP N= of the graphic parameter before starting the program under cycle operation mode. • Drawing using dashed The tool path is shown with a dashed line (----) for rapid traverse and lines and solid lines with a solid line (-----) for cutting feed. Displaying coordinates The displayed drawing is indicated with coordinates in a work coordinate system. • Displaying the machine The machine zero point is indicated with **o** mark. zero point Switching from a Even if the screen is switched to a non-drawing screen, drawing drawing screen to continues. When the drawing screen is displayed again, the entire another screen drawing appears (no parts are missing).

 Drawing for tool posts 1 and 2 (two-path lathe control) For the two-path lathe control, the screen is split vertically, and each half screen displays the tool path for either tool post.



Parameter GRL (bit 0 of No. 6500) specifies which tool post is to be displayed on which side.

- GRL = 0: Tool post 1 is displayed on the left half, and tool post 2 on the right half.
- GRL = 1 ; Tool post 1 is displayed on the right half, and tool post 2 on the left half.

### Restrictions

- Feedrate
- Changing the graphic parameters during automatic operation
- Coordinate axis names
- Zooming drawings

In case the feed rate is considerably high, drawing may not be executed correctly, decrease the speed by dry–run, etc. to execute drawing.

After a graphic parameter is changed, the **[REVIEW]** soft key must be pressed to initialize the graphic screen. Otherwise, the change to the graphic parameter is not reflected correctly.

The coordinate axis names are fixed to X or Z. For the two–path control, the first and second axes for tool post 1 are named X1 and Z1, respectively, and the first and second axes for tool post 2 are named X2 and Z2, respectively.

If the WORK and DIAMETER graphic parameters are not set correctly, the drawing cannot be magnified. To reduce a drawing, specify a negative value for the SCALE graphic parameter. The machine zero point is indicated with **o** mark.

# 13 HELP FUNCTION

The help function displays on the screen detailed information about alarms issued in the CNC and about CNC operations. The following information is displayed.

- Detailed information of alarms When the CNC is operated incorrectly or an erroneous machining program is executed, the CNC enters the alarm state. The help screen displays detailed information about the alarm that has been issued and how to reset it. The detailed information is displayed only for a limited number of P/S alarms. These alarms are often misunderstood and are rather difficult to understand.
- **Operation method** If you are not sure about a CNC operation, refer to the help screen for information about each operation.
- **Parameter table** When setting or referring to a system parameter, if you are not sure of the number of the parameter, the help screen displays a list of parameter Nos. for each function.

### **Help Function Procedure**

Procedure

1 Press the HELP key on the MDI. HELP (INITIAL MENU) screen is displayed.

| HELP (INITIAI | MENU)  | 01234 | N00001           |  |
|---------------|--|-------|------------------|--|
|               | **** HELP ****   | k     |                  |  |
|               | <ol> <li>ALARM DETAIN</li> <li>OPERATION ME</li> <li>PARAMETER TA</li> </ol> | THOD  |                  |  |
| MEM **** ***  | *** 10:12<br>Opr ][ 3 para ]   |       | 0 T0000<br>] [ ] |  |

Fig. 13 (a) HELP (INITIAL MENU) Screen

The user cannot switch the screen display from the PMC screen or CUSTOM screen to the help screen. The user can return to the normal

CNC screen by pressing the |HELP| key or another function key.

### ALARM DETAIL screen

2 Press soft key [1 ALAM] on the HELP (INITIAL MENU) screen to display detailed information about an alarm currently being raised.

```
HELP (ALARM DETAIL)
                                  00010 N00001
NUMBER : 027
                                                 Alarm No.
M'SAGE : NO AXES COMMANDED IN G43/G44-
                                                 Normal explana-
FUNCTION : TOOL LENGTH COMPENSATION C
                                                  tion on alarm
ALARM :
                                                  Function
   IN TOOL LENGTH COMPENSATION TYPE C,
                                                  classification
   NO AXIS IS DESIGNATED IN G43 & G44
                                                  Alarm details
   BLOCKS. IN TOOL LENGTH COMPENSATION
   TYPE C, IT TRIES TO LATCH ON TO
   ANOTHER AXIS WITHOUT OFFSET CANCE-
   LING.
>100
                                S
                                      0 T0000
MEM **** *** ***
                        10:12:25
 [ 1 ALM ] [ 2 OPR ] [ 3 PARA ] [
                                    ][
                                             ]
```

Fig. 13 (b) ALARM DETAIL Screen when P/S Alarm No. 27 is issued

Note that only details of the alarm identified at the top of the screen are displayed on the screen.

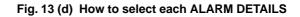
If the alarms are all reset while the help screen is displayed, the alarm displayed on the ALARM DETAIL screen is deleted, indicating that no alarm is issued.

```
HELP (ALARM DETAIL)
                                   01234 N00001
NUMBER
          :
M'SAGE
          :
FUNCTION :
ALARM
       <<ALARM IS NOT GENERATED>>
 ENTER THE DETAIL-REQUIRED ALARM NUMBER,
 AND PRESS [SELECT] KEY
>100
                                 S
                                       0 T0000
MEM **** *** ***
                         10:12:25
[ 1 ALM ] [ 2 OPR ] [ 3 PARA ] [
                                     ][
                                               1
```

#### Fig. 13 (c) ALARM DETAIL Screen when No Alarm is issued

**3** To get details on another alarm number, first enter the alarm number, then press soft key **[SELECT]**. This operation is useful for investigating alarms not currently being raised.

>100 S 0 T0000 MEM \*\*\*\* \*\*\* \*\*\* 10:12:25 [ ][ ][ ][ ][ SELECT]



| $\boldsymbol{\ell}$ |   |             |              |  |
|---------------------|---|-------------|--------------|--|
| HELP (ALA           | RM DETAIL)  | c           | 01234 N00001 |  |
|                     |   |             |              |  |
| NUMBER              | : 100   |             |              |  |
| M'SAGE              | : PARAMETER W   | RITE ENABLE |              |  |
| FUNCTION            | :   |             |              |  |
| ALARM               | :   |             |              |  |
| <                   | <alarm is="" not<="" td=""><td>GENERATED&gt;&gt;</td><td></td><td></td></alarm> | GENERATED>> |              |  |
| >100                |   | S           | 0 T0000      |  |
| <u>MEM</u> ****     | *** ***   | 10:12:25    |              |  |
| [ ]                 | 1 [ ]   | ][          | ][ SELECT ]  |  |

Fig. 13 (e) ALARM DETAIL Screen when P/S alarm No. 100 is selected

OPERATION METHOD screen

4 To determine an operating procedure for the CNC, press the soft key [2 OPR] key on the HELP (INITIAL MENU) screen. The OPERATION METHOD menu screen is then displayed. (See Fig. 13 (f).)

| HELP (OPERATION METHOD) 01:      | 234 | N00001 |
|----------------------------------|-----|--------|
| 1. PROGRAM EDIT                  |     |        |
| 2. SEARCH                        |     |        |
| 3. RESET                         |     |        |
| 4. DATA INPUT WITH MDI           |     |        |
| 5. DATA INPUT WITH TAPE          |     |        |
| 6. OUTPUT                        |     |        |
| 7. INPUT WITH FANUC CASSETTE     |     |        |
| 8. OUTPUT WITH FANUC CASSETTE    |     |        |
| 9. MEMORY CLEAR                  |     |        |
|                                  |     |        |
| S                                | 0   | T0000  |
| MEM **** *** *** 10:12:25        |     |        |
| [ 1 ALM ] [ 2 OPR ] [ 3 PARA ] [ | ][  | 1      |
|                                  |     |        |

Fig. 13 (f) OPERATION METHOD Menu Screen

To select an operating procedure, enter an item No. from the keyboard then press the **[SELECT]** key.

— 777 —

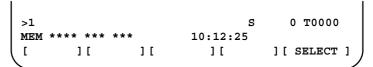


Fig. 13 (g) How to select each OPERATION METHOD screen

When "1. PROGRAM EDIT" is selected, for example, the screen in Figure 13 (g) is displayed.

On each OPERATION METHOD screen, it is possible to change the displayed page by pressing the PAGE key. The current page No. is shown at the upper right corner on the screen.

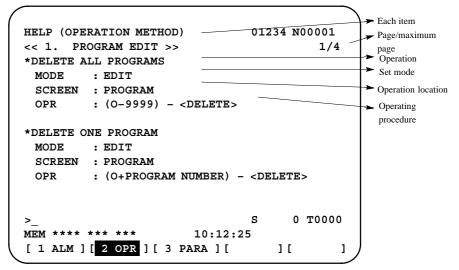


Fig. 13 (h) Selected OPERATION METHOD screen

5 To return to the OPERATION METHOD menu screen, press the RETURN MENU key to display "[2 OPR]" again, and then press the [2 OPR] key again.

To directly select another OPERATION METHOD screen on the screen shown in Figure 13 (h), enter an item No. from the keyboard and press the **[SELECT]** key.

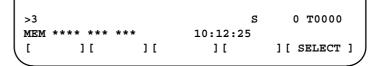


Fig. 13 (i) How to select another OPERATION METHOD screen

PARAMETER TABLE screen

6 If you are not sure of the No. of a system parameter to be set, or to refer to a system parameter, press the [3 PARA] key on the HELP (INITIAL MENU) screen. A list of parameter Nos. for each function is displayed. (See Figure 13 (j).)

It is possible to change the displayed page on the parameter screen. The current page No. is shown at the upper right corner on the screen.

| HELP (PARAMETER TABLE)                                     | 01234     | N00001<br>1/4     |
|--|-----------|-------------------|
| * SETTEING<br>* READER/PUNCHER INTERFACE                   | -         | 0000~)<br>0100~)  |
| * AXIS CONTROL<br>/SETTING UNIT<br>* COORDINATE SYSTEM     | •         | 1000~)<br>1200~)  |
| * STROKE LIMIT<br>* FEED RATE                              | (No.      | 1300~)<br>1400~)  |
| * ACCEL/DECELERATION CTRL<br>* SERVORELATED                | (No.      | 1600~)<br>1800~)  |
| * DI/DO<br>>_  | (No.<br>S | 3000~)<br>0 T0000 |
| MEM **** *** *** 10:12:25 [ 1 ALM ] [ 2 OPR ] [ 3 PARA ] [ | ]         | رد ا              |

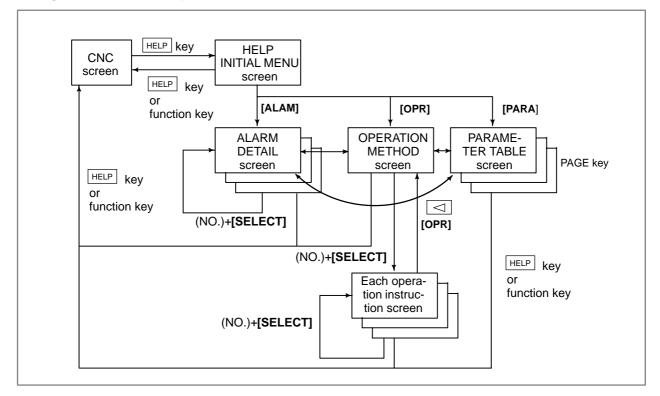
Fig. 13 (j) PARAMETER TABLE screen

7 To exit from the help screen, press the HELP key or another function key

key.

### Explanation

### • Configuration of the Help Screen



# **IV. MAINTENANCE**

### METHOD OF REPLACING BATTERY This chapter describes how to replace the CNC backup battery and absolute pulse coder battery. This chapter consists of the following sections: 1.1 REPLACING BATTERY FOR LCD-MOUNTED TYPE i SERIES **1.2 REPLACING THE BATTERY FOR STAND-ALONE TYPE** *i* SERIES **1.3 BATTERY IN THE INTELLIGENT TERMINAL (3 VDC) 1.4 BATTERY FOR SEPARATE ABSOLUTE PULSE CODERS** (6 VDC) **1.5 BATTERY FOR ABSOLUTE PULSE CODER BUILT INTO THE MOTOR (6 VDC) Battery for memory** Part programs, offset data, and system parameters are stored in CMOS backup memory in the control unit. The power to the CMOS memory is backed up by a lithium battery mounted on the front panel of the control unit. Therefore, the above data is not lost even if the main battery fails. The backup battery is installed in the control unit prior to being shipped from the factory. This battery can provide backup for the memory contents for about a year. When the battery voltage falls, alarm message "BAT" blinks on the LCD display and the battery alarm signal is output to the PMC. When this alarm is displayed, replace the battery as soon as possible. In general, the battery can be replaced within one or two weeks of the alarm first being issued. This, however, depends on the system configuration. If the battery voltage subsequently drops further, backup of memory can no longer be provided. Turning on the power to the control unit in this state causes system alarm 910 (SRAM parity alarm) to be issued because the contents of memory are lost. Replace the battery, clear the entire memory, then reenter the data. Replace the memory backup battery while the control unit is turned off. The following two kinds of batteries can be used. • Lithium battery, incorporated into the CNC control unit. • Two alkaline dry cells (size D) in an external battery case. NOTE A lithium battery is installed as standard at the factory.

# 1.1 REPLACING BATTERY FOR LCD-MOUNTED TYPE *i* SERIES

| <ul> <li>Replacement proce</li> </ul> | edure |
|---------------------------------------|-------|
|---------------------------------------|-------|

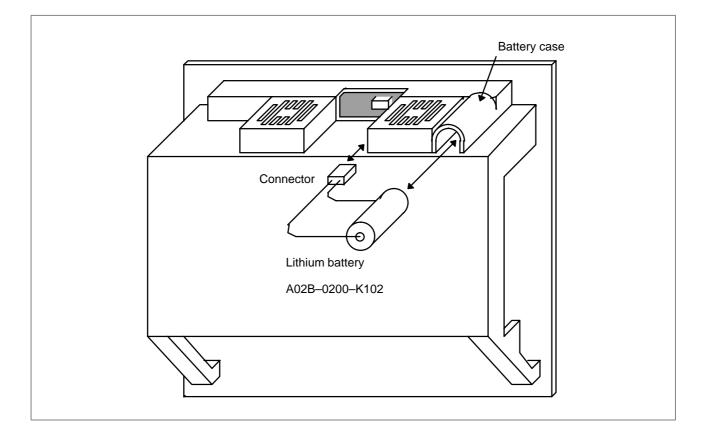
When a lithium battery is used

Prepare a new lithium battery (ordering code: A02B–0200–K102 (FANUC specification: A98L–0031–0012)).

- 1) Turn on the power to the CNC. After about 30 seconds, turn off the power.
- 2) Remove the old battery from the top of the CNC control unit. First, unplug the battery connector, then take the battery out of its case.

The battery case of a control unit without option slots is located at the top end of the unit as shown in the figure of the previous page. The battery case of a control unit with 2 slots or 4 slots is located in the central area of the top of the unit (between fans).

3) Insert a new battery and reconnect the connector.



### WARNING

Using other than the recommended battery may result in the battery exploding. Replace the battery only with the specified battery (A02B–0200–K102).

### CAUTION

Steps 1) to 3) should be completed within 30 minutes (or within 5 minutes for the 160*i*/180*i* with the PC function). Do not leave the control unit without a battery for any longer than the specified period. Otherwise, the contents of memory may be lost. If steps 1) to 3) may not be completed within 30 minutes, save all contents of the CMOS memory to the memory card beforehand. Thus, if the contents of the CMOS memory are lost, the contents can be restored easily. For the method of operation, refer to Maintenance manual (B–63005EN).

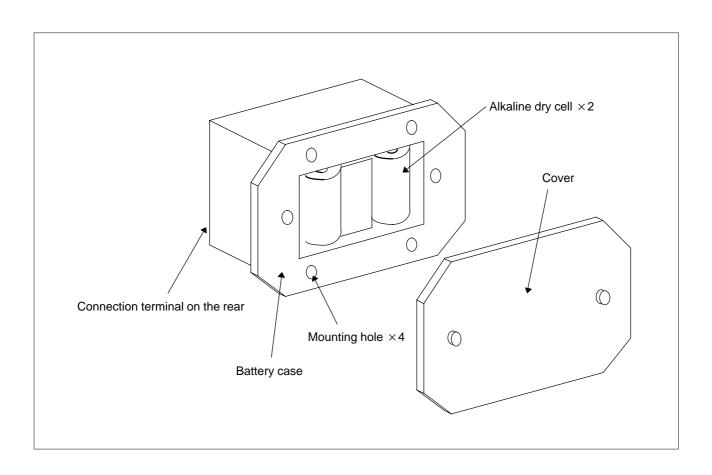
When discarding a battery, observe the applicable ordinances or other rules of your local government. Also, cover the terminals of the battery with vinyl tape or the like to prevent a short–circuit.

### Replacing commercial alkaline dry cells (size D)

- 1) Prepare two alkaline dry cells (size D) commercially available.
- 2) Turn on the power to the Series 16i/18i/160i/180i.
- 3) Remove the battery case cover.
- 4) Replace the cells, paying careful attention to their orientation.
- 5) Reinstall the cover onto the battery case.

### CAUTION

When replacing the alkaline dry cells while the power is off, use the same procedure as that for lithium battery replacement described above.



# 1.2 REPLACING THE BATTERY FOR STAND-ALONE TYPE *i* SERIES

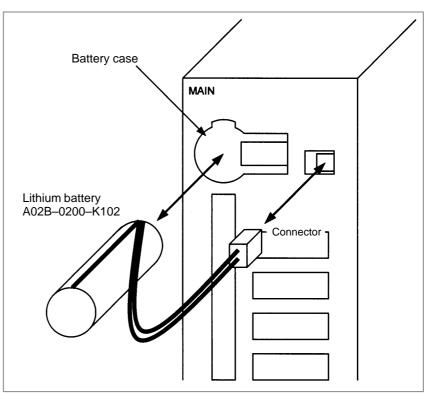
• Replacing the battery

If a lithium battery is used, have A02B–0200–K102 (FANUC internal code: A98L–0031–0012) handy.

- (1) Turn the CNC on. About 30 seconds later, turn the CNC off.
- (2) Remove the battery from the top area of the CNC unit. Disconnect the connector first. Then, remove the battery from the battery case.

The battery case is provided in the top area of the face plate of the main CPU board.

(3) Replace the battery, then connect the connector.



### WARNING

The incorrect mounting of the battery may cause an explosion. Avoid using any battery other than the one specified here (A02B–0200–K102).

### NOTE

Complete steps (1) to (3) within 30 minutes.

If the battery is left removed for a long time, the memory would lose the contents.

If there is a danger that the replacement cannot be completed within 30 minutes, save the whole contents of the CMOS memory to a memory card. The contents of the memory can be easily restored with the memory card in case the memory loses the contents.

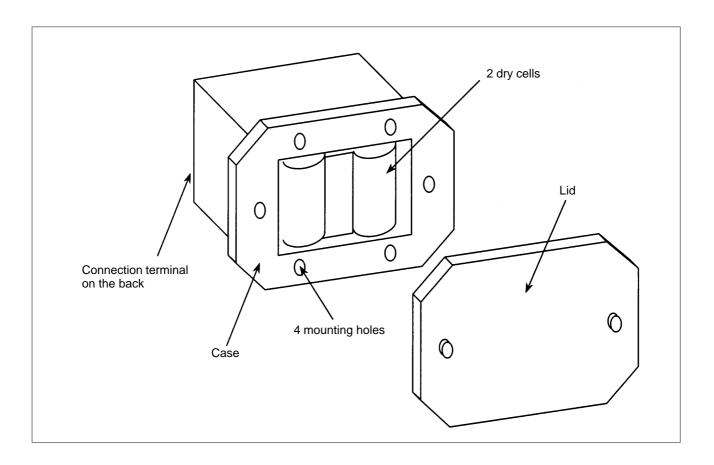
Discard the dead battery, observing appropriate municipal rules and regulations. When discarding the battery, insulate the terminal with a tape so that no short–circuit would occur.

# When using commercial D-size alkaline dry cells

- Replacing the battery
- (1) Have commercial D-size alkaline dry cells handy.
- (2) Turn the CNC on.
- (3) Remove the lid from the battery case.
- (4) Replace the old dry cells with new ones. Mount the dry cells in a correct orientation.
- (5) Replace the lid on the battery case.

### NOTE

In the power–off state, the battery should be replaced as in the case of the lithium battery, which is descried above.



### 1.3 BATTERY IN THE INTELLIGENT TERMINAL (3 VDC)

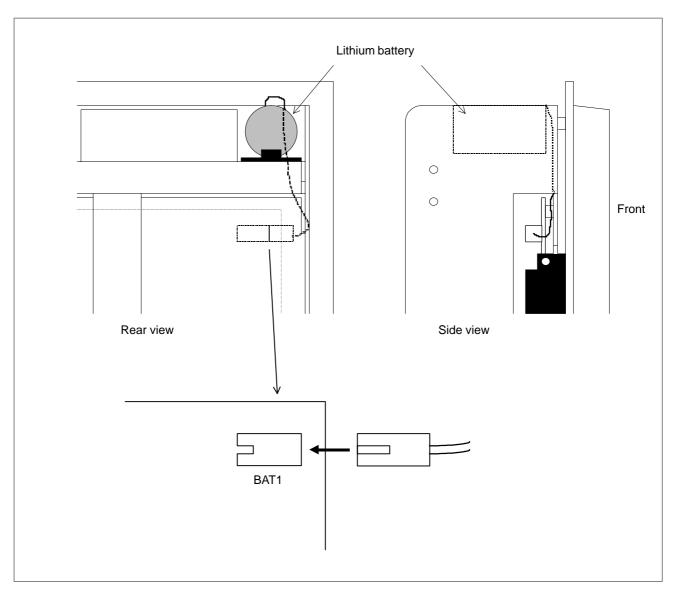
### Replacing the battery

A lithium battery is used to back up BIOS data in the intelligent terminal. This battery is factory–set in the intelligent terminal. This battery has sufficient capacity to retain BIOS data for one year.

When the battery voltage becomes low, the LCD screen blinks. (The LCD screen also blinks if a fan alarm is issued.) If the screen blinks, replace the battery as soon as possible (within one week). FANUC recommends that the battery be replaced once per year regardless of whether a battery alarm is issued.

- (1) To guard against the possible loss or destruction of BIOS parameters, write down the BIOS parameter values.
- (2) Obtain a new lithium battery (A02B–0200–K102).
- (3) After power has been supplied for at least five seconds, turn off the power to intelligent terminal type 2. Remove the intelligent terminal from the panel so that replacement work can be done from the rear of the intelligent terminal.
- (4) Detach the connector of the lithium battery, and remove the battery from the battery holder.
- (5) Run the cable for the new lithium battery as shown in the figure.
- (6) Attach the connector, and place the battery in the battery holder.
- (7) Install intelligent terminal type 2 again.
- (8) Turn on the power, and check that the BIOS parameters are maintained (BIOS setup is not activated forcibly).

Between removing an old battery and inserting new battery, no more than five minutes must be allowed to elapse.



Lithium battery connection

# 1.4 BATTERY FOR SEPARATE ABSOLUTE PULSE CODERS (6 VDC)

One battery unit can maintain current position data for six absolute pulse coders for a year.

When the voltage of the battery becomes low, APC alarms 3n6 to 3n8 (n: axis number) are displayed on the CRT display. When APC alarm 3n7 is displayed, replace the battery as soon as possible. In general, the battery should be replaced within two or three weeks, however, this depends on the number of pulse coders used.

If the voltage of the battery becomes any lower, the current positions for the pulse coders can no longer be maintained. Turning on the power to the control unit in this state causes APC alarm 3n0 (reference position return request alarm) to occur. Return the tool to the reference position after replacing the battery.

See Section 7.1.3 for details of connecting the battery to separate absolute pulse coders. The battery for the built–in absolute pulse coder is installed in the servo amplifier. For an explanation of the replacement procedure, refer to the FANUC SERVO MOTOR  $\alpha$  Series Maintenance Manual.

### **Replacing batteries**

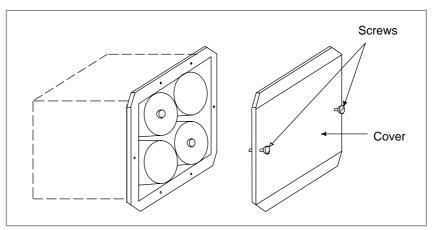
Obtain four commercially available alkaline batteries (size D).

(1) Turn on the power to the machine (*i* Series CNC).

(2) Loosen the screws of the battery case, and remove the cover.

(3) Replace the dry batteries in the case.

Note the polarity of the batteries as shown in the figure below (orient two batteries one way and the other two in the opposite direction).



(4) After installing the new batteries, replace the cover.

(5) Turn off the power to the machine (*i* Series CNC).

### WARNING

If the batteries are installed incorrectly, an explosion may occur. Never use batteries other than the specified type (Size D alkaline batteries).

### CAUTION

Replace batteries while the power to the *i* Series CNC is on. Note that, if batteries are replaced while no power is supplied to the CNC, the recorded absolute position is lost.

# 1.5 BATTERY FOR ABSOLUTE PULSE CODER BUILT INTO THE MOTOR (6 VDC)

The battery for the absolute pulse coder built into the motor is installed in the servo amplifier. For how to connect and replace the battery, refer to the following manuals:

- FANUC SERVO MOTOR α Series Maintenance Manual
- FANUC SERVO MOTOR β Series Maintenance Manual
- FANUC SERVO MOTOR β Series (I/O Link Option) Maintenance Manual

# APPENDIX

# A TAPE CODE LIST

|           | 15 | SO | co | de         |   |   |   |   |   |           | E | IA | coc | le |   |   |            |   |   | Remarl    | ٢S   |               |
|-----------|----|----|----|------------|---|---|---|---|---|-----------|---|----|-----|----|---|---|------------|---|---|-----------|------|---------------|
| Character | 8  | 7  | 6  | 5          | 4 |   | 3 | 2 | 1 | Character | 8 | 7  | 6   | 5  | 4 |   | 3          | 2 | 1 |           |      | stom<br>cro B |
|           |    |    |    |            |   |   |   |   |   |           |   |    |     |    |   |   |            |   |   |           | used | Used          |
| 0         |    |    | 0  | 0          |   | 0 |   |   |   | 0         |   |    | 0   |    |   | 0 |            |   |   | Number 0  |      |               |
| 1         | 0  |    | 0  | 0          |   | 0 |   |   | 0 | 1         |   |    |     |    |   | 0 |            |   | 0 | Number 1  |      |               |
| 2         | 0  |    | 0  | 0          |   | 0 |   | 0 |   | 2         |   |    |     |    |   | 0 |            | 0 |   | Number 2  |      |               |
| 3         |    |    | 0  | 0          |   | 0 |   | 0 | 0 | 3         |   |    |     | 0  |   | 0 |            | 0 | 0 | Number 3  |      |               |
| 4         | 0  |    | 0  | 0          |   | 0 | 0 |   |   | 4         |   |    |     |    |   | 0 | 0          |   |   | Number 4  |      |               |
| 5         |    |    | 0  | 0          |   | 0 | 0 |   | 0 | 5         |   |    |     | 0  |   | 0 | 0          |   | 0 | Number 5  |      |               |
| 6         |    |    | 0  | 0          |   | 0 | 0 | 0 |   | 6         |   |    |     | 0  |   | 0 | 0          | 0 |   | Number 6  |      |               |
| 7         | 0  |    | 0  | $\bigcirc$ |   | 0 | 0 | 0 | 0 | 7         |   |    |     |    |   | 0 | $\bigcirc$ | 0 | 0 | Number 7  |      |               |
| 8         | 0  |    | 0  | 0          | 0 | 0 |   |   |   | 8         |   |    |     |    | 0 | 0 |            |   |   | Number 8  |      |               |
| 9         |    |    | 0  | 0          | 0 | 0 |   |   | 0 | 9         |   |    |     | 0  | 0 | 0 |            |   | 0 | Number 9  |      |               |
| А         |    | 0  |    |            |   | 0 |   |   | 0 | а         |   | 0  | 0   |    |   | 0 |            |   | 0 | Address A |      |               |
| В         |    | 0  |    |            |   | 0 |   | 0 |   | b         |   | 0  | 0   |    |   | 0 |            | 0 |   | Address B |      |               |
| С         | 0  | 0  |    |            |   | 0 |   | 0 | 0 | С         |   | 0  | 0   | 0  |   | 0 |            | 0 | 0 | Address C |      |               |
| D         |    | 0  |    |            |   | 0 | 0 |   |   | d         |   | 0  | 0   |    |   | 0 | 0          |   |   | Address D |      |               |
| E         | 0  | 0  |    |            |   | 0 | 0 |   | 0 | е         |   | 0  | 0   | 0  |   | 0 | 0          |   | 0 | Address E |      |               |
| F         | 0  | 0  |    |            |   | 0 | 0 | 0 |   | f         |   | 0  | 0   | 0  |   | 0 | 0          | 0 |   | Address F |      |               |
| G         |    | 0  |    |            |   | 0 | 0 | 0 | 0 | g         |   | 0  | 0   |    |   | 0 | 0          | 0 | 0 | Address G |      |               |
| Н         |    | 0  |    |            | 0 | 0 |   |   |   | h         |   | 0  | 0   |    | 0 | 0 |            |   |   | Address H |      |               |
| I         | 0  | 0  |    |            | 0 | 0 |   |   | 0 | i         |   | 0  | 0   | 0  | 0 | 0 |            |   | 0 | Address I |      |               |
| J         | 0  | 0  |    |            | 0 | 0 |   | 0 |   | j         |   | 0  |     | 0  |   | 0 |            | 0 | 0 | Address J |      |               |
| K         |    | 0  |    |            | 0 | 0 |   | 0 | 0 | k         |   | 0  |     | 0  |   | 0 |            | 0 |   | Address K |      |               |
| L         | 0  | 0  |    |            | 0 | 0 | 0 |   |   | I         |   | 0  |     |    |   | 0 |            | 0 | 0 | Address L |      |               |
| М         |    | 0  |    |            | 0 | 0 | 0 |   | 0 | m         |   | 0  |     | 0  |   | 0 | 0          |   |   | Address M |      |               |
| N         |    | 0  |    | 1          | 0 | 0 | 0 | 0 |   | n         |   | 0  |     |    |   | 0 | 0          |   | 0 | Address N |      |               |
| 0         | 0  | 0  |    | 1          | 0 | 0 | 0 | 0 | 0 | 0         |   | 0  |     |    |   | 0 | 0          | 0 |   | Address O |      |               |
| Р         |    | 0  |    | 0          |   | 0 |   |   |   | р         |   | 0  |     | 0  |   | 0 | 0          | 0 | 0 | Address P |      |               |
| Q         | 0  | 0  |    | 0          |   | 0 |   |   | 0 | q         |   | 0  |     | 0  | 0 | 0 |            |   |   | Address Q |      |               |
| R         | 0  | 0  |    | 0          |   | 0 |   | 0 |   | r         |   | 0  |     |    | 0 | 0 |            |   | 0 | Address R |      |               |
| S         |    | 0  |    | 0          |   | 0 |   | 0 | 0 | S         |   |    | 0   | 0  |   | 0 |            | 0 |   | Address S |      |               |
| Т         | 0  | 0  |    | 0          |   | 0 | 0 |   |   | t         |   |    | 0   |    |   | 0 |            | 0 | 0 | Address T |      |               |
| U         |    | 0  |    | 0          | 1 | 0 | 0 |   | 0 | u         |   |    | 0   | 0  |   | 0 | 0          |   |   | Address U |      |               |
| V         |    | 0  |    | 0          |   | 0 | 0 | 0 |   | v         |   |    | 0   |    |   | 0 | 0          |   | 0 | Address V |      |               |
| W         | 0  | 0  |    | 0          |   | 0 | 0 | 0 | 0 | W         |   |    | 0   |    |   | 0 | 0          | 0 |   | Address W |      |               |
| Х         | 0  | 0  |    | 0          | 0 | 0 |   | 1 |   | х         |   |    | 0   | 0  |   | 0 | 0          | 0 | 0 | Address X |      |               |
| Y         |    | 0  |    | 0          | 0 | 0 | 1 | 1 | 0 | у         |   |    | 0   | 0  | 0 | 0 |            |   |   | Address Y |      |               |
| Z         |    | 0  |    | 0          | 0 | 0 |   | 0 |   | Z         |   |    | 0   |    | 0 | 0 |            |   | 0 | Address Z |      |               |

### A. TAPE CODE LIST

|           | I | S | Эc | ode | e |   |   |   |   |   |                        | E | IA | CO | de |   |   |   |   |   | Т      | Remarks   |   |                      |
|-----------|---|---|----|-----|---|---|---|---|---|---|------------------------|---|----|----|----|---|---|---|---|---|--------|---|---|----------------------|
| Character | 8 | 7 | 6  | 5   | 4 |   |   | 3 | 2 | 1 | Character              | 8 | 7  | 6  | 5  | 4 |   | 3 | 2 | 1 |        |   |   | tom<br>tro B<br>Used |
| DEL       | 0 | С | C  | С   | C |   | ) | 0 | 0 | 0 | Del                    |   | 0  | 0  | 0  | 0 | 0 | 0 | 0 | 0 |        | Delete<br>(deleting a mispunch)   | × | ×                    |
| NUL       |   |   |    |     |   | C | > |   |   |   | Blank                  |   |    |    |    |   | 0 |   |   |   | r<br>r | No punch. With EIA<br>code, this code can-<br>not be used in a sig-<br>nificant information<br>section. | × | ×                    |
| BS        | 0 |   |    |     | С |   | ) |   |   |   | BS                     |   |    | 0  |    | 0 | 0 |   | 0 |   | E      | Backspace   | × | ×                    |
| HT        |   |   |    |     | С |   | ) |   |   | 0 | Tab                    |   |    | 0  | 0  | 0 | 0 | 0 | 0 |   | ٦      | Tabulator   | × | ×                    |
| LF or NL  |   |   |    |     | С |   | ) |   | 0 |   | CR or EOB              | 0 |    |    |    |   | 0 |   |   |   | E      | End of block  |   |                      |
| CR        | 0 |   |    |     | С |   | ) | 0 |   | 0 |                        |   |    |    |    |   |   |   |   |   | 0      | Carriage return   | × | ×                    |
| SP        | 0 |   | С  |     |   | C | ) |   |   |   | SP                     |   |    |    | 0  |   | 0 |   |   |   | 3      | Space   |   |                      |
| %         | 0 |   | С  |     |   | C | ) | 0 |   | 0 | ER                     |   |    |    |    | 0 | 0 |   | 0 | 0 | 1      | Absolute rewind stop  |   |                      |
| (         |   |   | С  |     | С |   | ) |   |   |   | (2–4–5)                |   |    |    | 0  | 0 | 0 |   | 0 |   |        | Control out<br>(start of comment)   |   |                      |
| )         | 0 |   | С  |     | С |   | ) |   |   | 0 | (2–4–7)                |   | 0  |    |    | 0 | 0 |   | 0 |   |        | Control in<br>(end of comment)  |   |                      |
| +         |   |   | С  |     | С |   | ) |   | 0 | 0 | +                      |   | 0  | 0  | 0  |   | 0 |   |   |   | F      | Plus sign   | Δ |                      |
| _         |   |   | С  |     | C |   | ) | 0 |   | 0 | -                      |   | 0  |    |    |   | 0 |   |   |   | ſ      | Minus sign  |   |                      |
| :         |   |   | С  | C   | C |   | ) |   | 0 |   |                        |   |    |    |    |   |   |   |   |   | 0      | Colon (address O)   |   |                      |
| /         | 0 |   | С  |     | С |   | ) | 0 | 0 | 0 | /                      |   |    | 0  | 0  |   | 0 |   |   | 0 |        | Optional block skip   |   |                      |
|           |   |   | С  |     | C |   | ) | 0 | 0 |   |                        |   | 0  | 0  |    | 0 | 0 |   | 0 | 0 | F      | Period (decimal point)  |   |                      |
| #         | 0 |   | С  | '   |   | C | ) |   | 0 | 0 | Parameter<br>(No.6012) |   |    |    |    |   |   |   |   |   | 5      | Sharp   |   |                      |
| \$        |   |   | С  |     |   | C | ) | 0 |   |   |                        |   |    |    |    |   |   |   |   |   |        | Dollar sign   | × | ×                    |
| &         | 0 |   | С  |     |   | 0 | ) | 0 | 0 |   | &                      |   |    |    |    | 0 | 0 | 0 | 0 |   | 1      | Ampersand   | Δ | 0                    |
| ,         |   |   | С  |     |   | C | > | 0 | 0 | 0 |                        |   |    |    |    |   |   |   |   |   | ļ      | Apostrophe  | Δ | Δ                    |
| *         | 0 |   | С  |     | С |   | ) |   | 0 |   | Parameter<br>(No.6010) |   |    |    |    |   |   |   |   |   | ļ      | Asterisk  | Δ |                      |
| ,         | 0 |   | С  |     | С |   | ) | 0 |   |   | ,                      |   |    | 0  | 0  | 0 | 0 |   | 0 | 0 |        | Comma   |   |                      |
| ;         | 0 |   | С  | C   | C |   | > |   | 0 | 0 |                        |   |    |    |    |   |   |   |   |   | 3      | Semicolon   | × | ×                    |
| <         |   |   | С  | C   | C |   | ) | 0 |   |   |                        |   |    |    |    |   |   |   |   |   | L      | Left angle bracket  | Δ | Δ                    |
| =         | 0 |   | С  | С   | C |   | ) | 0 |   | 0 | Parameter<br>(No.6011) |   |    |    |    |   |   |   |   |   | E      | Equal sign  | Δ |                      |
| >         | O |   | C  | C   | C |   | > | 0 | 0 |   |                        |   |    |    |    |   |   |   |   |   | F      | Right angle bracket   | Δ | Δ                    |
| ?         |   |   | С  | C   | C |   | > | 0 | 0 | 0 |                        |   |    |    |    |   |   |   |   |   | 0      | Question mark   | Δ | 0                    |
| @         | O | C | )  |     |   | 0 | > |   |   |   |                        |   |    |    |    |   |   |   |   |   | 0      | Commercial at mark  | Δ | 0                    |
| "         |   |   | С  |     |   | 1 |   |   | 0 |   |                        |   |    |    |    |   |   |   |   |   | 0      | Quotation mark  | Δ | Δ                    |
| [         | 0 | С | )  | С   | C |   | > |   | 0 | 0 | Parameter<br>(No.6013) |   |    |    |    |   |   |   |   |   | L      | Left square bracket   | Δ |                      |
| ]         | 0 | С | )  | С   | C |   |   | 0 |   | 0 | Parameter<br>(No.6014) |   |    |    |    |   |   |   |   |   | F      | Right square bracket  | Δ |                      |

### NOTE

1 The symbols used in the remark column have the following meanings.

- (Space) : The character will be registered in memory and has a specific meaning.
  - If it is used incorrectly in a statement other than a comment, an alarm occurs.
- $\times$  : The character will not be registered in memory, but will be ignored.
- $\Delta$  : The character will be registered in memmory, but will be ignored during program execution.
- $\bigcirc$ : The character will be registered in memory. If it is used in a statement other than a comment, an alarm occurs.
- □ : If it is used in a statement other than a comment, the character will not be registered in memory. If it is used in a comment, it will be registered in memory.
- 2 Codes not in this table are ignored if their parity is correct.
- 3 Codes with incorrect parity cause the TH alarm. But they are ignored without generating the TH alarm when they are in the comment section.
- 4 A character with all eight holes punched is ignored and does not generate TH alarm in EIA code.

# B LIST OF FUNCTIONS AND TAPE FORMAT

Some functions cannot be added as options depending on the model. In the tables below,  $\mathbb{P}$  \_:presents a combination of arbitrary axis addresses using X and Z.

x = 1st basic axis (X usually)

z = 2nd basic axis (Z usually)

|  |  | (1/3)   |
|--|--|---|
| Functions                                      | Illustration   | Tape format   |
| Positioning (G00)                              | Start point  | G00 IP_;  |
| Linear interpolation (G01)                     | Start point  | G01 IP_ F_;   |
| Circular interpolation<br>(G02, G03)           | Start point<br>R J G02<br>(x, y)<br>(x, y)<br>G03<br>Start<br>point<br>J | $ \left\{ \begin{matrix} G02\\G03 \end{matrix} \right\} X_{-} Z_{-} \left\{ \begin{matrix} R_{-}\\I_{-} K_{-} \end{matrix} \right\} F_{-}; $        |
| Dwell (G04)                                    |  | $G04 \left\{ egin{array}{c} X_{-} \ P_{-} \end{array}  ight\} ;$  |
| Change of offsetvalue by program(G10)          |  | Tool geometry offset value<br>G10 P_X_Z_R_Q_;<br>P=1000+Geometry offset number<br>Tool wear offset value<br>G10 P_X_Z_R_Q_;<br>P=Wear offset number |
| Inch/metric conversion<br>(G20, G21)           |  | Inch input : G20<br>Metric input : G21  |
| Spindle speed fluctuation detection (G25, G26) |  | G25 ;<br>G26 P_ Q_ R_ ;   |

| Functions   | Illustration   | Tape format   |
|---|--|---|
| Reference position return check (G27)   | Start position   | G27 ₽_;   |
| Reference position return<br>(G28)<br>2nd, reference position re-<br>turn (G30) | Reference position (G28)   | G28 ₽_;<br>G30 ₽_;  |
| Cutter compensation<br>(G40, G41, G42)  | G40<br>Tool<br>G41<br>G42  | $ \left\{ \begin{array}{c} G41 \\ G42 \end{array} \right\} P_{-}; $<br>P : Tool offset number<br>G40 : Cancel |
| Skip fubction (G31)   | Skip<br>Start signal   | G31 IP_F_;  |
| Thread cutting (G32)  | → <sup>F</sup> →   | Equal lead thread cutting G32 IP_ F_;   |
| Automatic tool compensation<br>(G36, G37)                                       | Measurementt<br>position<br>Measurementt<br>position arrival<br>signal<br>Start<br>position<br>Compensation<br>value | G36 X <u>xa</u> ;<br>G37 Z <u>za</u> ;  |
| Coordinate system setting<br>Spindle speed setting<br>(G50)                     | X Z  | G50 X_Z_ ;<br>Coordinate system setting<br>G50 S_ ; Spindle speed setting                                     |
| Mirror image for double<br>turret (G68, G69)                                    |  | G68 ;<br>Mirror image for double turret on<br>G69 ; Mirror image cancel                                       |

(2/3)

# B. LIST OF FUNCTIONS AND TAPE FORMAT

| Functions  | Illustration   | Tape format   |
|--|--|---|
| Feed per minute (G98)<br>Feed per revolution (G99) | mm/min inch/min<br>mm/rev inch/rev                   | G98 F_ ;<br>G99 F_ ;  |
| Constant surface speed<br>control (G96/G97)        | m/min or feet/min                                    | G96 S_ ;<br>G97 ; Cancel  |
| Chamfering, Corner R                               |  | $ \begin{array}{c} X_{-}; \left\{ \begin{array}{c} C \pm k \\ R_{-} \end{array} \right\} \ P_{-}; \\ \\ Z_{-}; \left\{ \begin{array}{c} C \pm i \\ R_{-} \end{array} \right\} \ P_{-}; \end{array} $  |
| Canned cycle<br>(G71 to G76)<br>(G90, G92, G94)    | Refer to II.13. FUNCTIONS TO<br>SIMPLIFY PROGRAMMING | $\begin{array}{c} N_{-} G70 \ P_{-} Q_{-}; \\ G71 \ U_{-} R_{-}; \\ G71 \ P_{-} Q_{-} U_{-} W_{-} F_{-} S_{-} T_{-}; \\ G72 \ W_{-} R_{-}; \\ G72 \ P_{-} Q_{-} U_{-} W_{-} F_{-} S_{-} T_{-}; \\ G73 \ U_{-} W_{-} R_{-}; \\ G73 \ P_{-} Q_{-} U_{-} W_{-} F_{-} S_{-} T_{-}; \\ G74 \ R_{-}; \\ G74 \ R_{-}; \\ G74 \ X(u)_{-} Z(w)_{-} P_{-} Q_{-} R_{-} F_{-}; \\ G75 \ R_{-}; \\ G76 \ P_{-} Q_{-} R_{-}; \\ G76 \ P_{-} Q_{-} R_{-}; \\ G76 \ X(u)_{-} Z(w)_{-} P_{-} Q_{-} R_{-} F_{-}; \\ \begin{cases} G90 \\ G92 \\ \end{cases} \ X_{-} Z_{-} I_{-} F_{-}; \\ G94 \ X_{-} Z_{-} K_{-} F_{-}; \end{cases}$ |



### Linear axis

• In case of millimeter input, feed screw is millimeter

|                                | Incremen   | nt system  |
|--------------------------------|--|--|
|                                | IS–B   | IS–C   |
| Least input increment          | 0.001 mm   | 0.0001 mm  |
| Least command increment        | X : 0.0005 mm<br>Y : 0.001 mm  | X : 0.00005 mm<br>Y : 0.0001 mm  |
| Max. programmable<br>dimension | ±99999.999 mm  | ±9999.9999 mm  |
| Max. rapid traverse *1         | 240000 mm/min  | 100000 mm/min  |
| Feedrate range *1              | Feed per minute :<br>1 to 240000 mm/min<br>Feed per revolution<br>0.0001 to 500.0000<br>mm/rev | Feed per minute :<br>1 to 100000 mm/min<br>Feed per revolution<br>0.0001 to 500.0000<br>mm/rev |
| Incremental feed               | 0.001, 0.01, 0.1, 1mm/step   | 0.0001, 0.001, 0.01, 0.1<br>mm/step  |
| Tool compensation              | 0 to ±999.999 mm   | 0 to ±999.9999 mm  |
| Backlash compensation          | 0 to ±0.255 mm   | 0 to ±0.255 mm   |
| Dwell time                     | 0 to 99999.999 sec   | 0 to 99999.999 sec   |

### In case of inch input, feed screw is millimeter

|                                | Incremer  | nt system   |
|--------------------------------|---|---|
|                                | IS–B  | IS–C  |
| Least input increment          | 0.0001 inch   | 0.00001 inch  |
| Least command increment        | X : 0.00005 inch<br>Y : 0.0001 inch   | X : 0.000005 inch<br>Y : 0.00001 inch   |
| Max. programmable<br>dimension | ±9999.9999 inch   | ±393.70078 inch   |
| Max. rapid traverse *1         | 240000 mm/min   | 100000 mm/min   |
| Feedrate range *1              | Feed per minute :<br>0.01 to 9600 inch/min<br>Feed per revolution<br>0.000001 to 9.999999<br>inch/rev | Feed per minute :<br>0.01 to 4000 inch/min<br>Feed per revolution<br>0.000001 to 9.999999<br>inch/rev |
| Incremental feed               | 0.0001, 0.001, 0.01, 0.1<br>inch/step   | 0.00001, 0.0001, 0.001,<br>0.01 inch/step   |
| Tool compensation              | 0 to ±99.9999 inch  | 0 to ±99.9999 inch  |
| Backlash compensation          | 0 to ±0.255 mm  | 0 to ±0.255 mm  |
| Dwell time                     | 0 to 99999.999 sec  | 0 to 9999.9999 sec  |

### In case of inch input, feed screw is inch

|                             | Increment system   |  |
|-----------------------------|--|--|
|                             | IS–B   | IS-C   |
| Least input increment       | 0.0001 inch  | 0.00001 inch   |
| Least command increment     | X : 0.00005 inch<br>Y : 0.0001 inch  | X : 0.000005 inch<br>Y : 0.00001 inch  |
| Max. programmable dimension | ±9999.9999 inch  | ±999.99999 inch  |
| Max. rapid traverse *1      | 9600 inch/min  | 4000 inch/min  |
| Feedrate range *1           | Feed per minute :<br>0.01 to 9600 inch/min<br>Feed per revolution<br>0.000001 to 9.9999999<br>inch/rev | Feed per minute :<br>0.01 to 4000 inch/min<br>Feed per revolution<br>0.000001 to 9.9999999<br>inch/rev |
| Incremental feed            | 0.0001, 0.001, 0.01, 0.1<br>inch/step  | 0.00001, 0.0001, 0.001,<br>0.01 inch/step  |
| Tool compensation           | 0 to ±99.9999 inch   | 0 to ±99.9999 inch   |
| Backlash compensation       | 0 to ±0.0255 inch  | 0 to ±0.0255 inch  |
| Dwell time                  | 0 to 99999.999 sec   | 0 to 9999.9999 sec   |

# • In case of millimeter input, feed screw is inch

|                                | Increment system   |  |
|--------------------------------|--|--|
|                                | IS–B   | IS–C   |
| Least input increment          | 0.001 mm   | 0.0001 mm  |
| Least command increment        | X : 0.00005 inch<br>Y : 0.0001 inch  | X : 0.000005 inch<br>Y : 0.00001 inch  |
| Max. programmable<br>dimension | ±99999.999 mm  | ±9999.9999 mm  |
| Max. rapid traverse *1         | 9600 inch/min  | 960 inch/min   |
| Feedrate range *1              | Feed per minute :<br>1 to 240000 mm/min<br>Feed per revolution<br>0.0001 to 500.0000<br>mm/rev | Feed per minute :<br>1 to 100000 mm/min<br>Feed per revolution<br>0.0001 to 500.0000<br>mm/rev |
| Incremental feed               | 0.001, 0.01, 0.1, 1mm/step   | 0.0001, 0.001, 0.01, 0.1<br>mm/step  |
| Tool compensation              | 0 to ±999.999 mm   | 0 to ±999.9999 mm  |
| Backlash compensation          | 0 to ±0.0255 inch  | 0 to ±0.0255 inch  |
| Dwell time                     | 0 to 99999.999 sec   | 0 to 9999.9999 sec   |

### **Rotation axis**

|                             | Increment system            |                                      |
|-----------------------------|-----------------------------|--------------------------------------|
|                             | IS–B                        | IS–C                                 |
| Least input increment       | 0.001 deg                   | 0.0001 deg                           |
| Least command increment     | ±0.001 deg                  | ±0.0001 deg                          |
| Max. programmable dimension | ±99999.999 deg              | ±9999.9999 deg                       |
| Max. rapid traverse *1      | 240000 deg/min              | 100000 deg/min                       |
| Feedrate range *1           | 1 to 240000 deg/min         | 1 to 100000 deg/min                  |
| Incremental feed            | 0.001, 0.01, 0.1, 1deg/step | 0.0001, 0.001, 0.01, 0.1<br>deg/step |
| Tool compensation           | 0 to ±999.999 mm            | 0 to ±999.9999 mm                    |
| Backlash compensation       | 0 to ±0.255 deg             | 0 to ±0.255 deg                      |

### NOTE

\*1 The feedrate range shown above are limitations depending on CNC interpolation capacity.

As a whole system, limitations depending on servo system must also be considered.

# NOMOGRAPHS

## D.1 INCORRECT THREADED LENGTH

The leads of a thread are generally incorrect in  $\delta_1$  and  $\delta_2$ , as shown in Fig. D.1 (a), due to automatic acceleration and deceleration.

Thus distance allowances must be made to the extent of  $\delta_1$  and  $\delta_2$  in the program.

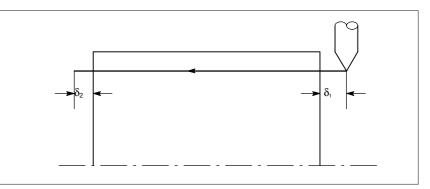


Fig. D.1 (a) Incorrect thread position

### **Explanations**

• How to determine  $\delta_2$ 

$$\begin{split} \delta_2 &= T_1 V \ (\text{mm}) \ \dots \dots \ (1) \\ V &= \frac{1}{60} RL \\ T_1 &: \text{ Time constant of servo system (sec)} \\ V &: \text{ Cutting speed (mm/sec)} \\ R &: \text{ Spindle speed (rpm)} \\ L &: \text{ Thread feed (mm)} \end{split} \qquad \begin{array}{l} \text{Time constant } T_1 \ (\text{sec) of the servo system: Usually} \\ 0.033 \ \text{s.} \end{split}$$

### • How to determine $\delta_1$

$$\begin{split} \delta_1 &= \{t - T_1 + T_1 \exp(-\frac{t}{T_1})\} V \qquad \dots \dots \qquad (2) \\ a &= \exp(-\frac{t}{T_1}) \qquad \dots \dots \qquad (3) \\ T_1 &: \text{ Time constant of servo system (sec)} \\ V: \text{ Cutting speed (mm/sec)} \qquad \qquad \begin{array}{c} \text{Time constant } T_1 \text{ (sec) of the servo system: Usually} \\ 0.033 \text{ s.} \end{array}$$

The lead at the beginning of thread cutting is shorter than the specified lead L, and the allowable lead error is  $\Delta L$ . Then as follows.

$$a = \frac{\Delta L}{L}$$

When the value of H $\alpha$ I is determined, the time lapse until the thread accuracy is attained. The time HtI is substituted in (2) to determine  $\delta_1$ : Constants V and T<sub>1</sub> are determined in the same way as for  $\delta_2$ . Since the calculation of  $\delta_1$  is rather complex, a nomography is provided on the following pages.

#### • How to use nomograph

First specify the class and the lead of a thread. The thread accuracy,  $\alpha$ , will be obtained at (1), and depending on the time constant of cutting feed acceleration/ deceleration, the  $\delta_1$  value when V = 10mm / s will be obtained at (2). Then, depending on the speed of thread cutting,  $\delta_1$  for speed other than 10mm/ s can be obtained at (3).

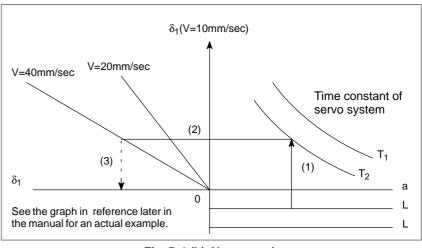


Fig. D.1 (b) Nomograph

**NOTE** The equations for  $\delta_1$ , and  $\delta_2$  are for when the acceleration/deceleration time constant for cutting feed is 0.

# D.2 SIMPLE CALCULATION OF INCORRECT THREAD LENGTH

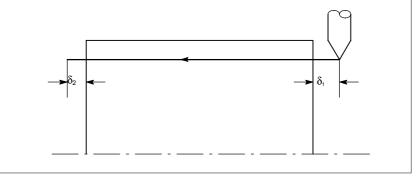


Fig. D.2 Incorrect threaded portion

## Explanations

• How to determine  $\delta_{\textbf{2}}$ 

$$\begin{split} \delta_2 &= \frac{LR}{1800 *} \text{ (mm)} \\ \text{R: Spindle speed (rpm)} \\ \text{L: Thread lead (mm)} \end{split} * When time constant T of the servo system is 0.033 s. \end{split}$$

### • How to determine $\delta_1$

$$\begin{split} \delta_1 &= \frac{LR}{1800*}(-1-lna) \quad (mm) \\ &= \delta_2(-1-lna) \quad (mm) \\ R: \text{ Spindle speed (rpm)} & * \text{ When time constant T of the servo system is 0.033 s.} \\ \text{Following a is a permitted value of thread.} \\ \hline \hline \begin{array}{c} a & -1-lna \\ \hline 0.005 & 4.298 \\ \hline 0.01 & 3.605 \\ \hline \end{array} \end{split}$$

| Exam  | nloc |
|-------|------|
| сханн | pies |

| R=350rpm  |
|---|
| L=1mm   |
| a=0.01 then   |
| $\delta_2 = \frac{350 \times 1}{1800} = 0.194 \text{ (mm)}$ |
| $\delta_1 = \delta_2 \times 3.605 = 0.701$ (mm)             |

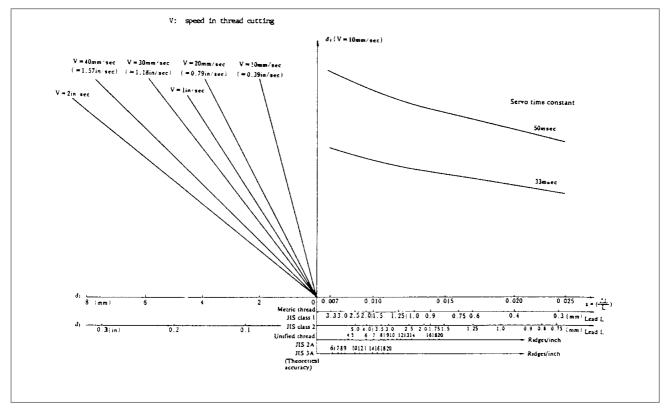
0.015

0.02

3.200

2.912

### • Reference



Nomograph for obtaining approach distance  $\delta_1$ 

## D.3 TOOL PATH AT CORNER

When servo system delay (by exponential acceleration/deceleration at cutting or caused by the positioning system when a servo motor is used) is accompanied by cornering, a slight deviation is produced between the tool path (tool center path) and the programmed path as shown in Fig. D.3 (a).

Time constant  $T_1$  of the exponential acceleration/deceleration is fixed to 0.

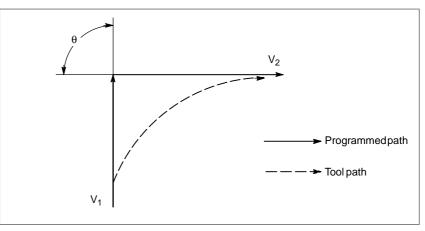


Fig. D.3 (a) Slight deviation between the tool path and the programmed path

This tool path is determined by the following parameters:

- $\cdot$  Feedrate (V<sub>1</sub>, V<sub>2</sub>)
- $\cdot \text{ Corner angle } (\theta)$
- $\cdot$  Exponential acceleration / deceleration time constant (T<sub>1</sub>) at cutting (T<sub>1</sub> = 0)
- · Presence or absence of buffer register.

The above parameters are used to theoretically analyze the tool path and above tool path is drawn with the parameter which is set as an example. When actually programming, the above items must be considered and programming must be performed carefully so that the shape of the workpiece is within the desired precision.

In other words, when the shape of the workpiece is not within the theoretical precision, the commands of the next block must not be read until the specified feedrate becomes zero. The dwell function is then used to stop the machine for the appropriate period.

### Analysis

The tool path shown in Fig. D.3 (b) is analyzed based on the following conditions:

Feedrate is constant at both blocks before and after cornering. The controller has a buffer register. (The error differs with the reading speed of the tape reader, number of characters of the next block, etc.)

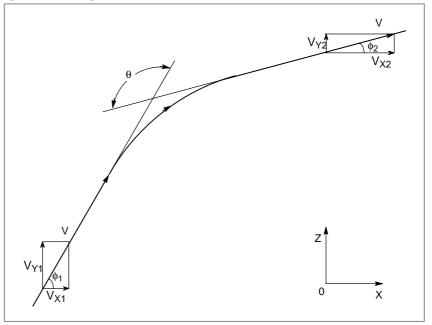
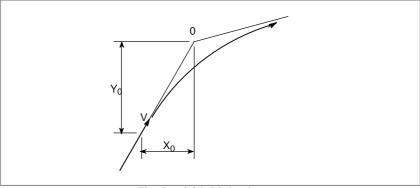


Fig. D.3 (b) Example of tool path

• Description of conditions and symbols

| $V_{X1} = V \cos \phi_1$  |
|---|
| $V_{Y1} = V \sin \phi_1$  |
| $V_{X2} = V\cos\phi_2$  |
| $V_{Y2} = V \sin \phi_2$  |
| <ul> <li>V: Feedrate at both blocks before and after cornering</li> <li>V<sub>X1</sub>: X-axis component of feedrate of preceding block</li> <li>V<sub>Y1</sub>: Y-axis component of feedrate of preceding block</li> <li>V<sub>X2</sub>: X-axis component of feedrate of following block</li> <li>V<sub>Y2</sub>: Y-axis component of feedrate of following block</li> <li>0: Corner angle</li> <li>\$\phi_1\$: Angle formed by specified path direction of preceding block and X-axis</li> <li>\$\phi_2\$: Angle formed by specified path direction of following block</li> </ul> |

#### • Initial value calculation



### Fig. D.3 (c) Initial value

The initial value when cornering begins, that is, the X and Y coordinates at the end of command distribution by the controller, is determined by the feedrate and the positioning system time constant of the servo motor.

$$\begin{split} X_0 &= V_{X1}(T_1 + T_2) \\ Y_0 &= V_{Y1}(T_1 + T_2) \\ T_1: \text{Exponential acceleration / deceleration time constant. (T=0)} \\ T_2: \text{Time constant of positioning system (Inverse of position loop gain)} \end{split}$$

 Analysis of corner tool path The equations below represent the feedrate for the corner section in X-axis direction and Y-axis direction.

$$V_{X}(t) = (V_{X2} - V_{X1}) [1 - \frac{V_{X1}}{T_1 - T_2} \{T_1 \exp(-\frac{t}{T_1}) - T_2 \exp(-\frac{t}{T_2})\} + V_{X1}]$$
  
=  $V_{X2} [1 - \frac{V_{X1}}{T_1 - T_2} \{T_1 \exp(-\frac{t}{T_1}) - T_2 \exp(-\frac{t}{T_2})\}]$   
 $V_{Y}(t) = \frac{V_{Y1} - V_{Y2}}{T_1 - T_2} \{T_1 \exp(-\frac{t}{T_1}) - T_2 \exp(-\frac{t}{T_2})\} + V_{Y2}$ 

Therefore, the coordinates of the tool path at time *t* are calculated from the following equations:

$$X(t) = \int_{0}^{t} V_{X}(t)dt - X_{0}$$
  
=  $\frac{V_{X2} - V_{X1}}{T_{1} - T_{2}} (T_{1}^{2} \exp(-\frac{t}{T_{1}}) - T_{2}^{2} \exp(-\frac{t}{T_{2}})) - V_{X2}(T_{1} + T_{2} - t)$   
$$Y(t) = \int_{0}^{t} V_{Y}(t)dt - Y_{0}$$
  
=  $\frac{V_{Y2} - V_{Y1}}{T_{1} - T_{2}} (T_{1}^{2} \exp(-\frac{t}{T_{1}}) - T_{2}^{2} \exp(-\frac{t}{T_{2}})) - V_{Y2}(T_{1} + T_{2} - t)$ 

Х

#### D.4 RADIUS DIRECTION ERROR AT CIRCLE CUTTING

When a servo motor is used, the positioning system causes an error between input commands and output results. Since the tool advances along the specified segment, an error is not produced in linear interpolation. In circular interpolation, however, radial errors may be produced, specially for circular cutting at high speeds. This error can be obtained as follows:

⊿r

 $\Delta r = \frac{1}{2}(T_1^2 + T_2^2(1 - \alpha^2))\frac{V^2}{r} \dots \dots (1)$   $\Delta r : Maximum radius error (mm)$ v: Feedrate (mm/s) r: Circle radius (mm) T<sub>1</sub> : Exponential acceleration/deceleration time constant (sec) at cutting (T=0) T<sub>2</sub> : Time constant of positoning system (sec). (Inverse of positon loop gain) a : Feed forward coefficient (%) In the case of bell–shaped acceleration/deceleration and linear acceleration/ deceleration after cutting feed interpolation, an approximation of this radius

Linear acceleration/deceleration after cutting feed interpolation

$$\Delta r = \left(\frac{1}{24}T_1^2 + \frac{1}{2}T_2^2(1-\alpha^2)\right)\frac{V^2}{r}$$

error can be obtained with the following expression:

Bell-shaped acceleration/deceleration after cutting feed interpolation

$$\varDelta r = \left(\frac{1}{48}T_1^2 + \frac{1}{2}T_2^2(1-\alpha^2)\right)\frac{V^2}{r}$$

Thus, the radius error in the case of bell–shaped acceleration/deceleration and linear acceleration/deceleration after interpolation is smaller than in case of exponential acceleration/deceleration by a factor of 12, excluding any error caused by a servo loop time constant.

#### Fig. D.4 (a) Radius direction error of circular cutting

Since the machining radius r (mm) and allowable error $\Delta r$  (mm) of the workpiece is given in actual machining, the allowable limit feedrate v (mm /sec) is determined by equation (1).

Since the acceleration/deceleration time constant at cutting which is set by this equipment varies with the machine tool, refer to the manual issued by the machine tool builder.

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# Ε

## STATUS WHEN TURNING POWER ON, WHEN CLEAR AND WHEN RESET

Parameter 3402 (CLR) is used to select whether resetting the CNC places it in the cleared state or in the reset state (0: reset state/1: cleared state). The symbols in the tables below mean the following :

 $\bigcirc$ : The status is not changed or the movement is continued.

 $\times$ :The status is cancelled or the movement is interrupted.

|                 | Item                                  | When turning power on  | Cleared   | Reset   |
|-----------------|---------------------------------------|--|---|---|
| Setting<br>data | Offset value                          | 0  | 0   | 0   |
| uala            | Data set by the MDI setting operation | 0  | 0   | 0   |
|                 | Parameter                             | 0  | 0   | 0   |
| Various<br>data | Programs in memory                    | 0  | 0   | 0   |
| uala            | Contents in the buffer storage        | ×  | ×   | <ul><li>○ : MDI mode</li><li>× : Other mode</li></ul> |
|                 | Display of sequence number            | 0  | ○ (Note 1)  | ○ (Note 1)  |
|                 | One shot G code                       | ×  | ×   | ×   |
|                 | Modal G code                          | Initial G codes.<br>(The G20 and G21 codes re-<br>turn to the same state they<br>were in when the power was<br>last turned off.) | Initial G codes.<br>(G20/G21 are not<br>changed.) | 0   |
|                 | F                                     | Zero   | Zero  | 0   |
|                 | S, T, M                               | ×  | 0   | 0   |
|                 | K (Number of re-<br>peats)            | ×  | ×   | ×   |
| Work coo        | rdinate value                         | Zero   | 0   | 0   |

### E. STATUS WHEN TURNING POWER ON, WHEN CLEAR AND WHEN RESET

APPENDIX

B-63004EN/02

|                    | ltem  | When turning power on                         | Cleared                                       | Reset   |
|--------------------|---|---|---|---|
| Action in Movement |   | ×   | ×   | ×   |
| operation          | Dwell   | ×   | ×   | ×   |
|                    | Issuance of M, S and T codes                        | ×   | ×   | ×   |
|                    | Tool offset   | ×   | Depending on parame-<br>ter LVK(No.5003#6)    | ○ : MDI mode<br>Other modes depend on<br>parameter<br>LVK(No.5003#6). |
|                    | Tool nose radius compensation                       | ×   | ×   | <ul><li>○ : MDI mode</li><li>× : Other modes</li></ul>                |
|                    | Storing called sub-<br>program number               | ×   | × (Note 2)                                    | ○ : MDI mode<br>× : Other modes (Note 2)                              |
| Output<br>signals  | CNC alarm signal<br>AL                              | Extinguish if there is no cause for the alarm | Extinguish if there is no cause for the alarm | Extinguish if there is no cause for the alarm                         |
|                    | Reference position<br>return completion<br>LED      | ×   | ○ (× : Emergency stop)                        | ○ (× : Emergency stop)  |
|                    | S, T and B codes                                    | ×   | 0   | 0   |
|                    | M code  | ×   | ×   | ×   |
|                    | M, S and T strobe signals                           | ×   | ×   | ×   |
|                    | Spindle revolution<br>signal (S analog sig-<br>nal) | ×   | 0   | 0   |
|                    | CNC ready signal MA                                 | ON  | 0   | 0   |
|                    | Servo ready signal<br>SA                            | ON (When other than servo alarm)              | ON (When other than servo alarm)              | ON (When other than servo alarm)                                      |
|                    | Cycle start LED<br>(STL)                            | ×   | ×   | ×   |
|                    | Feed hold LED (SPL)                                 | ×   | ×   | ×   |

#### NOTE

- 1 When heading is performed, the main program number is displayed.
- 2 When a reset is performed during execution of a subprogram, control returns the main program. Execution cannot be started from the middle of the subprogram.

## F

### CHARACTER-TO-CODES CORRESPONDENCE TABLE

| Character | Code | Comment | Character | Code | Comment              |
|-----------|------|---------|-----------|------|----------------------|
| А         | 065  |         | 6         | 054  |                      |
| В         | 066  |         | 7         | 055  |                      |
| С         | 067  |         | 8         | 056  |                      |
| D         | 068  |         | 9         | 057  |                      |
| E         | 069  |         |           | 032  | Space                |
| F         | 070  |         | !         | 033  | Exclamation mark     |
| G         | 071  |         | "         | 034  | Quotation mark       |
| Н         | 072  |         | #         | 035  | Hash sign            |
| I         | 073  |         | \$        | 036  | Dollar sign          |
| J         | 074  |         | %         | 037  | Percent              |
| К         | 075  |         | &         | 038  | Ampersand            |
| L         | 076  |         | ,         | 039  | Apostrophe           |
| М         | 077  |         | (         | 040  | Leftparenthesis      |
| N         | 078  |         | )         | 041  | Rightparenthesis     |
| 0         | 079  |         | *         | 042  | Asterisk             |
| Р         | 080  |         | +         | 043  | Plus sign            |
| Q         | 081  |         | ,         | 044  | Comma                |
| R         | 082  |         | -         | 045  | Minus sign           |
| S         | 083  |         |           | 046  | Period               |
| Т         | 084  |         | /         | 047  | Slash                |
| U         | 085  |         | :         | 058  | Colon                |
| V         | 086  |         | ;         | 059  | Semicolon            |
| W         | 087  |         | <         | 060  | Left angle bracket   |
| Х         | 088  |         | =         | 061  | Equal sign           |
| Y         | 089  |         | >         | 062  | Right angle bracket  |
| Z         | 090  |         | ?         | 063  | Question mark        |
| 0         | 048  |         | @         | 064  | HAtl mark            |
| 1         | 049  |         | [         | 091  | Left square bracket  |
| 2         | 050  |         | ^         | 092  |                      |
| 3         | 051  |         | ¥         | 093  | Yen sign             |
| 4         | 052  |         | ]         | 094  | Right square bracket |
| 5         | 053  |         | _         | 095  | Underscore           |

# 

#### 1) Program errors (P/S alarm)

| Number | Message                         | Contents   |
|--------|---------------------------------|--|
| 000    | PLEASE TURN OFF POWER           | A parameter which requires the power off was input, turn off power.  |
| 001    | TH PARITY ALARM                 | TH alarm (A character with incorrect parity was input).<br>Correct the tape.   |
| 002    | TV PARITY ALARM                 | TV alarm (The number of characters in a block is odd). This alarm will be generated only when the TV check is effective.   |
| 003    | TOO MANY DIGITS                 | Data exceeding the maximum allowable number of digits was input.<br>(Refer to the item of max. programmable dimensions.)   |
| 004    | ADDRESS NOT FOUND               | A numeral or the sign " – " was input without an address at the beginning of a block. Modify the program .   |
| 005    | NO DATA AFTER ADDRESS           | The address was not followed by the appropriate data but was fol-<br>lowed by another address or EOB code. Modify the program.   |
| 006    | ILLEGAL USE OF NEGATIVE SIGN    | Sign " – " input error (Sign " – " was input after an address with which it cannot be used. Or two or more " – " signs were input.) Modify the program.  |
| 007    | ILLEGAL USE OF DECIMAL POINT    | Decimal point " . " input error (A decimal point was input after an ad-<br>dress with which it can not be used. Or two decimal points were in-<br>put.)<br>Modify the program.   |
| 009    | ILLEGAL ADDRESS INPUT           | Unusable character was input in significant area.<br>Modify the program.   |
| 010    | IMPROPER G-CODE                 | An unusable G code or G code corresponding to the function not pro-<br>vided is specified. Modify the program.   |
| 011    | NO FEEDRATE COMMANDED           | Feedrate was not commanded to a cutting feed or the feedrate was inadequate. Modify the program.   |
| 014    | ILLEGAL LEAD COMMAND            | In variable lead threading, the lead incremental and decremental out-<br>putted by address K exceed the maximum command value or a com-<br>mand such that the lead becomes a negative value is given.<br>Modify the program.   |
| 015    | TOO MANY AXES COMMANDED         | An attempt has been made to move the tool along more than the maxi-<br>mum number of simultaneously controlled axes. Alternatively, no axis<br>movement command or an axis movement command for two or more<br>axes has been specified in the block containing the command for skip<br>using the torque limit signal (G31 P99/98). The command must be ac-<br>companied with an axis movement command for a single axis, in the<br>same block. |
| 020    | OVER TOLERANCE OF RADIUS        | In circular interpolation (G02 or G03), difference of the distance be-<br>tween the start point and the center of an arc and that between the<br>end point and the center of the arc exceeded the value specified in<br>parameter No. 3410.  |
| 021    | ILLEGAL PLANE AXIS<br>COMMANDED | An axis not included in the selected plane (by using G17, G18, G19) was commanded in circular interpolation. Modify the program.   |
| 022    | CIRCULAR INTERPOLATION          | In circular interpolation, radius R, or the distance between the start point and the center of the arc, I, J, or K, has not been specified.  |

| Number | Message                              | Contents   |
|--------|--------------------------------------|--|
| 023    | ILLEGAL RADIUS COMMAND               | In circular interpolation by radius designation, negative value was commanded for address R. Modify the program.   |
| 028    | ILLEGAL PLANE SELECT                 | In the plane selection command, two or more axes in the same direc-<br>tion are commanded.<br>Modify the program.  |
| 029    | ILLEGAL OFFSET VALUE                 | The offset values specified by T code is too large.<br>Modify the program.   |
| 030    | ILLEGAL OFFSET NUMBER                | The offset number in T function specified for tool offset is too large.<br>Modify the program.   |
| 031    | ILLEGAL P COMMAND IN G10             | In setting an offset amount by G10, the offset number following ad-<br>dress P was excessive or it was not specified.<br>Modify the program.   |
| 032    | ILLEGAL OFFSET VALUE IN G10          | In setting an offset amount by G10 or in writing an offset amount by system variables, the offset amount was excessive.  |
| 033    | NO SOLUTION AT NRC                   | A point of intersection cannot be determined for tool nose radius com-<br>pensation. Modify the program.   |
| 034    | NO CIRC ALLOWED IN ST-UP<br>/EXT BLK | The start up or cancel was going to be performed in the G02 or G03 mode in tool nose radius compensation. Modify the program.  |
| 035    | CAN NOT COMMANDED G31                | Skip cutting (G31) was specified in tool nose radius compensation mode. Modify the program.  |
| 037    | CAN NOT CHANGE PLANE IN NRC          | The offset plane is switched in tool nose radius compensation.<br>Modify the program.  |
| 038    | INTERFERENCE IN CIRCULAR<br>BLOCK    | Overcutting will occur in tool nose radius compensation because the arc start point or end point coincides with the arc center.<br>Modify the program.   |
| 039    | CHF/CNR NOT ALLOWED IN NRC           | Chamfering or corner R was specified with a start–up, a cancel, or switching between G41 and G42 in tool nose radius compensation. The program may cause overcutting to occur in chamfering or corner R. Modify the program. |
| 040    | INTERFERENCE IN G90/G94<br>BLOCK     | Overcutting will occur in tool nose radius compensation in canned cycle G90 or G94. Modify the program.  |
| 041    | INTERFERENCE IN NRC                  | Overcutting will occur in tool nose radius compensation.<br>Modify the program.  |
| 046    | ILLEGAL REFERENCE RETURN<br>COMMAND  | Other than P2, P3 and P4 are commanded for 2nd, 3rd and 4th reference position return command.   |
| 050    | CHF/CNR NOT ALLOWED IN THRD<br>BLK   | Chamfering or corner R is commanded in the thread cutting block.<br>Modify the program.  |
| 051    | MISSING MOVE AFTER CHF/CNR           | Improper movement or the move distance was specified in the block<br>next to the chamfering or corner R block.<br>Modify the program.  |
| 052    | CODE IS NOT G01 AFTER<br>CHF/CNR     | The block next to the chamfering or corner R block is not G01.<br>Modify the program.  |
| 053    | TOO MANY ADDRESS<br>COMMANDS         | In the chamfering and corner R commands, two or more of I, K and R are specified. Otherwise, the character after a comma(",") is not C or R in direct drawing dimensions programming. Modify the program.                    |
| 054    | NO TAPER ALLOWED AFTER<br>CHF/CNR    | A block in which chamfering in the specified angle or the corner R was specified includes a taper command. Modify the program.   |
| 055    | MISSING MOVE VALUE IN<br>CHF/CNR     | In chamfering or corner R block, the move distance is less than chamfer or corner R amount.  |

| Number | Message                             | Contents  |
|--------|-------------------------------------|---|
| 056    | NO END POINT & ANGLE IN<br>CHF/CNR  | Neither the end point nor angle is specified in the command for the block next to that for which only the angle is specified (A). In the chamfering common, I(K) is commanded for the X(Z) axis.  |
| 057    | NO SOLUTION OF BLOCK END            | Block end point is not calculated correctly in direct dimension drawing programming.  |
| 058    | END POINT NOT FOUND                 | Block end point is not found in direct dimension drawing program-<br>ming.  |
| 059    | PROGRAM NUMBER NOT FOUND            | In an external program number search or external workpiece number<br>search, a specified program number was not found. Otherwise, a<br>program specified for searching is being edited in background pro-<br>cessing. Check the program number and external signal. Or discon-<br>tinue the background editing. |
| 060    | SEQUENCE NUMBER NOT FOUND           | Commanded sequence number was not found in the sequence number search. Check the sequence number.   |
| 061    | ADDRESS P/Q NOT FOUND IN<br>G70–G73 | Address P or Q is not specified in G70, G71, G72, or G73 command.<br>Modify the program.  |
| 062    | ILLEGAL COMMAND IN G71-G76          | 1 The depth of cut in G71 or G72 is zero or negative value.   |
|        |                                     | 2 The repetitive count in G73 is zero or negative value.  |
|        |                                     | 3 The negative value is specified to $\Delta i$ or $\Delta k$ is zero in G74 or G75.  |
|        |                                     | 4 A value other than zero is specified to address U or W, though ∆i or ∆k is zero in G74 or G75.  |
|        |                                     | 5 A negative value is specified to ∆d, though the relief direction in G74 or G75 is determined.   |
|        |                                     | 6 Zero or a negative value is specified to the height of thread or depth of cut of first time in G76.   |
|        |                                     | 7 The specified minimum depth of cut in G76 is greater than the height of thread.   |
|        |                                     | 8 An unusable angle of tool tip is specified in G76.  |
|        |                                     | Modify the program.   |
| 063    | SEQUENCE NUMBER NOT FOUND           | The sequence number specified by address P in G70, G71, G72, or G73 command cannot be searched. Modify the program.   |
| 064    | SHAPE PROGRAM NOT<br>MONOTONOUSLY   | A target shape which is not monotonous increase or decrease was specified in a repetitive canned cycle (G71 or G72).  |
| 065    | ILLEGAL COMMAND IN G71-G73          | 1 G00 or G01 is not commanded at the block with the sequence number which is specified by address P in G71, G72, or G73 command.  |
|        |                                     | 2 Address Z(W) or X(U) was commanded in the block with a se-<br>quence number which is specified by address P in G71 or G72,<br>respectively.   |
|        |                                     | Modify the program.   |
| 066    | IMPROPER G-CODE IN G71-G73          | An unallowable G code was commanded between two blocks speci-<br>fied by address P in G71, G72, or G73. Modify the program.   |
| 067    | CAN NOT OPERATE IN MDI MODE         | G70, G71, G72, or G73 command with address P and Q was speci-<br>fied.<br>Modify the program.   |
| 069    | FORMAT ERROR IN G70–G73             | The final move command in the blocks specified by P and Q of G70, G71, G72, or G73 ended with chamfering or corner R.   |
| 070    | NO PROGRAM SPACE IN MEMORY          | The memory area is insufficient.<br>Delete any unnecessary programs, then retry.  |
| 071    | DATA NOT FOUND                      | The address to be searched was not found. Or the program with spe-<br>cified program number was not found in program number search.<br>Check the data.  |

| Number | Message                               | Contents  |
|--------|---------------------------------------|---|
| 072    | TOO MANY PROGRAMS                     | The number of programs to be stored exceeded 63 (basic), 125 (option), 200 (option), 400 (option), or 1000 (option). Delete unnecessary programs and execute program registration again.  |
| 073    | PROGRAM NUMBER ALREADY IN<br>USE      | The commanded program number has already been used.<br>Change the program number or delete unnecessary programs and<br>execute program registration again.  |
| 074    | ILLEGAL PROGRAM NUMBER                | The program number is other than 1 to 9999.<br>Modify the program number.   |
| 075    | PROTECT                               | An attempt was made to register a program whose number was pro-<br>tected.  |
| 076    | ADDRESS P NOT DEFINED                 | Address P (program number) was not commanded in the block which includes an M98, G65, or G66 command. Modify the program.   |
| 077    | SUB PROGRAM NESTING ERROR             | The subprogram was called in five folds. Modify the program.  |
| 078    | NUMBER NOT FOUND                      | A program number or a sequence number which was specified by<br>address P in the block which includes an M98, M99, M65 or G66 was<br>not found. The sequence number specified by a GOTO statement<br>was not found. Otherwise, a called program is being edited in back-<br>ground processing. Correct the program, or discontinue the back-<br>ground editing. |
| 079    | PROGRAM VERIFY ERROR                  | In memory or program collation, a program in memory does not agree<br>with that read from an external I/O device. Check both the programs<br>in memory and those from the external device.  |
| 080    | G37 ARRIVAL SIGNAL NOT<br>ASSERTED    | In the automatic tool compensation function (G36, G37), the measurement position reach signal (XAE or ZAE) is not turned on within an area specified in parameter 6254 (value $\varepsilon$ ). This is due to a setting or operator error.  |
| 081    | OFFSET NUMBER NOT FOUND IN<br>G37     | Automatic tool compensation (G36, G37) was specified without a T code. (Automatic tool compensation function) Modify the program.   |
| 082    | T-CODE NOT ALLOWED IN G37             | T code and automatic tool compensation (G36, G37) were specified<br>in the same block. (Automatic tool compensation function)<br>Modify the program.  |
| 083    | ILLEGAL AXIS COMMAND IN G37           | In automatic tool compensation (G36, G37), an invalid axis was spe-<br>cified or the command is incremental. Modify the program.  |
| 085    | COMMUNICATION ERROR                   | When entering data in the memory by using Reader / Puncher inter-<br>face, an overrun, parity or framing error was generated. The number<br>of bits of input data or setting of baud rate or specification No. of I/O<br>unit is incorrect.   |
| 086    | DR SIGNAL OFF                         | When entering data in the memory by using Reader / Puncher inter-<br>face, the ready signal (DR) of reader / puncher was turned off.<br>Power supply of I/O unit is off or cable is not connected or a P.C.B. is<br>defective.  |
| 087    | BUFFER OVERFLOW                       | When entering data in the memory by using Reader / Puncher inter-<br>face, though the read terminate command is specified, input is not<br>interrupted after 10 characters read. I/O unit or P.C.B. is defective.   |
| 088    | G LAN FILE TRANS ERROR<br>(CHANNEL-1) | File data transfer over the OSI–Ethernet was terminated as a result of a transfer error.  |
| 089    | G LAN FILE TRANS ERROR<br>(CHANNEL-2) | File data transfer over the OSI–Ethernet was terminated as a result of a transfer error.  |
| 090    | REFERENCE RETURN<br>INCOMPLETE        | The reference position return cannot be performed normally because<br>the reference position return start point is too close to the reference<br>position or the speed is too slow. Separate the start point far enough<br>from the reference position, or specify a sufficiently fast speed for<br>reference position return. Check the program contents.      |

| Number | Message                             | Contents   |
|--------|-------------------------------------|--|
| 091    | REFERENCE RETURN<br>INCOMPLETE      | In the automatic operation halt state, manual reference position return cannot be performed.   |
| 092    | AXES NOT ON THE REFERENCE<br>POINT  | The commanded axis by G27 (Reference position return check) did not return to the reference position.  |
| 094    | P TYPE NOT ALLOWED (COORD<br>CHG)   | P type cannot be specified when the program is restarted. (After the automatic operation was interrupted, the coordinate system setting operation was performed.)<br>Perform the correct operation according to th operator's manual.                    |
| 095    | P TYPE NOT ALLOWED (EXT OFS<br>CHG) | P type cannot be specified when the program is restarted. (After the automatic operation was interrupted, the external workpiece offset amount changed.)<br>Perform the correct operation according to th operator's manual.                             |
| 096    | P TYPE NOT ALLOWED (WRK OFS<br>CHG) | P type cannot be specified when the program is restarted. (After the automatic operation was interrupted, the workpiece offset amount changed.)<br>Perform the correct operation according to th operator's manual.                                      |
| 097    | P TYPE NOT ALLOWED (AUTO<br>EXEC)   | P type cannot be directed when the program is restarted. (After power ON, after emergency stop or P/S alarm 94 to 97 were reset, no automatic operation was performed.) Perform automatic operation.   |
| 098    | G28 FOUND IN SEQUENCE<br>RETURN     | A command of the program restart was specified without the refer-<br>ence position return operation after power ON or emergency stop,<br>and G28 was found during search.<br>Perform the reference position return.                                      |
| 099    | MDI EXEC NOT ALLOWED AFT.<br>SEARCH | After completion of search in program restart, a move command is given with MDI.   |
| 100    | PARAMETER WRITE ENABLE              | On the PARAMETER(SETTING) screen, PWE(parameter writing enabled) is set to 1. Set it to 0, then reset the system.  |
| 101    | PLEASE CLEAR MEMORY                 | The power turned off while rewriting the memory by program edit op-<br>eration. If this alarm has occurred, press <reset> while pressing<br/><prog>, and only the program being edited will be deleted.<br/>Register the deleted program.</prog></reset> |
| 111    | CALCULATED DATA OVERFLOW            | The result of calculation is out of the allowable range $(-10^{47} \text{ to } -10^{-29}, 0, \text{ and } 10^{-29} \text{ to } 10^{47}).$  |
| 112    | DIVIDED BY ZERO                     | Division by zero was specified. (including tan 90°)<br>Modify the program.   |
| 113    | IMPROPER COMMAND                    | A function which cannot be used in custom macro is commanded.<br>Modify the program.   |
| 114    | FORMAT ERROR IN MACRO               | There is an error in other formats than <formula>.<br/>Modify the program.</formula>   |

| Number | Message                              | Contents  |
|--------|--------------------------------------|---|
| 115    | ILLEGAL VARIABLE NUMBER              | A value not defined as a variable number is designated in the custom macro or in high-speed cycle cutting.<br>The header contents are improper in a high speed cycle cutting. This alarm is given in the following cases: |
|        |                                      | 1. The header corresponding to the specified machining cycle num-<br>ber called is not found.   |
|        |                                      | <ol> <li>The cycle connection data value is out of the allowable range<br/>(0 – 999).</li> </ol>  |
|        |                                      | 3. The number of data in the header is out of the allowable range $(0 - 32767)$ .   |
|        |                                      | 4. The start data variable number of executable format data is out of the allowable range (#20000 – #85535).  |
|        |                                      | 5. The storing data variable number of executable format data is out of the allowable range (#85535).   |
|        |                                      | 6. The storing start data variable number of executable format data is overlapped with the variable number used in the header.  |
|        |                                      | Modify the program.   |
| 116    | WRITE PROTECTED VARIABLE             | The left side of substitution statement is a variable whose substitution is inhibited. Modify the program.  |
| 118    | PARENTHESIS NESTING ERROR            | The nesting of bracket exceeds the upper limit (quintuple).<br>Modify the program.  |
| 119    | ILLEGAL ARGUMENT                     | The SQRT argument is negative, BCD argument is negative, or other values than 0 to 9 are present on each line of BIN argument. Modify the program.  |
| 122    | QUADRUPLE MACRO<br>MODAL–CALL        | A total of four macro calls and macro modal calls are nested.<br>Modify the program.  |
| 123    | CAN NOT USE MACRO COMMAND<br>IN DNC  | Macro control command is used during DNC operation.<br>Modify the program.  |
| 124    | MISSING END STATEMENT                | DO – END does not correspond to 1 : 1. Modify the program.  |
| 125    | FORMAT ERROR IN MACRO                | <formula> format is erroneous. Modify the program.</formula>  |
| 126    | ILLEGAL LOOP NUMBER                  | In DOn, $1 \le n \le 3$ is not established. Modify the program.   |
| 127    | NC, MACRO STATEMENT IN SAME<br>BLOCK | NC and custom macro commands coexist.<br>Modify the program.  |
| 128    | ILLEGAL MACRO SEQUENCE<br>NUMBER     | The sequence number specified in the branch command was not 0 to 9999. Or, it cannot be searched. Modify the program.   |
| 129    | ILLEGAL ARGUMENT ADDRESS             | An address which is not allowed in <argument designation=""> is used.<br/>Modify the program.</argument>  |
| 130    | ILLEGAL AXIS OPERATION               | An axis control command was given by PMC to an axis controlled by CNC. Or an axis control command was given by CNC to an axis controlled by PMC. Modify the program.  |
| 131    | TOO MANY EXTERNAL ALARM<br>MESSAGES  | Five or more alarms have generated in external alarm message.<br>Consult the PMC ladder diagram to find the cause.  |
| 132    | ALARM NUMBER NOT FOUND               | No alarm No. concerned exists in external alarm message clear.<br>Check the PMC ladder diagram.   |
| 133    | ILLEGAL DATA IN EXT. ALARM<br>MSG    | Small section data is erroneous in external alarm message or exter-<br>nal operator message. Check the PMC ladder diagram.  |
| 135    | SPINDLE ORIENTATION PLEASE           | Without any spindle orientation , an attempt was made for spindle indexing. Perform spindle orientation.  |
| 136    | C/H–CODE & MOVE CMD IN SAME<br>BLK.  | A move command of other axes was specified to the same block as spindle indexing addresses C, H. Modify the program.  |

| Number | Message   | Contents  |
|--------|---|---|
| 137    | M-CODE & MOVE CMD IN SAME<br>BLK.                       | A move command of other axes was specified to the same block as M–code related to spindle indexing. Modify the program.   |
| 138    | G SUPERIMPOSED DATA<br>OVERFLOW                         | In PMC axis control, the increment for pulse distribution on the CNC and PMC side are too large when the superimposed control extended function is used.  |
| 139    | CAN NOT CHANGE PMC<br>CONTROL AXIS                      | An axis is selected in commanding by PMC axis control.<br>Modify the program.   |
| 145    | ILLEGAL COMMAND G112/G113                               | <ul> <li>The conditions are incorrect when the polar coordinate interpolation starts or it is canceled.</li> <li>1) In modes other than G40, G12.1/G13.1 was specified.</li> <li>2) An error is found in the plane selection. Parameters No. 5460 and No. 5461 are incorrectly specified.</li> <li>Modify the value of program or parameter.</li> </ul>   |
| 146    | IMPROPER G CODE   | G codes which cannot be specified in the polar coordinate interpola-<br>tion mode was specified. See section II–4.4 and modify the program.   |
| 149    | FORMAT ERROR IN G10L3                                   | A code other than Q1, Q2, P1 or P2 was specified as the life count type in the extended tool life management.   |
| 150    | ILLEGAL TOOL GROUP NUMBER                               | Tool Group No. exceeds the maximum allowable value.<br>Modify the program.  |
| 151    | TOOL GROUP NUMBER NOT<br>FOUND                          | The tool group commanded in the machining program is not set.<br>Modify the value of program or parameter.  |
| 152    | NO SPACE FOR TOOL ENTRY                                 | The number of tools within one group exceeds the maximum value registrable. Modify the number of tools.   |
| 153    | T-CODE NOT FOUND  | In tool life data registration, a T code was not specified where one should be. Correct the program.  |
| 155    | ILLEGAL T-CODE IN M06                                   | In the machining program, M06 and T code in the same block do not correspond to the group in use. Correct the program.  |
| 156    | P/L COMMAND NOT FOUND                                   | P and L commands are missing at the head of program in which the tool group is set. Correct the program.  |
| 157    | TOO MANY TOOL GROUPS                                    | The number of tool groups to be set exceeds the maximum allowable value. (See parameter No. 6800 bit 0 and 1) Modify the program.   |
| 158    | ILLEGAL TOOL LIFE DATA                                  | The tool life to be set is too excessive. Modify the setting value.   |
| 159    | TOOL DATA SETTING<br>INCOMPLETE                         | During executing a life data setting program, power was turned off.<br>Set again.   |
| 160    | MISMATCH WATING M–CODE<br>(only with two path control)  | Different M code is commanded in heads 1 and 2 as waiting M code.<br>Modify the program.  |
| 169    | ILLEGAL TOOL GEOMETRY DATA<br>(At two–path)             | Incorrect tool figure data in interference check.<br>Set correct data, or select correct tool figure data.  |
|        | ILLEGAL TOOL GEOMETRY DATA (only with two path control) | Incorrect tool figure data in interference check.   |
| 175    | ILLEGAL G107 COMMAND                                    | Conditions when performing circular interpolation start or cancel not correct. To change the mode to the cylindrical interpolation mode, specify the command in a format of "G07.1 rotation–axis name radius of cylinder."  |
| 176    | IMPROPER G-CODE IN G107                                 | <ul> <li>Any of the following G codes which cannot be specified in the cylindrical interpolation mode was specified.</li> <li>1) G codes for positioning, such as G28, G76, G81 – G89, including the codes specifying the rapid traverse cycle</li> <li>2) G codes for setting a coordinate system: G50, G52</li> <li>3) G code for selecting coordinate system: G53 G54–G59 Modify the program.</li> </ul> |
| 177    | CHECK SUM ERROR<br>(G05 MODE)                           | Check sum error<br>Modify the program.  |

| Number | Message                             | Contents   |
|--------|-------------------------------------|--|
| 178    | G05 NOT ALLOWED IN G41/G42<br>MODE  | G05 was commanded in the G41/G42 mode.<br>Correct the program.   |
| 179    | PARAM. (NO. 7510) SETTING<br>ERROR  | The number of controlled axes set by the parameter 7510 exceeds the maximum number. Modify the parameter setting value.  |
| 180    | COMMUNICATION ERROR<br>(REMOTE BUF) | Remote buffer connection alarm has generated. Confirm the number of cables, parameters and I/O device.   |
| 190    | ILLEGAL AXIS SELECT                 | In the constant surface speed control, the axis specification is wrong.<br>(See parameter No. 3770.) The specified axis command (P) contains<br>an illegal value.<br>Correct the program.  |
| 194    | SPINDLE COMMAND IN<br>SYNCHRO-MODE  | A contour control mode, spindle positioning (Cs–axis control) mode,<br>or rigid tapping mode was specified during the serial spindle<br>synchronous control mode. Correct the program so that the serial<br>spindle synchronous control mode is released in advance. |
| 197    | C-AXIS COMMANDED IN SPINDLE<br>MODE | The program specified a movement along the Cf–axis when the sig-<br>nal CON(DGN=G027#7) was off. Correct the program, or consult the<br>PMC ladder diagram to find the reason the signal is not turned on.   |
| 199    | MACRO WORD UNDEFINED                | Undefined macro word was used. Modify the custom macro.  |
| 200    | ILLEGAL S CODE COMMAND              | In the rigid tapping, an S value is out of the range or is not specified.<br>The maximum values for S which can be specified in rigid tapping is<br>set in parameters 5241 to 5243. Change the setting in the parameter<br>or modify the program.                    |
| 201    | FEEDRATE NOT FOUND IN RIGID<br>TAP  | In the rigid tapping, no F value is specified.<br>Correct the program.   |
| 202    | POSITION LSI OVERFLOW               | In the rigid tapping, spindle distribution value is too large.   |
| 203    | PROGRAM MISS AT RIGID<br>TAPPING    | In the rigid tapping, position for a rigid M code (M29) or an S com-<br>mand is incorrect. Modify the program.   |
| 204    | ILLEGAL AXIS OPERATION              | In the rigid tapping, an axis movement is specified between the rigid M code (M29) block and G84 (G88) block. Modify the program.  |
| 205    | RIGID MODE DI SIGNAL OFF            | Rigid tapping signal (DGNG061 #1) is not 1 when G84 (G88) is<br>executed though the rigid M code (M29) is specified. Consult the<br>PMC ladder diagram to find the reason the signal is not turned on.   |
| 210    | CAN NOT COMAND M198/M099            | 1 M198 and M199 are executed in the schedule operation. Or M198 is executed in the DNC operation. Modify the program.  |
|        |                                     | 2 In a multiple repetitive pocketing canned cycle, an interrupt macro was specified, and M99 was executed.   |
| 211    | G31 (HIGH) NOT ALLOWED IN G99       | G31 is commanded in the per revolution command when the high–<br>speed skip option is provided. Modify the program.  |
| 212    | ILLEGAL PLANE SELECT                | The direct drawing dimensions programming is commanded for the plane other than the Z–X plane. Correct the program.  |
| 213    | ILLEGAL COMMAND IN<br>SYNCHRO-MODE  | Movement is commanded for the axis to be synchronously controlled.   |
| 214    | ILLEGAL COMMAND IN<br>SYNCHRO-MODE  | Coordinate system is set or tool compensation of the shift type is executed in the synchronous control. Correct the program.   |
| 217    | DUPLICATE G251 (COMMANDS)           | G51.2 or G251 is further commanded in the polygon machining mode. Modify the program.  |
| 218    | NOT FOUND P/Q COMMAND IN<br>G251    | P or Q is not commanded in the G251 block, or the command value is out of the range. Modify the program.   |
| 219    | COMMAND G250/G251<br>INDEPENDENTLY  | G251 and G250 are not independent blocks.  |
| 220    | ILLEGAL COMMAND IN<br>SYNCHR-MODE   | In the synchronous operation, movement is commanded by the NC program or PMC axis control interface for the synchronous axis.  |

| 221  |   |   |
|------|---|---|
|      | ILLEGAL COMMAND IN<br>SYNCHR-MODE                                       | Polygon machining synchronous operation and axis control or bal-<br>ance cutting are executed at a time. Modify the program.  |
| 224  | RETURN TO REFERENCE POINT   | Not returned to reference point before cycle start.   |
| 225  | SYNCHRONOUS/MIXED CONTROL<br>ERROR                                      | This alarm is generated in the following circumstances. (Searched for during synchronous and mixed control command.   |
|      | (only with two path control only)                                       | 1 When there is a mistake in axis number parameter setting.   |
|      |   | 2 When there is a mistake in control commanded.   |
|      |   | Modify the program or the parameter.  |
| 226  | ILLEGAL COMMAND IN<br>SYNCHRO–MODE<br>(only with two path control only) | A travel command has been sent to the axis being synchronized in synchronous mode. Modify the program or the parameter.   |
| 229  | CAN NOT KEEP SYNCHRO-STATE  | This alarm is generated in the following circumstances.   |
|      | (only with two path control only)                                       | 1 When the synchro/mixed state could not be kept due to system overload.  |
|      |   | 2 The above condition occurred in CNC devices (hardware) and synchro-state could not be kept.   |
|      |   | (This alarm is not generated in normal use conditions.)   |
| 231  | FORMAT ERROR IN G10 OR L50  | Any of the following errors occurred in the specified format at the pro-<br>grammable–parameter input.  |
|      |   | 1 Address N or R was not entered.   |
|      |   | 2 A number not specified for a parameter was entered.   |
|      |   | 3 The axis number was too large.  |
|      |   | 4 An axis number was not specified in the axis-type parameter.  |
|      |   | 5 An axis number was specified in the parameter which is not an axis type.  |
|      |   | 6 An attempt was made to reset bit 4 of parameter 3202 (NE9) or<br>change parameter 3210 (PSSWD) when they are protected by a<br>password. Correct the program.   |
| 232  | ILLEGAL AXIS COMMAND IN<br>HELICAL                                      | Three or more axes were specified as helical axes in the helical inter-<br>polation mode.   |
| 233  | DEVICE BUSY   | When an attempt was made to use a unit such as that connected via the RS-232-C interface, other users were using it.  |
| 239  | BP/S ALARM  | While punching was being performed with the function for controlling external I/O units ,background editing was performed.  |
| 240  | BP/S ALARM  | Background editing was performed during MDI operation.  |
| 244  | P/S ALARM   | In the skip function activated by the torque limit signal, the number of accumulated erroneous pulses exceed 32767 before the signal was input. Therefore, the pulses cannot be corrected with one distribution. Change the conditions, such as federates along axes and torque limit, and try again. |
| 245  | T-CODE NOT ALOWED IN THIS<br>BLOCK                                      | One of the G codes, G50, G10, and G04, which cannot be specified in the same block as a T code, was specified with a T code.  |
| 246  | ENCODE PROGRAM NUMBER<br>ERROR  | During read of an encrypted program, an attempt was made to store<br>the program with a number exceeding the protection range.<br>(See parameter Nos. 3222 and 3223.)   |
| 247  | ILLEGAL CODE USED FOR<br>OUTPUT   | When an encrypted program is output, EIA is set for the punch code. Specify ISO.  |
| 5010 | END OF RECORD   | The end of record (%) was specified.  |
| 5016 | ILLEGAL COMBINATION OF M<br>CODE  | M codes which belonged to the same group were specified in a block.<br>Alternatively,an M code which must be specified without other M<br>codes in the block was specified in a block with other M codes.   |

| Number | Message                             | Contents  |  |  |  |
|--------|-------------------------------------|---|--|--|--|
| 5018   | POLYGON AXIS SPPED ERROR            | The rotating speed ratio of the command value cannot be maintained<br>in the G51.2 mode , because the spped of the spindle or the polygon<br>turning synchronous axis exceeds the clamp value or itis too slow. |  |  |  |
| 5020   | PARAMETER OF RESTART ERROR          | An erroneous parameter was specified for restarting a program.  |  |  |  |
| 5030   | ILLEGAL COMMAND (G100)              | The end command (G110) was specified before the registration start command (G101, G102, or G103) was specified for the B–axis.  |  |  |  |
| 5031   | ILLEGAL COMMAND (G100, G102, G103)  | While a registration start command (G101, G102, or G103) was being executed, another registration start command was specified for the B–axis.   |  |  |  |
| 5032   | NEW PRG REGISTERED IN B-AXS<br>MOVE | While the machine was moving about the B-axis, at attempt was made to register another move command.  |  |  |  |
| 5033   | NO PROG SPACE IN MEMORY<br>B–AXIS   | Commands for movement about the B-axis were not registered be-<br>cause of insufficient program memory.   |  |  |  |
| 5034   | PLURAL COMMAND IN G110              | Multiple movements were specified with the G110 code for the B-axis.  |  |  |  |
| 5035   | NO FEEDRATE COMMANDED<br>B–AXIS     | A feedrate was not specified for cutting feed about the B-axis.   |  |  |  |
| 5036   | ADDRESS R NOT DEFINED IN<br>G81–G86 | Point R was not specified for the canned cycle for the B-axis.  |  |  |  |
| 5037   | ADDRESS Q NOT DEFINED IN G83        | Depth of cut Q was not specified for the G83 code (peck drilling cycle). Alternatively, 0 was specified in Q for teh B–axis.  |  |  |  |
| 5038   | TOO MANY START M-CODE<br>COMMAND    | More than six M codes for starting movement about the B-axis were specified.  |  |  |  |
| 5039   | START UNREGISTERED B-AXIS<br>PROG   | An attempt was made to execute a program for the B-axis which had not been registered.  |  |  |  |
| 5040   | CAN NOT COMMANDED B-AXIS<br>MOVE    | The machine could not move about the B–axis because parameter No.8250 was incorrectly specified, or because the PMC axis system could not be used.  |  |  |  |
| 5041   | CAN NOT COMMANDED G110<br>BLOCK     | Blocks containing the G110 codes were successively specified in tool–tip radius compensation for the B–axis.  |  |  |  |
| 5046   | ILLEGAL PARAMETER (ST.COMP)         | Parameters related to straightness compensation have been erro-<br>neously specified. Possible causes are as follows :  |  |  |  |
|        |                                     | 1 Invalid axis numbers have been assigned to move or compensa-<br>tion axes.  |  |  |  |
|        |                                     | 2 The number of pitcherror compensation points between the maxi-<br>mum positive and maximum negative points exceeds 128.   |  |  |  |
|        |                                     | 3 Straightness compensation point numbers have been assigned in other than ascending order.   |  |  |  |
|        |                                     | 4 Straightness compensation points could not belocated between the maximum positive and maximum negative pitch error compensation points.   |  |  |  |
|        |                                     | 5 The amount of compensation per compensation point is too large or too small.  |  |  |  |
| 5051   | M-NET CODE ERROR                    | Abnormal character reception<br>(Characters except code used to transmit)   |  |  |  |
| 5052   | M–NET ETX ERROR                     | "ETX" code is abnormal.   |  |  |  |
| 5053   | M-NET CONNECT ERROR                 | Connection time supervision error (parameter No.175)  |  |  |  |
| 5054   | M-NET RECEIVE ERROR                 | Boring time supervision error (parameter No.176)  |  |  |  |
| 5055   | M–NET PRT/FRM ERROR                 | Vertical parity or framing error detection  |  |  |  |

| Number | Message                              | Contents  |
|--------|--------------------------------------|---|
| 5056   | M-NET BOARD SYSTEM DOWN              | Transmit time–out error (parameter No. 177)<br>ROM parity error<br>CPU interruption detection of not listed above   |
| 5058   | G35/G36 FORMAT ERROR                 | A command for changing the major axis was specified during circular threading. Alternatively, the leangth of the major axis was specified to be 0.  |
| 5059   | RADIUS IS OUT OF RANGE               | During circular interpolation, the center of the arc specified with I, J, and K caused the radius to exceed nine digits.  |
| 5073   | NO DECIMAL POINT                     | A decimal point is not specified for a command for which a decimal point must be specified.   |
| 5074   | ADDRESS DUPLICATION ERROR            | The same address appears more than once in a block. Alternatively, a block contains two or more G codes belonging to the same group.  |
| 5082   | DATA SERVER ERROR                    | Details are displayed on the data server message screen.  |
| 5134   | FSSB : OPEN READY TIME OUT           | Initialization did not place FSSB in the open ready state.  |
| 5135   | FSSB : ERROR MODE                    | FSSB has entered error mode.  |
| 5136   | FSSB : NUMBER OF AMPS IS<br>SMALL    | In comparison with the number of controlled axes, the number of amplifiers recognized by FSSB is not enough.  |
| 5137   | FSSB : CONFIGURATION ERROR           | FSSB detected a configuration error.  |
| 5138   | FSSB : AXIS SETTING NOT<br>COMPLETE  | In automatic setting mode, axis setting has not been made yet.<br>Perform axis setting on the FSSB setting screen.  |
| 5139   | FSSB : ERROR                         | Servo initialization did not terminate normally.<br>The optical cable may be defective, or there may be an error in connec-<br>tion to the amplifier or another module.<br>Check the optical cable and the connection status. |
| 5155   | NOT RESTART PROGRAM BY G05           | During servo leaning control by G05, an attempt was made to perform restart operation after feed hold or interlock. This restart operation cannot be performed. (G05 leaning control terminates at the same time.)            |
| 5195   | DIRECTION CAN NOT BE JUDGED          | When the touch sensor with a single contact signal input is used in the direct input B function for tool offset measurement values, the stored pulse direction is not constant. One of the following conditions exists:       |
|        |                                      | The stop state exists in offset write mode.   |
|        |                                      | Servo off state   |
|        |                                      | The direction varies.   |
|        |                                      | Movement takes place simultaneously along two axes.   |
| 5197   | FSSB : OPEN TIME OUT                 | The CNC permitted FSSB to open, but FSSB was not opened.  |
| 5198   | FSSB : ID DATA NOT READ              | Temporary assignment failed, so amplifier initial ID information could not be read.   |
| 5199   | FINE TORQUE SENSING<br>PARAMETER     | <ul> <li>A parameter related to the fine torque sensing function is illegal.</li> <li>The storage interval is invalid.</li> <li>An invalid axis number is set as the target axis.</li> <li>Correct the parameter.</li> </ul>  |
| 5212   | SCREEN COPY : PARAMETER<br>ERROR     | There is a parameter setting error. Check that 4 is set as the I/O channel.   |
| 5213   | SCREEN COPY :<br>COMMUNICATION ERROR | The memory card cannot be used. Check the memory card. (Check whether the memory card is write–protected or defective.)   |
| 5214   | SCREEN COPY : DATA TRANSFER<br>ERROR | Data transfer to the memory card failed.<br>Check whether the memory card space is insufficient and whether the<br>memory card was removed during data transfer.  |

| Number | Message                            | Contents   |
|--------|------------------------------------|--|
| 5218   | ILLEGAL PARAMETER (INCL.<br>COMP)  | There is an inclination compensation parameter setting error.<br>Cause:  |
|        |                                    | 1. The number of pitch error compensation points between the negative (–) end and positive (+) end exceeds 128.  |
|        |                                    | 2. The relationship in magnitude among the inclination compensation point numbers is incorrect.  |
|        |                                    | 3. An inclination compensation point is not located between the negative (-) end and positive (+) end of the pitch error compensation points.  |
|        |                                    | 4. The amount of compensation per compensation point is too large or too small.  |
|        |                                    | Correct the parameter.   |
| 5220   | REFERENCE POINT ADJUSTMENT<br>MODE | A parameter for automatically set a reference position is set. (Bit 2 of parameter No. 1819 = 1)<br>Perform automatic setting.<br>(Position the machine at the reference position manually, then perform manual reference position return.)<br>Supplementary: Automatic setting sets bit 2 of parameter No. 1819 to 0. |
| 5222   | SRAM CORRECTABLE ERROR             | The SRAM correctable error cannot be corrected.<br>Cause:<br>A memory problem occurred during memory initialization.<br>Action:  |
|        |                                    | Replace the master printed circuit board (SRAM module).  |
| 5227   | FILE NOT FOUND                     | A specified file is not found during communication with the built-in Handy File.   |
| 5228   | SAME NAME USED                     | There are duplicate file names in the built-in Handy File.   |
| 5229   | WRITE PROTECTED                    | A floppy disk in the built-in Handy File is write protected.   |
| 5231   | TOO MANY FILES                     | The number of files exceeds the limit during communication with the built-in Handy File.   |
| 5232   | DATA OVER-FLOW                     | There is not enough floppy disk space in the built-in Handy File.  |
| 5235   | COMMUNICATION ERROR                | A communication error occurred during communication with the built-in Handy File.  |
| 5237   | READ ERROR                         | A floppy disk in the built-in Handy File cannot be read from. The floppy disk may be defective, or the head may be dirty. Alternatively, the Handy File is defective.  |
| 5238   | WRITE ERROR                        | A floppy disk in the built–in Handy File cannot be written to. The floppy disk may be defective, or the head may be dirty. Alternatively, the Handy File is defective.   |
| 5242   | ILLEGAL AXIS NUMBER                | The axis number of the synchronous master axis or slave axis is incor-<br>rect. (This alarm is issued when flexible synchronization is turned on.)<br>Alternatively, the axis number of the slave axis is smaller than that of the<br>master axis.   |
| 5243   | DATA OUT OF RANGE                  | The gear ratio is not set correctly. (This alarm is issued when flexible synchronization is turned on.)  |
| 5244   | TOO MANY DI ON                     | Even when an M code was encountered in automatic operation mode,<br>the flexible synchronization mode signal was not driven on or off.<br>Check the ladder and M codes.  |
| 5245   | OTHER AXIS ARE COMMANDED           | One of the following command conditions was present during flexible synchronization or when flexible synchronization was turned on:  |
|        |                                    | 1. The synchronous master axis or slave axis is the EGB axis.  |
|        |                                    | 2. The synchronous master axis or slave axis is the chopping axis.   |
|        |                                    | 3. In reference position return mode   |

| Number | Message                            | Contents  |
|--------|------------------------------------|---|
| 5251   | ILLEGAL PARAMETER IN G54.2         | A fixture offset parameter (No. 7580 to 7588) is illegal. Correct the parameter.  |
| 5252   | ILLEGAL P COMMAND IN G54.2         | The P value specifying the offset number of a fixture offset is too large.<br>Correct the program.  |
| 5257   | G41/G42 NOT ALLOWED IN MDI<br>MODE | G41/G42 (cutter compensation C: M series, tool–nose radius compensation: T series) was specified in MDI mode. (Depending on the setting of bit 4 of parameter No. 5008) |
| 5303   | TOUCH PANEL ERROR                  | A touch panel error occurred.<br>Cause:   |
|        |                                    | 1. The touch panel is kept pressed.   |
|        |                                    | 2. The touch panel was pressed when power was turned on.  |
|        |                                    | Remove the above causes, and turn on the power again.   |

#### 2) Background edit alarm

| Number                   | Message    | Contents   |
|--------------------------|------------|--|
| 070 to 074<br>085 to 087 | BP/S alarm | BP/S alarm occurs in the same number as the P/S alarm that occurs in ordinary program edit.  |
| 140                      | BP/S alarm | It was attempted to select or delete in the background a program be-<br>ing selected in the foreground. <b>(NOTE)</b><br>Use background editing correctly. |

#### NOTE

Alarm in background edit is displayed in the key input line of the background edit screen instead of the ordinary alarm screen and is resettable by any of the MDI key operation.

#### 3) Absolute pulse coder (APC) alarm

| Number | Message                            | Contents  |  |
|--------|------------------------------------|---|--|
| 300    | n AXIS NEED ZRN                    | Manual reference position return is required for the nth-axis (n=1 to 8).   |  |
| 301    | APC ALARM:n AXIS<br>COMMUNICATION  | nth–axis (n=1 to 8) APC communication error. Failure in data transmission Possible causes include a faulty APC, cable, or servo interface module.   |  |
| 302    | APC ALARM:n AXIS<br>OVER TIME      | nth–axis (n=1 to 8) APC overtime error.<br>Failure in data transmission.<br>Possible causes include a faulty APC, cable, or servo interface module. |  |
| 303    | APC ALARM:n AXIS<br>FRAMING        | nth–axis (n=1 to 8) APC framing error. Failure in data transmission.<br>Possible causes include a faulty APC, cable, or servo interface module.     |  |
| 304    | APC ALARM:n AXIS<br>PARITY         | nth–axis (n=1 to 8) APC parity error.<br>Failure in data transmission. Possible causes include a faulty APC, cable, or servo interface module.      |  |
| 305    | APC ALARM:n AXIS<br>PULSE MISS     | nth–axis (n=1 to 8) APC pulse error alarm.<br>APC alarm. APC or cable may be faulty.  |  |
| 306    | APC ALARM:n AXIS<br>BATTERY ZERO   | nth–axis (n=1 to 8) APC battery voltage has decreased to a low level so that the data cannot be held.<br>APC alarm. Battery or cable may be faulty. |  |
| 307    | APC ALARM:n AXIS<br>BATTERY DOWN 1 | nth–axis (n=1 to 8) axis APC battery voltage reaches a level where the battery must be renewed.<br>APC alarm. Replace the battery.                  |  |

| Number | Message Contents                   |  |
|--------|------------------------------------|--|
| 308    | APC ALARM:n AXIS<br>BATTERY DOWN 2 | nth–axis (n=1 to 8) APC battery voltage has reached a level where the battery must be renewed (including when power is OFF).<br>APC alarm .Replace battery.  |
| 309    | APC ALARM:n AXIS ZRN<br>IMPOSSIBLE | An attempt was made to perform reference position return without rotating the motor through one or more turns. Rotate the motor through one or more turns, turn off the power then on again, then perform reference position return. |

APPENDIX

#### 4) Serial pulse coder (SPC) alarms

| No. | Message                               | Description  |
|-----|---------------------------------------|--|
| 360 | n AXIS : ABNORMAL CHECKSUM<br>(INT)   | A checksum error occurred in the built-in pulse coder.   |
| 361 | n AXIS : ABNORMAL PHASE DATA<br>(INT) | A phase data error occurred in the built-in pulse coder.   |
| 362 | n AXIS : ABNORMAL REV.DATA<br>(INT)   | A rotation speed count error occurred in the built-in pulse coder.                                       |
| 363 | n AXIS : ABNORMAL CLOCK (INT)         | A clock error occurred in the built-in pulse coder.  |
| 364 | n AXIS : SOFT PHASE ALARM (INT)       | The digital servo software detected invalid data in the built-in pulse coder.                            |
| 365 | n AXIS : BROKEN LED (INT)             | An LED error occurred in the built-in pulse coder.   |
| 366 | n AXIS : PULSE MISS (INT)             | A pulse error occurred in the built-in pulse coder.  |
| 367 | n AXIS : COUNT MISS (INT)             | A count error occurred in the built-in pulse coder.  |
| 368 | n AXIS : SERIAL DATA ERROR<br>(INT)   | Communication data from the built-in pulse coder cannot be re-<br>ceived.                                |
| 369 | n AXIS : DATA TRANS. ERROR<br>(INT)   | A CRC or stop bit error occurred in the communication data being received from the built-in pulse coder. |
| 380 | n AXIS : BROKEN LED (EXT)             | The separate detector is erroneous.  |
| 381 | n AXIS : ABNORMAL PHASE<br>(EXT LIN)  | A phase data error occurred in the separate linear scale.  |
| 382 | n AXIS : COUNT MISS (EXT)             | A pulse error occurred in the separate detector.   |
| 383 | n AXIS : PULSE MISS (EXT)             | A count error occurred in the separate detector.   |
| 384 | n AXIS : SOFT PHASE ALARM<br>(EXT)    | The digital servo software detected invalid data in the separate detector.                               |
| 385 | n AXIS : SERIAL DATA ERROR<br>(EXT)   | Communication data from the separate detector cannot be received.  |
| 386 | n AXIS : DATA TRANS. ERROR<br>(EXT)   | A CRC or stop bit error occurred in the communication data being received from the separate detector.    |

### • The details of serial pulse coder alarm

|  | #7                                       | #6        | #5       | #4       | #3        | #2       | #1  | #0  |
|--|--|-----------|----------|----------|-----------|----------|-----|-----|
| 202  |  | CSA       | BLA      | PHA      | PCA       | BZA      | СКА | SPH |
| #6 (C  | #6 (CSA) : Check sum alarm has occurred. |           |          |          |           |          |     |     |
| #5 (Bl   | (LA) : Ba                                | attery lo | w alarm  | has occu | irred.    |          |     |     |
| #4 (PI   | HA) : Pl                                 | nase data | trouble  | alarm ha | as occurr | red.     |     |     |
| #3 (PC   | $CA) : S_{l}$                            | peed cou  | nt troub | le alarm | has occu  | rred.    |     |     |
| #2 (B2   | $\mathbf{Z}\mathbf{A}$ ) : $\mathbf{B}$  | attery ze | ro alarm | has occu | urred.    |          |     |     |
| #1 (CI   | <b>KA)</b> : C                           | lock alar | m has o  | ccurred. |           |          |     |     |
| #0 (SI   | PH) : So                                 | oft phase | data tro | uble ala | rm has o  | ccurred. |     |     |
|  | #7                                       | #6        | #5       | #4       | #3        | #2       | #1  | #0  |
| 203  | DTE                                      | CRC       | STB      | PRM      |           |          |     |     |
| <ul><li>#7 (DTE) : Data error has occurred.</li><li>#6 (CRC) : CRC error has occurred.</li></ul> |  |           |          |          |           |          |     |     |

- **#5 (STB)** : Stop bit error has occurred.
- **#4 (PRM)** : Parameter error alarm has occurred. In this case, a servo parameter error alarm (No. 417) is also output.

#### 5) Servo alarms

| Number | Message                                   | Contents  |  |  |
|--------|---|---|--|--|
| 401    | SERVO ALARM: n-TH AXIS VRDY<br>OFF        | The n-th axis (axis 1-8) servo amplifier READY signal (DRDY) went off. Refer to procedure of trouble shooting.  |  |  |
| 402    | SERVO ALARM: SV CARD NOT<br>EXIST         | The axis control card is not provided.  |  |  |
| 403    | SERVO ALARM: CARD/SOFT<br>MISMATCH        | The combination of the axis control card and servo software is illegal.<br>The possible causes are as follows:  |  |  |
|        |   | A correct axis control card is not provided.  |  |  |
|        |   | Correct servo software is not installed on flash memory.  |  |  |
| 404    | SERVO ALARM: n–TH AXIS VRDY<br>ON         | Even though the n-th axis (axis 1-8) READY signal (MCON) went off, the servo amplifier READY signal (DRDY) is still on. Or, when the power was turned on, DRDY went on even though MCON was off. Check that the servo interface module and servo amp are connected. |  |  |
| 405    | SERVO ALARM: (ZERO POINT<br>RETURN FAULT) | Position control system fault. Due to an NC or servo system fault in the reference position return, there is the possibility that reference position return could not be executed correctly. Try again from the manual reference position return.                   |  |  |
| 407    | SERVO ALARM: EXCESS ERROR                 | The difference in synchronous axis position deviation exceeded the set value.   |  |  |
| 409    | SERVO ALARM: n AXIS TORQUE<br>ALM         | Abnormal servo motor load has been detected. Alternatively, abnormal spindle motor load has been detected in Cs mode.   |  |  |
| 410    | SERVO ALARM: n–TH AXIS –<br>EXCESS ERROR  | The position deviation value when the n-th axis (axis 1-8) stops is larger than the set value.<br>Refer to procedure of trouble shooting.   |  |  |
| 411    | SERVO ALARM: n–TH AXIS –<br>EXCESS ERROR  | The position deviation value when the n-th axis (axis 1-8) moves is larger than the set value.<br>Refer to procedure of trouble shooting.   |  |  |
| 413    | SERVO ALARM: n-th AXIS - LSI<br>OVERFLOW  | The contents of the error register for the n–th axis (axis 1–8) exceeded $\pm 2^{31}$ power. This error usually occurs as the result of an improperly set parameters.   |  |  |

| Number | Message  | Contents  |
|--------|--|---|
| 415    | SERVO ALARM: n–TH AXIS –<br>EXCESS SHIFT         | A speed higher than 524288000 units/s was attempted to be set in the n-th axis (axis 1-8). This error occurs as the result of improperly set CMR.   |
| 417    | SERVO ALARM: n–TH AXIS –<br>PARAMETER INCORRECT  | This alarm occurs when the n–th axis (axis 1–8) is in one of the conditions listed below. (Digital servo system alarm)  |
|        |  | 1) The value set in Parameter No. 2020 (motor form) is out of the speci-<br>fied limit.   |
|        |  | 2) A proper value (111 or –111) is not set in parameter No.2022 (motor revolution direction).   |
|        |  | <ol> <li>Illegal data (a value below 0, etc.) was set in parameter No. 2023<br/>(number of speed feedback pulses per motor revolution).</li> </ol>  |
|        |  | 4) Illegal data (a value below 0, etc.) was set in parameter No. 2024 (number of position feedback pulses per motor revolution).  |
|        |  | 5) Parameters No. 2084 and No. 2085 (flexible field gear rate) have not been set.   |
|        |  | 6) A value outside the limit of {1 to the number of control axes} or a non-<br>continuous value (Parameter 1023 (servo axis number) contains a<br>value out of the range from 1 to the number of axes, or an isolated<br>value (for example, 4 not preeded by 3).was set in parameter No.<br>1023 (servo axisnumber). |
| 420    | SERVO ALARM: n AXIS SYNC<br>TORQUE<br>(M series) | During simple synchronous control, the difference between the torque commands for the master and slave axes exceeded the value set in parameter No. 2031.   |
| 421    | SERVO ALARM: n AXIS EXCESS<br>ER (D)             | The difference between the errors in the semi–closed loop and closed loop has become excessive during dual position feedback. Check the values of the dual position conversion coefficients in parameters No. 2078 and 2079.  |
| 422    | SERVO ALARM: n AXIS                              | In torque control of PMC axis control, a specified allowable speed has been exceeded.   |
| 423    | SERVO ALARM: n AXIS                              | In torque control of PMC axis control, the parameter–set allowable cumulative travel distance has been exceeded.  |
| 430    | n AXIS : SV. MOTOR OVERHEAT                      | A servo motor overheat occurred.  |
| 431    | n AXIS : CNV. OVERLOAD                           | 1) PSM: Overheat occurred.  |
|        |  | 2) β series SVU: Overheat occurred.   |
| 432    | n AXIS : CNV. LOWVOLT                            | 1) PSM: Phase missing occurred in the input voltage.  |
|        | CON./POWFAULT                                    | 2) PSMR: The control power supply voltage has dropped.  |
|        |  | 3) $\alpha$ series SVU: The control power supply voltage has dropped.   |
| 433    | n AXIS : CNV. LOW VOLT DC LINK                   | 1) PSM: The DC link voltage has dropped.  |
|        |  | 2) PSMR: The DC link voltage has dropped.   |
|        |  | 3) $\alpha$ series SVU: The DC link voltage has dropped.  |
|        |  | 4) $\beta$ series SVU: The DC link voltage has dropped.   |
| 434    | n AXIS : INV. LOW VOLT CONTROL                   | SVM: The control power supply voltage has dropped.  |
| 435    | n AXIS : INV. LOW VOLT DC LINK                   | SVM: The DC link voltage has dropped.   |
| 436    | n AXIS : SOFTTHERMAL (OVC)                       | The digital servo software detected the soft thermal state (OVC).   |
| 437    | n AXIS : CNV. OVERCURRENT<br>POWER               | PSM: Overcurrent flowed into the input circuit.   |
| 438    | n AXIS : INV. ABNORMAL                           | 1) SVM: The motor current is too high.  |
|        | CURRENT  | 2) $\alpha$ series SVU: The motor current is too high.  |
|        |  | 3) $\beta$ series SVU: The motor current is too high.   |

| Number | Message                              | Contents  |
|--------|--------------------------------------|---|
| 439    | n AXIS : CNV. OVERVOLT POWER         | 1) PSM: The DC link voltage is too high.  |
|        |                                      | 2) PSMR: The DC link voltage is too high.   |
|        |                                      | 3) $\alpha$ series SVU: The C link voltage is too high.   |
|        |                                      | 4) $\beta$ series SVU: The link voltage is too high.  |
| 440    | n AXIS : CNV. EX DECELERATION        | 1) PSMR: The regenerative discharge amount is too large.  |
|        | POW.                                 | 2) $\alpha$ series SVU: The regenerative discharge amount is too large. Alternatively, the regenerative discharge circuit is abnormal.                                      |
| 441    | n AXIS : ABNORMAL CURRENT<br>OFFSET  | The digital servo software detected an abnormality in the motor current detection circuit.  |
| 442    | n AXIS : CNV. CHARGE FAULT/INV.      | 1) PSM: The spare discharge circuit of the DC link is abnormal.   |
|        | DB                                   | 2) PSMR: The spare discharge circuit of the DC link is abnormal.  |
|        |                                      | 3) $\alpha$ series SVU: The dynamic brake circuit is abnormal.  |
| 443    | n AXIS : CNV. COOLING FAN            | 1) PSM: The internal stirring fan failed.   |
|        | FAILURE                              | 2) PSMR: The internal stirring fan failed.  |
|        |                                      | 3) $\beta$ series SVU: The internal stirring fan failed.  |
| 444    | n AXIS : INV. COOLING FAN<br>FAILURE | SVM: The internal stirring fan failed.  |
| 445    | n AXIS : SOFT DISCONNECT<br>ALARM    | The digital servo software detected a broken wire in the pulse coder.   |
| 446    | n AXIS : HARD DISCONNECT<br>ALARM    | A broken wire in the built-in pulse coder was detected by hardware.   |
| 447    | n AXIS : HARD DISCONNECT (EXT)       | A broken wire in the separate detector was detected by hardware.  |
| 448    | n AXIS : UNMATCHED FEEDBACK<br>ALARM | The sign of feedback data from the built-in pulse coder differs from that of feedback data from the separate detector.  |
| 449    | n AXIS : INV. IPM ALARM              | 1) SVM: IPM (intelligent power module) detected an alarm.   |
|        |                                      | 2) $\alpha$ series SVU: IPM (intelligent power module) detected an alarm.   |
| 460    | n AXIS : FSSB DISCONNECT             | FSSB communication was disconnected suddenly. The possible causes are as follows:   |
|        |                                      | 1) The FSSB communication cable was disconnected or broken.   |
|        |                                      | 2) The power to the amplifier was turned off suddenly.  |
|        |                                      | 3) A low–voltage alarm was issued by the amplifier.   |
| 461    | n AXIS : ILLEGAL AMP INTERFACE       | The axes of the 2-axis amplifier were assigned to the fast type inter-<br>face.   |
| 462    | n AXIS : SEND CNC DATA FAILED        | Because of an FSSB communication error, a slave could not receive correct data.   |
| 463    | n AXIS : SEND SLAVE DATA<br>FAILED   | Because of an FSSB communication error, the servo system could not receive correct data.  |
| 464    | n AXIS : WRITE ID DATA FAILED        | An attempt was made to write maintenance information on the amplifier maintenance screen, but it failed.  |
| 465    | n AXIS : READ ID DATA FAILED         | At power-up, amplifier initial ID information could not be read.  |
| 466    | n AXIS : MOTOR/AMP<br>COMBINATION    | The maximum current rating for the amplifier does not match that for the motor.   |
| 467    | n AXIS : ILLEGAL SETTING OF<br>AXIS  | The servo function for the following has not been enabled when an axis occupying a single DSP (corresponding to two ordinary axes) is specified on the axis setting screen. |
|        |                                      | 1. Learning control (bit 5 of parameter No. 2008 = 1)   |
|        |                                      | 2. High-speed current loop (bit 0 of parameter No. 2004 = 1)  |
|        |                                      | 3. High-speed interface axis (bit 4 of parameter No. 2005 = 1)  |

#### Details of servo alarm The details of servo alarm are displayed in the diagnosis display (No. 200 and No.204) as shown below. #5 #7 #6 #4 #3 #2 #1 #0 200 OVL LV OVC HCA HVA DCA FBA OFA #7 (OVL) : An overload alarm is being generated. #6 (LV) : A low voltage alarm is being generated in servo amp. #5 (OVC) : A overcurrent alarm is being generated inside of digital servo. #4 (HCA) : An abnormal current alarm is being generated in servo amp.

- **#3 (HVA)** : An overvoltage alarm is being generated in servo amp.
- $H_2(\mathbf{DCA}) = \mathbf{A} = \mathbf{A} = \mathbf{A} + \mathbf{A} = \mathbf{A} + \mathbf{A} = \mathbf{A} + 
- **#2 (DCA)** : A regenerative discharge circuit alarm is being generated in servo amp.
- #1 (FBA) : A disconnection alarm is being generated.#0 (OFA) : An overflow alarm is being generated inside of digital servo.

|  |   | 0.001110.00 | ului III IS | 001115 5 | eneratea | morae o | i aigitai | 501 /0. |
|--|---|-------------|-------------|----------|----------|---------|-----------|---------|
|  | - |             |             |          |          |         |           |         |

|     | #1  | #6 | #5 | #4  | #3 | #2 | #1 | #0 |
|-----|-----|----|----|-----|----|----|----|----|
| 201 | ALD |    |    | EXP |    |    |    |    |

When OVL equal 1 in diagnostic data No.200 (servo alarm No. 400 is being generated):

**#7 (ALD)** 0: Motor overheating

1 : Amplifier overheating

When FBAL equal 1 in diagnostic data No.200 (servo alarm No. 416 is being generated):

| ALD | EXP | Alarm details   |
|-----|-----|---|
| 1   | 0   | Built-in pulse coder disconnection (hardware)             |
| 1   | 1   | Separately installed pulse coder disconnection (hardware) |
| 0   | 0   | Pulse coder is not connected due to software.             |

|     | #7 | #6  | #5  | #4  | #3  | #2 | #1 | #0 |
|-----|----|-----|-----|-----|-----|----|----|----|
| 204 |    | OFS | MCC | LDA | PMS |    |    |    |

- #6 (OFS) : A current conversion error has occured in the digital servo.
- **#5** (MCC) : A magnetic contactor contact in the servo amplifier has welded.
- #4 (LDA) : The LED indicates that serial pulse coder C is defective.
- **#3 (PMS)** : A feedback pulse error has occured because the feedback cable is defective.

#### 6) Over travel alamrs

| Number | Message           | Contents   |
|--------|-------------------|--|
| 500    | OVER TRAVEL : +n  | Exceeded the n-th axis (axis 1 to 8) + side stored stroke limit I.<br>(Parameter No.1320 or 1326 <b>NOTE</b> )   |
| 501    | OVER TRAVEL :n    | Exceeded the n-th axis (axis 1 to 8) - side stored stroke limit I.<br>(Parameter No.1321 or 1327 <b>NOTE</b> )   |
| 502    | OVER TRAVEL : +n  | Exceeded the n-th axis (axis 1 to 8) + side stored stroke limit II.<br>(Parameter No.1322)   |
| 503    | OVER TRAVEL :n    | Exceeded the n-th axis (axis 1 to 8) - side stored stroke limit II. (Parameter No.1323)  |
| 504    | OVER TRAVEL : +n  | Exceeded the n-th axis (axis 1 to 8) + side stored stroke limit III.<br>(Parameter No.1324)  |
| 505    | OVER TRAVEL :n    | Exceeded the n-th axis (axis 1 to 8) - side stored stroke limit III. (Parameter No.1325)   |
| 506    | OVER TRAVEL : +n  | Exceeded the n-th axis (axis 1 to 8) + side hardware OT.   |
| 507    | OVER TRAVEL :n    | Exceeded the n-th axis (axis 1 to 8) - side hardware OT.   |
| 508    | INTERFERENCE : +n | When n-axis is moving in the positive direction, it interferes with the order tool post (only with two-path control)   |
| 509    | INTERFERENCE : -n | When n-axis is moving in the negative direction, it interferes with the order tool post (only with two-path control)   |
| 510    | OVER TRAVEL : +n  | A stroke limit check, made before starting movement, found that the end point of a block falls within the plus (+) side inhibited area along the n–axis defined by a stroke limit. Correct the program.  |
| 511    | OVER TRAVEL :n    | A stroke limit check, made before starting movement, found that the end point of a block falls within the minus (–) side inhibited area along the N–axis defined by a stroke limit. Correct the program. |

#### NOTE

Over travel alarms No. 504 and No. 505 are provided only with the T series. Parameters 1326 and 1327 are effective when EXLM(stroke limit switch signal) is on.

#### 7) Overheat alarms

| Number | Message                | Contents  |
|--------|------------------------|---|
| 700    | OVERHEAT: CONTROL UNIT | Control unit overheat<br>Check that the fan motor operates normally, and clean the air filter.  |
| 701    | OVERHEAT: FAN MOTOR    | The fan motor on the top of the cabinet for the control unit is over-<br>heated. Check the operation of the fan motor and replace the motor if<br>necessary.  |
| 704    | OVERHEAT: SPINDLE      | Spindle overheat in the spindle fluctuation detection<br>(1)If the cutting load is heavy, relieve the cutting condition.<br>(2)Check whether the cutting tool is share.<br>(3)Another possible cause is a faulty spindle amp. |

#### 8) Rigid tapping alarm

| Number | Message                            | Contents  |
|--------|------------------------------------|---|
| 740    | RIGID TAP ALARM : EXCESS<br>ERROR  | During rigid tapping, the position deviation of the spindle in the stop state exceeded the setting. |
| 741    | RIGID TAP ALARM : EXCESS<br>ERROR  | During rigid tapping, the position deviation of the spindle in the stop state exceeded the setting. |
| 742    | RIGID TAP ALARM : LSI OVER<br>FLOW | During rigid tapping, an LSI overflow occurred on the spindle side.                                 |

#### 9) Serial spindle alarms

| Number | Message                             | Contents   |
|--------|-------------------------------------|--|
| 749    | S-SPINDLE LSI ERROR                 | It is serial communication error while system is executing after power supply on. Following reasons can be considered.   |
|        |                                     | 1) Optical cable connection is fault or cable is not connected or cable is cut.  |
|        |                                     | 2) MAIN CPU board or option 2 board is fault.  |
|        |                                     | 3) Spindle amp. printed board is fault.<br>If this alarm occurs when CNC power supply is turned on or when<br>this alarm can not be cleared even if CNC is reset, turn off the power<br>supply also turn off the power supply in spindle side.   |
| 750    | SPINDLE SERIAL LINK START<br>FAULT  | This alarm is generated when the spindle control unit is not ready for starting correctly when the power is turned on in the system with the serial spindle.   |
|        |                                     | <ul><li>The four reasons can be considered as follows:</li><li>1) An improperly connected optic cable, or the spindle control unit's power is OFF.</li></ul>   |
|        |                                     | <ul> <li>2) When the NC power was turned on under alarm conditions other<br/>than SU–01 or AL–24 which are shown on the LED display of the<br/>spindle control unit.<br/>In this case, turn the spindle amplifier power off once and perform<br/>startup again.</li> </ul>   |
|        |                                     | <ul> <li>3) Other reasons (improper combination of hardware)<br/>This alarm does not occur after the system including the spindle con-<br/>trol unit is activated.</li> </ul>  |
|        |                                     | <ul> <li>4) The second spindle (when SP2, bit 4 of parameter No. 3701, is 1) is<br/>in one of the above conditions 1) to 3).</li> <li>See diagnostic display No. 409 for details.</li> </ul>   |
| 752    | FIRST SPINDLE MODE CHANGE<br>FAULT  | This alarm is generated if the system does not properly terminate a mode change. The modes include the Cs contouring, spindle position-<br>ing, rigid tapping, and spindle control modes. The alarm is activated if the spindle control unit does not respond correctly to the mode change command issued by the NC. |
| 754    | SPINDLE-1 ABNORMAL TORQUE<br>ALM    | Abnormal first spindle motor load has been detected.   |
| 762    | SECOND SPINDLE MODE<br>CHANGE FAULT | Refer to alarm No. 752. (For 2nd axis)   |
| 764    | SPINDLE-2 ABNORMAL TORQUE<br>ALM    | Same as alarm No. 754 (for the second spindle)   |
| 772    | SPINDLE-3 MODE CHANGE<br>ERROR      | Same as alarm No. 752 (for the third spindle)  |
| 774    | SPINDLE-3 ABNORMAL TORQUE<br>ALM    | Same as alarm No. 754 (for the third spindle)  |
| 782    | SPINDLE-4 MODE CHANGE<br>ERROR      | Same as alarm number 752 (for the fourth spindle)  |
| 784    | SPINDLE-4 ABNORMAL TORQUE<br>ALM    | Same as alarm number 754 (for the fourth spindle)  |

• The details of spindle alarm No.750

The details of spindle alarm No. 750 are displayed in the diagnosis display (No. 409) as shown below.

|     | #7 | #6 | #5 | #4 | #3  | #2  | #1  | #0  |
|-----|----|----|----|----|-----|-----|-----|-----|
| 409 |    |    |    |    | SPE | S2E | S1E | SHE |

**#3 (SPE)** 0 : In the spindle serial control, the serial spindle parameters fulfill the spindle unit startup conditions.

- 1 : In the spindle serial control, the serial spindle parameters do not fulfill the spindle unit startup conditions.
- #2 (S2E) 0: The second spindle is normal during the spindle serial control startup.
  - 1 : The second spindle was detected to have a fault during the spindle serial control startup.
- **#1 (S1E)** 0: The first spindle is normal during the spindle serial control startup.
  - 1 : The first spindle was detected to have a fault during the spindle axis serial control startup.
- #0 (SHE) 0: The serial communications module in the CNC is normal.
  - 1: The serial communications module in the CNC was detected to have a fault.

#### NOTE\*1

Note that the meanings of the SPM indications differ depending on which LED, the red or yellow LED, is on. When the red LED is on, the SPM indicates a 2-digit alarm number. When the yellow LED is on, the SPM indicates an error number that designates a sequence problem (for example, when a rotation command is entered with the emergency stop state not released).

→ See Appendix A.4, "Error Codes (Serial Spindle)."

#### Alarm Numbers and Alarms Displayed on the $\alpha$ Series Spindle Amplifier

| No.   | Message                      | SPM in-<br>dica-<br>tion(*1) | Faulty location and remedy  | Description   |
|-------|------------------------------|------------------------------|---|---|
| (750) | SPINDLE SERIAL LINK<br>ERROR | A0<br>A                      | <ol> <li>Replace the ROM on the SPM<br/>control printed circuit board.</li> <li>Replace the SPM control printed<br/>circuit board.</li> </ol> | The program does not start normally.<br>ROM series error or hardware ab-<br>normality on the SPM control printed<br>circuit board   |
| (749) | S-SPINDLE LSI ERROR          | A1                           | Replace the SPM control printed cir-<br>cuit board.   | An abnormality was detected in the CPU peripheral circuit of the SPM control circuit.   |
| 7n01  | SPN_n_: MOTOR OVER-<br>HEAT  | 01                           | <ol> <li>Check and correct the peripheral<br/>temperature and load status.</li> <li>If the cooling fan stops, replace it.</li> </ol>          | The thermostat embedded in the mo-<br>tor winding operated.<br>The internal temperature of the motor<br>exceeds the specified level.<br>The motor is used in excess of the<br>continuous rating, or the cooling com-<br>ponent is abnormal. |
| 7n02  | SPN_n_: EX SPEED ER-<br>ROR  | 02                           | <ol> <li>Check and correct the cutting<br/>conditions to decrease the load.</li> <li>Correct parameter No. 4082.</li> </ol>                   | The motor speed cannot follow a spe-<br>cified speed.<br>An excessive motor load torque is de-<br>tected.<br>The acceleration/deceleration time in<br>parameter No. 4082 is insufficient.   |

| No.  | Message                                  | SPM in-<br>dica-<br>tion(*1) | Faulty location and remedy   | Description   |
|------|--|------------------------------|--|---|
| 7n03 | SPN_n_ : FUSE ON DC<br>LINK BLOWN        | 03                           | <ol> <li>Replace the SPM unit.</li> <li>Check the motor insulation status.</li> <li>Replace the interface cable.</li> </ol>  | The PSM becomes ready (00 is indi-<br>cated), but the DC link voltage is too<br>low in the SPM.<br>The fuse in the DC link section in the<br>SPM is blown. (The power device is<br>damaged or the motor is ground–<br>fault.)<br>The JX1A/JX1B connection cable is<br>abnormal. |
| 7n04 | SPN_n_: INPUT FUSE/<br>POWER FAULT       | 04                           | Check the PSM input power supply status.   | The PSM detects open phase of pow-<br>er. (PSM alarm indication: 5)   |
| 7n07 | SPN_n_: OVERSPEED                        | 07                           | Check for a sequence error. (For ex-<br>ample, check whether spindle syn-<br>chronization was specified when the<br>spindle could not be turned.)  | The motor speed has exceeded<br>115% of its rated speed.<br>When the spindle axis was in position<br>control mode, positional deviations<br>were accumulated excessively (SFR<br>and SRV were turned off during<br>spindle synchronization.)                                    |
| 7n09 | SPN_n_ : OVERHEAT<br>MAIN CIRCUIT        | 09                           | <ol> <li>Improve the heat sink cooling status.</li> <li>If the heat sink cooling fan stops, replace the SPM unit.</li> </ol>   | Abnormal temperature rise of the power transistor radiator  |
| 7n11 | SPN_n_ : OVERVOLT<br>POW CIRCUIT         | 11                           | <ol> <li>Check the selected PSM.</li> <li>Check the input power voltage and<br/>change in power during motor de-<br/>celeration. If the voltage exceeds<br/>253 VAC (for the 200–V system) or<br/>530 VAC (for the 400–V system),<br/>improve the power supply imped-<br/>ance.</li> </ol> | Overvoltage of the DC link section of<br>the PSM was detected. (PSM alarm<br>indication: 7)<br>PSM selection error. (The maximum<br>output specification of the PSM is ex-<br>ceeded.)  |
| 7n12 | SPN_n_ : OVERCUR-<br>RENT POW<br>CIRCUIT | 12                           | <ol> <li>Check the motor insulation status.</li> <li>Check the spindle parameters.</li> <li>Replace the SPM unit.</li> </ol>   | The motor output current is abnormal-<br>ly high.<br>A motor–specific parameter does not<br>match the motor model.<br>Poor motor insulation   |
| 7n15 | SPN_n_: SP SWITCH<br>CONTROL<br>ALARM    | 15                           | <ol> <li>Check and correct the ladder sequence.</li> <li>Replace the switching MC.</li> </ol>  | The switch sequence in spindle<br>switch/output switch operation is ab-<br>normal.<br>The switching MC contact status<br>check signal and command do not<br>match.  |
| 7n16 | SPN_n_: RAM FAULT                        | 16                           | Replace the SPM control printed cir-<br>cuit board.  | Abnormality in an SPM control circuit component is detected. (RAM for external data is abnormal.)   |
| 7n18 | SPN_n_: SUMCHECK<br>ERROR PGM<br>DATA    | 18                           | Replace the SPM control printed cir-<br>cuit board.  | Abnormality in an SPM control circuit<br>component is detected. (Program<br>ROM data is abnormal.)  |
| 7n19 | SPN_n_: EX OFFSET<br>CURRENT U           | 19                           | Replace the SPM unit.  | Abnormality in an SPM component is detected. (The initial value for the U phase current detection circuit is abnormal.)   |

#### G. ALARM LIST

| No.  | Message                                  | SPM in-<br>dica-<br>tion(*1) | Faulty location and remedy   | Description  |
|------|--|------------------------------|--|--|
| 7n20 | SPN_n_: EX OFFSET<br>CURRENT V           | 20                           | Replace the SPM unit.  | Abnormality in an SPM component is detected. (The initial value of the V phase current detection circuit is abnormal.)   |
| 7n24 | SPN_n_: SERIAL<br>TRANSFER<br>ERROR      | 24                           | <ol> <li>Place the CNC-to-spindle cable<br/>away from the power cable.</li> <li>Replace the cable.</li> </ol>    | The CNC power is turned off (normal<br>power–off or broken cable).<br>An error is detected in communica-<br>tion data transferred to the CNC.  |
| 7n26 | SPN_n_: DISCONNECT<br>C-VELO DE-<br>TECT | 26                           | <ol> <li>Replace the cable.</li> <li>Re–adjust the pre–amplifier.</li> </ol>                                     | The signal amplitude of the detection<br>signal (connector JY2) on the Cs con-<br>tour control motor side is abnormal.<br>(Unconnected cable, adjustment er-<br>ror, etc.)   |
| 7n27 | SPN_n_: DISCONNECT<br>POS-CODER          | 27                           | <ol> <li>Replace the cable.</li> <li>Re–adjust the BZ sensor signal.</li> </ol>                                  | <ol> <li>The spindle position coder (connector JY4) signal is abnormal.</li> <li>The signal amplitude (connector JY2) of the MZ or BZ sensor is abnormal.<br/>(Unconnected cable, adjustment error, etc.)</li> </ol> |
| 7n28 | SPN_n_: DISCONNECT<br>C-POS DE-<br>TECT  | 28                           | <ol> <li>Replace the cable</li> <li>Re–adjust the pre–amplifier.</li> </ol>                                      | The position detection signal (con-<br>nector JY5) for Cs contour control is<br>abnormal.<br>(Unconnected cable, adjustment er-<br>ror, etc.)  |
| 7n29 | SPN_n_: SHORTTIME<br>OVERLOAD            | 29                           | Check and correct the load status.   | Excessive load has been applied<br>continuously for a certain period of<br>time. (This alarm is issued also when<br>the motor shaft has been locked in the<br>excitation state.)                                     |
| 7n30 | SPN_n_: OVERCUR-<br>RENT POW<br>CIRCUIT  | 30                           | Check and correct the power supply voltage.  | Overcurrent is detected in PSM main<br>circuit input. (PSM alarm indication:<br>1)<br>Unbalanced power supply.<br>PSM selection error (The maximum<br>PSM output specification is exceed-<br>ed.)                    |
| 7n31 | SPN_n_ : MOTOR LOCK<br>OR V-SIG LOS      | 31                           | <ol> <li>Check and correct the load status.</li> <li>Replace the motor sensor cable<br/>(JY2 or JY5).</li> </ol> | The motor cannot rotate at a specified<br>speed. (A level not exceeding the<br>SST level for the rotation command<br>has existed continuously.)<br>Abnormality in the speed detection<br>signal.                     |
| 7n32 | SPN_n_:RAM FAULT<br>SERIAL LSI           | 32                           | Replace the SPM control printed cir-<br>cuit board.  | Abnormality in an SPM control circuit<br>component is detected. (The LSI de-<br>vice for serial transfer is abnormal.)   |

| No.  | Message                                     | SPM in-<br>dica-<br>tion(*1) | Faulty location and remedy   | Description  |
|------|---|------------------------------|--|--|
| 7n33 | SPN_n_: SHORTAGE<br>POWER<br>CHARGE         | 33                           | <ol> <li>Check and correct the power supply voltage.</li> <li>Replace the PSM unit.</li> </ol>   | Charging of direct current power sup-<br>ply voltage in the power circuit section<br>is insufficient when the magnetic con-<br>tractor in the amplifier is turned on<br>(such as open phase and defective<br>charging resistor). |
| 7n34 | SPN_n_ : PARAMETER<br>SETTING ER-<br>ROR    | 34                           | Correct a parameter value according<br>to the manual.<br>If the parameter number is unknown,<br>connect the spindle check board, and<br>check the indicated parameter. | Parameter data exceeding the allow-<br>able limit is set.  |
| 7n35 | SPN_n_:EX SETTING<br>GEAR RATIO             | 35                           | Correct the value according to the parameter manual.   | Gear ratio data exceeding the allow-<br>able limit is set.   |
| 7n36 | SPN_n_: OVERFLOW<br>ERROR<br>COUNTER        | 36                           | Check whether the position gain value is too large, and correct the value.   | An error counter overflow occurred.  |
| 7n37 | SPN_n_: SPEED DE-<br>TECT PAR. ER-<br>ROR   | 37                           | Correct the value according to the parameter manual.   | The setting of the parameter for the number of pulses in the speed detector is incorrect.  |
| 7n39 | SPN_n_ : 1–ROT Cs SIG-<br>NAL ERROR         | 39                           | <ol> <li>Adjust the 1-rotation signal in the<br/>pre-amplifier.</li> <li>Check the cable shield status.</li> <li>Replace the cable.</li> </ol>                         | An incorrect relationship between the<br>1–rotation signal and the number of<br>AB phase pulses was detected dur-<br>ing Cs contour control.   |
| 7n40 | SPN_n_ : NO 1-ROT Cs<br>SIGNAL DE-<br>TECT  | 40                           | <ol> <li>Adjust the 1–rotation signal in the<br/>pre–amplifier.</li> <li>Check the cable shield status.</li> <li>Replace the cable.</li> </ol>                         | The 1–rotation signal is not gener-<br>ated during Cs contour control.   |
| 7n41 | SPN_n_: 1-ROT POS-<br>CODER ER-<br>ROR      | 41                           | <ol> <li>Check and correct the parameter.</li> <li>Replace the cable.</li> <li>Re–adjust the BZ sensor signal.</li> </ol>  | <ol> <li>The 1-rotation signal of the spindle position coder (connector JY4) is abnormal.</li> <li>The 1-rotation signal (connector JY2) of the MZ or BZ sensor is abnormal.</li> <li>Parameter setting error</li> </ol>         |
| 7n42 | SPN_n_ : NO 1-ROT.<br>POS-CODER<br>DETECT   | 42                           | <ol> <li>Replace the cable.</li> <li>Re–adjust the BZ sensor signal.</li> </ol>  | <ol> <li>The 1-rotation signal of the<br/>spindle position coder (connector<br/>JY4) is disconnected.</li> <li>The 1-rotation signal (connector<br/>JY2) of the MZ or BZ sensor is dis-<br/>connected.</li> </ol>                |
| 7n43 | SPN_n_ : DISCON. PC<br>FOR DIF. SP.<br>MODE | 43                           | Replace the cable.   | The differential speed position coder signal (connector JY8) in SPM type 3 is abnormal.  |
| 7n44 | SPN_n_: CONTROL<br>CIRCUIT(AD)<br>ERROR     | 44                           | Replace the SPM control printed cir-<br>cuit board.  | Abnormality in an SPM control circuit component was detected (A/D converter abnormality).  |
| 7n46 | SPN_n_: SCREW<br>1–ROT POS–<br>COD. ALARM   | 46                           | <ol> <li>Check and correct the parameter.</li> <li>Replace the cable.</li> <li>Re–adjust the BZ sensor signal.</li> </ol>  | An abnormality equivalent to alarm<br>41 was detected during thread cutting<br>operation.  |

#### G. ALARM LIST

| No.  | Message                                    | SPM in-<br>dica-<br>tion(*1) | Faulty location and remedy   | Description   |
|------|--|------------------------------|--|---|
| 7n47 | SPN_n_ : POS-CODER<br>SIGNAL AB-<br>NORMAL | 47                           | <ol> <li>Replace the cable.</li> <li>Re–adjust the BZ sensor signal.</li> <li>Correct the cable layout (vicinity of<br/>the power line).</li> </ol>  | <ol> <li>The A/B phase signal of the spindle position coder (connector JY4) is abnormal.</li> <li>The A/B phase signal (connector JY2) of the MZ or BZ sensor is abnormal.</li> <li>The relationship between the A/B phase and 1–rotation signal is incorrect (Pulse interval mismatch).</li> </ol> |
| 7n49 | SPN_n_ : HIGH CONV.<br>DIF. SPEED          | 49                           | Check whether the calculated differ-<br>ential speed value exceeds the maxi-<br>mum motor speed.   | In differential speed mode, the speed<br>of the other spindle converted to the<br>speed of the local spindle has ex-<br>ceeded the allowable limit (the differ-<br>ential speed is calculated by multiply-<br>ing the speed of the other spindle by<br>the gear ratio).                             |
| 7n50 | SPN_n_: SPNDL CON-<br>TROL OVER-<br>SPEED  | 50                           | Check whether the calculated value exceeds the maximum motor speed.  | In spindle synchronization, the speed<br>command calculation value exceed-<br>ed the allowable limit (the motor<br>speed is calculated by multiplying the<br>specified spindle speed by the gear<br>ratio).   |
| 7n51 | SPN_n_: LOW VOLT DC<br>LINK                | 51                           | <ol> <li>Check and correct the power supply voltage.</li> <li>Replace the MC.</li> </ol>   | Input voltage drop was detected.<br>(PSM alarm indication: 4) (Momen-<br>tary power failure or poor MC contact)   |
| 7n52 | SPN_n_: ITP SIGNAL<br>ABNORMAL I           | 52                           | <ol> <li>Replace the SPM control printed<br/>circuit board.</li> <li>Replace the spindle interface<br/>printed circuit board in the CNC.</li> </ol>  | NC interface abnormality was de-<br>tected (the ITP signal stopped).  |
| 7n53 | SPN_n_: ITP SIGNAL<br>ABNORMAL II          | 53                           | <ol> <li>Replace the SPM control printed<br/>circuit board.</li> <li>Replace the spindle interface<br/>printed circuit board in the CNC.</li> </ol>  | NC interface abnormality was de-<br>tected (the ITP signal stopped).  |
| 7n56 | SPN_n_: INNER COOL-<br>ING FAN STOP        | 56                           | Replace the SPM unit.  | The cooling fan in the SPM control cir-<br>cuit stopped.  |
| 7n57 | SPN_n_: EX DECEL-<br>ERATION<br>POWER      | 57                           | <ol> <li>Decrease the acceleration/deceleration duty.</li> <li>Check the cooling condition (peripheral temperature).</li> <li>If the cooling fan stops, replace the resistor.</li> <li>If the resistance is abnormal, replace the resistor.</li> </ol> | An overload was detected in the re-<br>generative resistance. (PSMR alarm<br>indication: 8)<br>Thermostat operation or short-time<br>overload was detected.<br>The regenerative resistor was dis-<br>connected, or an abnormal resis-<br>tance was detected.  |
| 7n58 | SPN_n_:OVERLOAD IN<br>PSM                  | 58                           | <ol> <li>Check the PSM cooling status.</li> <li>Replace the PSM unit.</li> </ol>   | The temperature of the radiator of the PSM has increased abnormally. (PSM alarm indication: 3)  |
| 7n59 | SPN_n_: COOLING FAN<br>STOP IN PSM         | 59                           | Replace the SPM unit.  | The cooling fan in the PSM stopped.<br>(PSM alarm indication: 2)  |

#### 10) System alarms

(These alarms cannot be reset with reset key.)

| Number | Message                           | Contents   |  |  |
|--------|-----------------------------------|--|--|--|
| 900    | ROM PARITY                        | A parity error occurred in the CNC, macro, or servo ROM. Correct t contents of the flash ROM having the displayed number.  |  |  |
| 910    | SRAM PARITY : (BYTE 0)            | A RAM parity error occurred in the part program storage RAM. Clear the RAM, or replace the SRAM module or motherboard. Subseque  |  |  |
| 911    | SRAM PARITY : (BYTE 1)            | ly, re–set the parameters and all other data.  |  |  |
| 912    | DRAM PARITY : (BYTE 0)            | A RAM parity error occurred in the DRAM module. Replace the  |  |  |
| 913    | DRAM PARITY : (BYTE 1)            | DRAM module.   |  |  |
| 914    | DRAM PARITY : (BYTE 2)            |  |  |  |
| 915    | DRAM PARITY : (BYTE 3)            |  |  |  |
| 916    | DRAM PARITY : (BYTE 4)            | -  |  |  |
| 917    | DRAM PARITY : (BYTE 5)            | -  |  |  |
| 918    | DRAM PARITY : (BYTE 6)            | -  |  |  |
| 919    | DRAM PARITY : (BYTE 7)            | -  |  |  |
| 920    | SERVO ALARM (1–4 AXIS)            | Servo alarm (first to fourth axis). A watchdog alarm condition oc-<br>curred, or a RAM parity error occurred in the axis control card.   |  |  |
|        |                                   | Replace the axis control card.   |  |  |
| 921    | SERVO ALARM (5–8 AXIS)            | Servo alarm (fifth to eighth axis). A watchdog alarm condition oc-<br>curred, or a RAM parity error occurred in the axis control card.   |  |  |
|        |                                   | Replace the axis control card.   |  |  |
| 926    | FSSB ALARM                        | FSSB alarm.<br>Replace the axis control card.  |  |  |
| 930    | CPU INTERRUPT                     | CPU error (abnormal interrupt).<br>The motherboard or CPU card may be faulty.  |  |  |
| 935    | SRAM ECC ERROR                    | An error occurred in RAM for part program storage.<br>Action:<br>Replace the master printed circuit board (SRAM module), perform<br>all–clear operation, and set all parameter and other data again. |  |  |
| 950    | PMC SYSTEM ALARM                  | An error occurred in the PMC.<br>The PMC control circuit on the motherboard may be faulty.   |  |  |
| 951    | PMC WATCH DOG ALARM               | An error occurred in the PMC.<br>(Watchdog alarm)<br>The motherboard may be faulty.  |  |  |
| 972    | NMI OCCURRED IN OTHER MOD-<br>ULE | An NMI occurred on a board other than the motherboard.<br>The option board may be faulty.  |  |  |
| 973    | NON MASK INTERRUPT                | An NMI occurred as a result of an unknown cause.   |  |  |
| 974    | F–BUS ERROR                       | A bus error occurred on the FANUC bus.<br>The motherboard or option board may be faulty.   |  |  |
| 975    | BUS ERROR                         | A bus error occurred on the motherboard.<br>The motherboard may be faulty.   |  |  |
| 976    | L-BUS ERROR                       | A bus error occurred on the local bus.<br>The motherboard may be faulty.   |  |  |

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