



*Changes for the Better*

MITSUBISHI CNC

# **Specifications Manual**

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## **C70**

# Introduction

This manual describes the specifications of CNC C70.

To safely use this CNC module, thoroughly study the "Precautions for Safety" on the next page before use.

## Details described in this manual


At the beginning of each item, a table indicating its specification according to the model.


○ : Standard


△ : Optional

□ : Selection

## CAUTION

 The items that are not described in this manual must be interpreted as "not possible".

 This manual is written on the assumption that all option functions are added.

 Some functions may differ or some functions may not be usable depending on the NC system (software) version.

## General precautions

(1) When the contents of this manual is updated, the version (A, B, ...) on the cover will be incremented.

(2) In this manual, the machining center system is described as "M system" and the lathe system is described as "L system".



## Precautions for Safety

Always read the specifications issued by the machine maker, this manual, related manuals and attached documents before installation, operation, programming, maintenance or inspection to ensure correct use. Understand this numerical controller, safety items and cautions before using the unit.

This manual ranks the safety precautions into "Danger", "Warning" and "Caution".



When there is a great risk that the user could be subject to fatalities or serious injuries if handling is mistaken.



When the user could be subject to fatalities or serious injuries if handling is mistaken.



When the user could be subject to injuries or when physical damage could occur if handling is mistaken.

Note that even items ranked as " **CAUTION**", may lead to major results depending on the situation. In any case, important information that must always be observed is described.

The meanings of the pictorial signs are given below.

The following signs indicate prohibition and compulsory.

|  |   |
|--|---|
|  | <p>This sign indicates prohibited behavior (must not do).<br/>For example,  indicates "Keep fire away".</p> |
|--|---|

|  |  |
|--|--|
|  | <p>This sign indicated a thing that is pompously (must do).<br/>For example,  indicates "it must be grounded".</p> |
|--|--|

The meaning of each pictorial sign is as follows.




|                |                                  |                       |                                      |                         |
|----------------|----------------------------------|-----------------------|--------------------------------------|-------------------------|
| <br>CAUTION    | <br>CAUTION<br>rotated object    | <br>CAUTION<br>HOT    | <br>Danger<br>Electric shock<br>risk | <br>Danger<br>explosive |
| <br>Prohibited | <br>Disassembly is<br>prohibited | <br>KEEP FIRE<br>AWAY | <br>General<br>instruction           | <br>Earth ground        |

|                                |
|--------------------------------|
| <b>DANGER</b>                  |
| Not applicable in this manual. |




|                                |
|--------------------------------|
| <b>WARNING</b>                 |
| Not applicable in this manual. |

 **CAUTION**

**1. Items related to product and manual**

-  The items that are not described in this manual must be interpreted as "not possible".
-  This manual is written on the assumption that all option functions are added.
-  Some functions may differ or some functions may not be usable depending on the NC system (software) version.

**2. Items related to start up and maintenance**

-  Follow the power specifications (input voltage range, frequency range, momentary power failure time range) described in this manual.
-  Follow the environment conditions (ambient temperature, humidity, vibration, atmosphere) described in this manual.
-  If the parameter is used to set the temperature rise detection function to invalid, overheating may occur, thereby disabling control and possibly resulting in the axes running out of control, which in turn may result in machine damage and/or bodily injury or destruction of the unit. It is for this reason that the detection function is normally left "valid" for operation.

## Treatment of waste

The following two laws will apply when disposing of this product. Considerations must be made to each law. The following laws are in effect in Japan. Thus, when using this product overseas, the local laws will have a priority. If necessary, indicate or notify these laws to the final user of the product.

- (1) Requirements for "Law for Promotion of Effective Utilization of Resources"
  - (a) Recycle as much of this product as possible when finished with use.
  - (b) When recycling, often parts are sorted into steel scraps and electric parts, etc., and sold to scrap contractors. Mitsubishi recommends sorting the product and selling the members to appropriate contractors.
  
- (2) Requirements for "Law for Treatment of Waste and Cleaning"
  - (a) Mitsubishi recommends recycling and selling the product when no longer needed according to item (1) above. The user should make an effort to reduce waste in this manner.
  - (b) When disposing a product that cannot be resold, it shall be treated as a waste product.
  - (c) The treatment of industrial waste must be commissioned to a licensed industrial waste treatment contractor, and appropriate measures, including a manifest control, must be taken.
  - (d) Batteries correspond to "primary batteries", and must be disposed of according to local disposal laws.



## Disposal



(Note) This symbol mark is for EU countries only.  
This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.

Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.

This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.

If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows:

Hg: mercury (0,0005%), Cd: cadmium (0,002%), Pb: lead (0,004%)

In the European Union there are separate collection systems for used batteries and accumulators. Please, dispose of batteries and accumulators correctly at your local community waste collection/recycling centre.

Please, help us to conserve the environment we live in!





## **Trademarks**

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## 本製品の取扱いについて

(日本語 /Japanese)

本製品は工業用 (クラス A) 電磁環境適合機器です。販売者あるいは使用者はこの点に注意し、住商業環境以外での使用をお願いいたします。

## Handling of our product

(English)

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

## 본 제품의 취급에 대해서

(한국어 /Korean)

이 기기는 업무용 (A 급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정외의 지역에서 사용하는 것을 목적으로 합니다.



# WARRANTY

Please confirm the following product warranty details before using MITSUBISHI CNC.

## **1. Warranty Period and Coverage**

Should any fault or defect (hereafter called "failure") for which we are liable occur in this product during the warranty period, we shall provide repair services at no cost through the distributor from which the product was purchased or through a Mitsubishi Electric service provider. Note, however that this shall not apply if the customer was informed prior to purchase of the product that the product is not covered under warranty. Also note that we are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit is replaced.

### **[Warranty Term]**

The term of warranty for this product shall be twenty-four (24) months from the date of delivery of product to the end user, provided the product purchased from us in Japan is installed in Japan (but in no event longer than thirty (30) months, including the distribution time after shipment from Mitsubishi Electric or its distributor).

Note that, for the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased; please refer to "2. Service in overseas countries" as will be explained.

### **[Limitations]**

- (1) The customer is requested to conduct an initial failure diagnosis by him/herself, as a general rule. It can also be carried out by us or our service provider upon the customer's request and the actual cost will be charged.
- (2) This warranty applies only when the conditions, method, environment, etc., of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual, user's manual, and the caution label affixed to the product, etc.
- (3) Even during the term of warranty, repair costs shall be charged to the customer in the following cases:
  - (a) a failure caused by improper storage or handling, carelessness or negligence, etc., or a failure caused by the customer's hardware or software problem
  - (b) a failure caused by any alteration, etc., to the product made by the customer without Mitsubishi Electric's approval
  - (c) a failure which may be regarded as avoidable, if the customer's equipment in which this product is incorporated is equipped with a safety device required by applicable laws or has any function or structure considered to be indispensable in the light of common sense in the industry
  - (d) a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
  - (e) any replacement of consumable parts (including a battery, relay and fuse)
  - (f) a failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning, and natural disasters
  - (g) a failure which is unforeseeable under technologies available at the time of shipment of this product from our company
  - (h) any other failures which we are not responsible for or which the customer acknowledges we are not responsible for

## **2. Service in Overseas Countries**

If the customer installs the product purchased from us in his/her machine or equipment, and export it to any country other than where he/she bought it, the customer may sign a paid warranty contract with our local FA center.

This falls under the case where the product purchased from us in or outside Japan is exported and installed in any country other than where it was purchased.

For details please contact the distributor from which the customer purchased the product.

## **3. Exclusion of Responsibility for Compensation against Loss of Opportunity, Secondary Loss, etc.**

Whether during or after the term of warranty, we assume no responsibility for any damages arising from causes for which we are not responsible, any losses of opportunity and/or profit incurred by the customer due to a failure of this product, any damages, secondary damages or compensation for accidents arising under specific circumstances that either foreseen or unforeseen by Mitsubishi Electric, any damages to products other than this product, or compensation for any replacement work, readjustment and startup test run of on-site machines or any other operations conducted by the customer.

## **4. Changes in Product Specifications**

Specifications shown in our catalogs, manuals or technical documents are subject to change without notice.

## **5. Product Application**

- (1) For the use of this product, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in the product, and a backup or fail-safe function should operate on an external system to the product when any failure or malfunction occurs.
- (2) Mitsubishi CNC is designed and manufactured solely for applications to machine tools to be used for industrial purposes. Do not use this product in any applications other than those specified above, especially those which are substantially influential on the public interest or which are expected to have significant influence on human lives or properties.



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## II. FUNCTIONAL SPECIFICATIONS

### C70 Series Specifications List

○: Standard    △: Option    □: Selection

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O: Standard   Δ: Option   □: Selection

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O: Standard    Δ: Option    □: Selection

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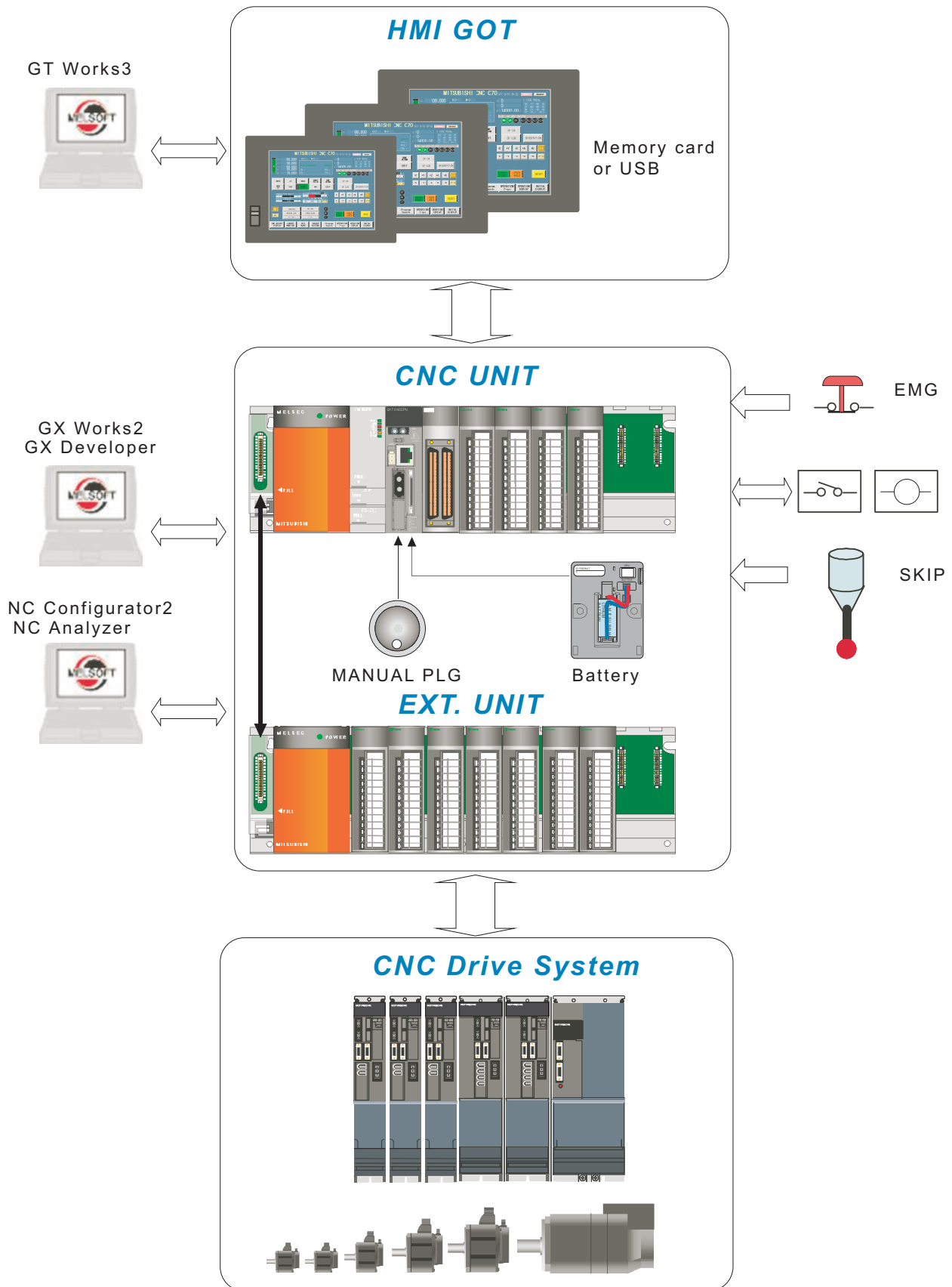


# **I GENERAL SPECIFICATIONS**

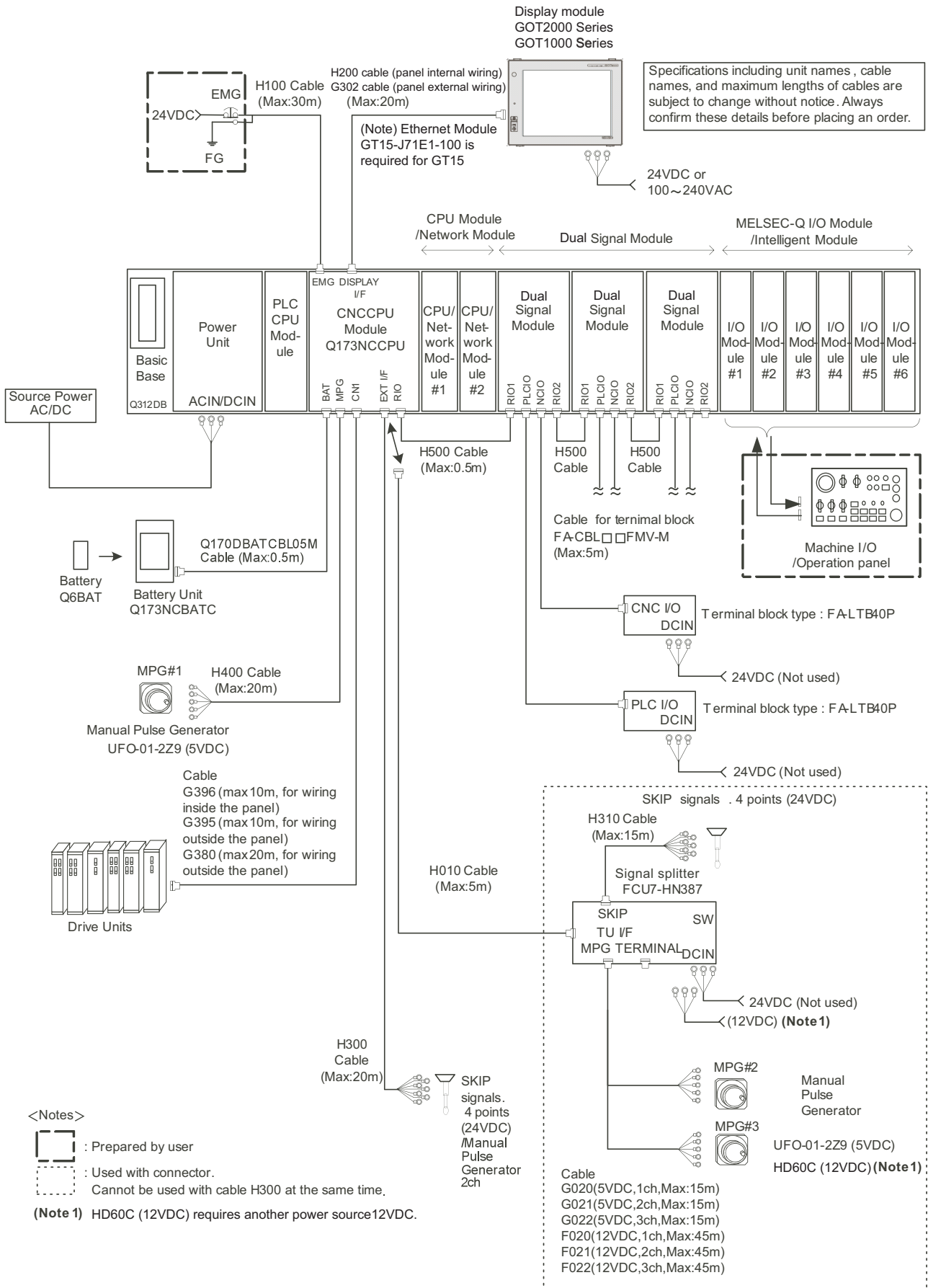


# 1. System Configuration

## 1.1 System Basic Configuration Drawing



### 1.2 General Connection Diagram



## 1.3 Component Modules

## 1.3.1 CNC Control Unit

## (1) Basic base

| Model name | Remarks  | Reference  |
|------------|----------|--|
| Q35DB      | 5 slots  | QCPU User's Manual<br>(Hardware Design,<br>Maintenance and Inspection)<br>(SH(NA)-080483ENG) |
| Q38DB      | 8 slots  |  |
| Q312DB     | 12 slots |  |

## (2) Power supply

| Model name | Remarks  | Reference  |
|------------|--|--|
| Q61P       | Input power supply : 100 to 240VAC<br>Output power supply : 5VDC<br>Output current:6A  | QCPU User's Manual<br>(Hardware Design,<br>Maintenance and Inspection)<br>(SH(NA)-080483ENG) |
| Q63P       | Input power supply: 24VDC<br>Output power supply: 5VDC<br>Output current: 6A   |  |
| Q64PN      | Input power supply : 100 to 240VAC<br>Output power supply : 5VDC<br>Output current : 8.5A  |  |
| Q64P       | Input power supply: 100 to 120VAC/<br>200 to 240VAC<br>Output power supply: 5VDC<br>Output current: 8.5A<br>(Note) Out of production |  |

(3) PLC CPU

| Model name | Remarks   | Reference  |
|------------|---|--|
| Q03UDCPU   | Program capacity: 30k steps                             | QCPU User's Manual<br>(Hardware Design,<br>Maintenance and Inspection)<br>(SH(NA)-080483ENG) |
| Q04UDHCPU  | Program capacity: 40k steps                             |  |
| Q06UDHCPU  | Program capacity: 60k steps                             |  |
| Q13UDHCPU  | Program capacity:130k steps                             |  |
| Q26UDHCPU  | Program capacity:260k steps                             |  |
| Q03UDECPU  | Ethernet built-in type, Program capacity: 30k steps     |  |
| Q04UDEHCPU | Ethernet built-in type, Program capacity: 40k steps     |  |
| Q06UDEHCPU | Ethernet built-in type, Program capacity: 60k steps     |  |
| Q10UDEHCPU | Ethernet built-in type, Program capacity: 100k steps    |  |
| Q13UDEHCPU | Ethernet built-in type, Program capacity: 130k steps    |  |
| Q26UDEHCPU | Ethernet built-in type, Program capacity: 260k steps    |  |
| Q03UDVCPU  | High-speed type, Program capacity: 30k steps<br>(Note)  |  |
| Q04UDVCPU  | High-speed type, Program capacity: 40k steps<br>(Note)  |  |
| Q06UDVCPU  | High-speed type, Program capacity: 60k steps<br>(Note)  |  |
| Q13UDVCPU  | High-speed type, Program capacity: 130k steps<br>(Note) |  |
| Q26UDVCPU  | High-speed type, Program capacity: 260k steps<br>(Note) |  |

(Note) The High-Speed Universal model is compatible with the safety observation function, but not yet certified under the European safety standards “EN ISO 13849-1 Cat3 PL d” or “EN62061/SIL CL2” by TUV.

(4) CNC CPU module

| Model name    | Remarks   |
|---------------|---|
| Q173NCCPU-S01 | CNC CPU module  |
| Battery kit   | One each of following accessories are provided:<br>Battery holder unit+Connection cable (0.5m) Q173NCBATC(Q170DBATC), Battery Q6BAT |

(5) Battery holder unit

| Model name | Remarks             |
|------------|---------------------|
| Q173NCBATC | Battery holder unit |

(6) Input module

(a) AC

| Model name | Remarks   | Reference  |
|------------|---|--|
| QX10       | 16 points, 100 to 120VAC<br>8mA(100VAC, 60Hz)/7mA(100VAC, 50Hz)<br>Response time: 20ms<br>16 points/common, 18-point terminal block   | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QX28       | 8 points, 100 to 240VAC<br>17mA(200VAC, 60Hz)<br>/14mA(200VAC, 50Hz)/8mA(100VAC, 60Hz)/<br>7mA(100VAC, 50Hz)<br>Response time: 20ms<br>8 points/common, 18-point terminal block |  |

(b) DC (positive common type)

| Model name | Remarks   | Reference  |
|------------|---|--|
| QX40       | 16 points, 24VDC, 4mA,<br>Response time: 1/5/10/20/70ms<br>16 points/common, Positive common type<br>18-point terminal block      | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QX40-S1    | 16 points, 24VDC, 6mA,<br>Response time: 0.1/0.2/0.4/0.6/1ms<br>16 points/common, Positive common type<br>18-point terminal block |  |
| QX41       | 32 points, 24VDC, 4mA,<br>Response time: 1/5/10/20/70ms<br>32 points/common, Positive common type<br>40-pin connector             |  |
| QX41-S1    | 32 points, 24VDC, 4mA,<br>Response time: 0.1/0.2/0.4/0.6/1ms<br>32 points/common, Positive common type<br>40-pin connector        |  |
| QX42       | 64 points, 24VDC, 4mA,<br>Response time: 1/5/10/20/70ms<br>32 points/common, Positive common type<br>40-pin connector             |  |
| QX42-S1    | 64 points, 24VDC, 4mA,<br>Response time: 0.1/0.2/0.4/0.6/1ms<br>32 points/common, Positive common type<br>40-pin connector        |  |



(c) DC sensor

| Model name | Remarks   | Reference  |
|------------|---|--|
| QX70       | 16 points, 5/12VDC, 1.2mA(5VDC)/3.3mA(12VDC)<br>Response time: 1/5/10/20/70ms<br>16 points/common, Positive/negative common type<br>18-point terminal block | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QX71       | 32 points, 5/12VDC, 1.2mA(5VDC)/3.3mA(12VDC)<br>Response time: 1/5/10/20/70ms<br>32 points/common, Positive/negative common type<br>40-pin connector        |  |
| QX72       | 64 points, 5/12VDC, 1.2mA(5VDC)/3.3mA(12VDC)<br>Response time: 1/5/10/20/70ms<br>32 points/common, Positive/negative common type<br>40-pin connector        |  |

(d) DC (negative common type)

| Model name | Remarks   | Reference  |
|------------|---|--|
| QX80       | 16 points, 24VDC, 4mA<br>Response time: 1/5/10/20/70ms<br>16 points/common, Negative common type<br>18-point terminal block | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QX81       | 32 points, 24VDC, 4mA<br>Response time: 1/5/10/20/70ms<br>32 points/common, Negative common type<br>37-pin D sub-connector  |  |
| QX82       | 64 points, 24VDC, 4mA<br>Response time: 1/5/10/20/70ms<br>32 points/common, Negative common type<br>40-pin connector        |  |
| QX82-S1    | 64 points, 24VDC 4mA<br>Response time: 0.2/0.3/0.5/0.7/1.3ms<br>32 points/common, Negative common type<br>40-pin connector  |  |

(7) Analog input module

(a) Voltage input module

| Model name | Remarks  | Reference   |
|------------|--|---|
| Q68ADV     | 8 channels,<br>Input: -10 to 10VDC<br>Output (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; 0 to 16000;<br>-16000 to 16000<br>Conversion speed: 80µs/channel<br>18-point terminal block | Analog-Digital Converter<br>Module User's Manual<br>(SH(NA)-080055) |

(b) Current input module

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q62AD-DGH  | 2 channels,<br>Input: 4 to 20mADC<br>Output (resolution): 0 to 32000; 0 to 64000<br>Conversion speed: 10ms/2channels<br>18-point terminal block, Channels are isolated,<br>Power supply for 2-wire transmitter  | Channel Isolated High<br>Resolution Analog-Digital<br>Converter Module/Channel<br>Isolated High Resolution<br>Analog-Digital Converter<br>Module (With Signal<br>Conditioning Function) User's<br>Manual<br>(SH(NA)-080277) |
| Q68ADI     | 8 channels,<br>Input: 0 to 20mADC<br>Output (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; 0 to 16000;<br>-16000 to 16000<br>Conversion speed: 80µs/channel<br>18-point terminal block | Analog-Digital Converter<br>Module User's Manual<br>(SH(NA)-080055)   |

(c) Voltage/current input module

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q64AD      | 4 channels,<br>Input: -10 to 10VDC, 0 to 20mADC<br>Output (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; 0 to 16000;<br>-16000 to 16000<br>Conversion speed: 80µs/channel<br>18-point terminal block | Analog-Digital Converter<br>Module User's Manual<br>(SH(NA)-080055)   |
| Q64AD-GH   | 4 channels,<br>Input: -10 to 10VDC, 0 to 20mADC<br>Output (resolution): 0 to 32000; -32000 to 32000;<br>0 to 64000; -64000 to 64000<br>Conversion speed: 10ms/4channels<br>18-point terminal block, Channels are isolated     | Channel Isolated High<br>Resolution Analog-Digital<br>Converter Module/Channel<br>Isolated High Resolution<br>Analog-Digital Converter<br>Module (With Signal<br>Conditioning Function) User's<br>Manual<br>(SH(NA)-080277) |

(8) Output module

(a) Relay

| Model name | Remarks   | Reference  |
|------------|---|--|
| QY10       | 16 points, 24VDC/240VAC, 2A/point, 8A/common<br>Response time: 12ms 16 points/common<br>18-point terminal block | I/O module Type Building<br>Block User's Manual<br>(SH(NA)-080042) |
| QY18A      | 8 points, 24VDC/240VAC, 2A/point<br>Response time: 12ms<br>18-point terminal block, All relays isolated         |  |

(b) Triac

| Model name | Remarks  | Reference  |
|------------|--|--|
| QY22       | 16 points, 100 to 240VAC, Minimum load voltage<br>Current: 24VAC, 100mA/100/240VAC, 25mA,<br>OFF-time leakage current: 1.5mA(120VAC)/<br>3mA(240VAC)<br>Response time: 1ms+0.5 cycle<br>16 points/common, 18-point terminal block<br>Surge killer provided | I/O module Type Building<br>Block User's Manual<br>(SH(NA)-080042) |

(c) Transistor (sink type)

| Model name | Remarks   | Reference  |
|------------|---|--|
| QY40P      | 16 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 16 points/common, Sink type<br>18-point terminal block, Thermal protection<br>provided, Short circuit protection provided<br>Surge killer provided | I/O module Type Building<br>Block User's Manual<br>(SH(NA)-080042) |
| QY41P      | 32 points, 12 to 24VDC<br>OFF-time leakage current: 0,1mA<br>Response time: 1ms, 32 points/common, Sink type<br>40-pin connector, Thermal protection provided<br>Short circuit protection provided<br>Surge killer provided         |  |
| QY42P      | 64 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 32 points/common, Sink type<br>40-pin connector, Thermal protection provided<br>Short circuit protection provided<br>Surge killer provided         |  |
| QY50       | 16 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 16 points/common, Sink type<br>18-point terminal block, Surge killer provided<br>Fuse provided   |  |

(d) Transistor (independent)

| Model name | Remarks   | Reference  |
|------------|---|--|
| QY68A      | 8 points, 5 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 10ms, Sink/source type<br>18-point terminal block, Surge killer provided<br>All points isolated | I/O module Type Building Block User's Manual (SH(NA)-080042) |

(e) TTL CMOS

| Model name | Remarks  | Reference  |
|------------|--|--|
| QY70       | 16 points, 5 to 12VDC, Response time: 0.5ms<br>16 points/common, Sink type<br>18-point terminal block, Fuse provided | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QY71       | 32 points, 5 to 12VDC, Response time: 0.5ms<br>32 points/common, Sink type<br>40-pin connector, Fuse provided        |  |

(f) Transistor (source type)

| Model name | Remarks   | Reference  |
|------------|---|--|
| QY80       | 16 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 16 points/common<br>Source type, 18-point terminal block<br>Surge killer provided, Fuse provided   | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| QY81P      | 32 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 32 points/common<br>Source type, 37-pin D sub-connector, Thermal protection provided, Short circuit protection provided, Surge killer provided |  |
| QY82P      | 64 points, 12 to 24VDC<br>OFF-time leakage current: 0.1mA<br>Response time: 1ms, 32 points/common, Source type<br>40-pin connector, Thermal protection provided<br>Short circuit protection provided<br>Surge killer provided   |  |

(9) Analog output module

(a) Voltage output module

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q68DAVN    | 8 channels<br>Input (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; -16000 to 16000<br>Output: -10 to 10VDC<br>Conversion speed: 80µs/channel<br>18-point terminal block, Transformer insulation<br>between power supply and output modules | Digital-Analog Converter<br>Module User's Manual<br>(SH(NA)-080054) |

(b) Current input module

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q68DAIN    | 8 channels<br>Input (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000<br>Output: 0 to 20mADC<br>Conversion speed: 80µs/channel<br>18-point terminal block, Transformer insulation<br>between power supply and output modules | Digital-Analog Converter<br>Module User's Manual<br>(SH(NA)-080054) |

(c) Voltage/current output module

| Model name | Remarks  | Reference  |
|------------|--|--|
| Q62DAN     | 2 channels<br>Input (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; -16000 to 16000<br>Output: -10 to 10VDC, 0 to 20mADC<br>Conversion speed: 80µs/channel<br>18-point terminal block, Transformer insulation<br>between power supply and output modules | Digital-Analog Converter<br>Module User's Manual<br>(SH(NA)-080054)                      |
| Q62DA-FG   | 2 channels<br>Input (resolution): 0 to 12000; -12000 to 12000; -<br>16000 to 16000<br>Output: -12 to 12VDC, 0 to 22mADC<br>Conversion speed: 10ms/2channels<br>18-point terminal block, Channels are isolated  | Channel Isolated Digital-<br>Analog Converter Module<br>User's Manual<br>(SH(NA)-080281) |
| Q64DAN     | 4 channels<br>Input (resolution): 0 to 4000; -4000 to 4000;<br>0 to 12000; -12000 to 12000; -16000 to 16000<br>Output: -10 to 10VDC, 0 to 20mADC<br>Conversion speed: 80µs/channel<br>18-point terminal block, Transformer insulation<br>between power supply and output modules | Digital-Analog Converter<br>Module User's Manual<br>(SH(NA)-080054)                      |

(10) Interrupt input module

| Model name | Remarks   | Reference  |
|------------|---|--|
| QI60       | 16 points, 24VDC 4mA<br>Response time: 0.1/0.2/0.4/0.6/1ms<br>16 points/common, 18-point terminal block | I/O module Type Building<br>Block User's Manual<br>(SH(NA)-080042) |

## (11) Temperature input module

## (a) RTD

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q64RD      | 4 channels<br>Platinum RTD (Pt100(JIS C1604-1997, IEC 751 1983), JPt100(JISC1604-1981))<br>Conversion speed: 40ms/channel<br>18-point terminal block  | RTD Input Module Channel Isolated<br>RTD Input Module User's Manual (SH(NA)-080142) |
| Q64RD-G    | 4 channels<br>Platinum RTD (Pt100(JIS C1604-1997, IEC 751 1983), JPt100(JISC1604-1981), Ni100Ω (DIN43760 1987))<br>Conversion speed: 40ms/channel<br>18-point terminal block, Channels are isolated |   |

## (b) Thermocouple

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q64TD      | 4 channels, Thermocouple (JIS C1602-1995)<br>Conversion speed: 40ms/channel<br>18-point terminal block  | Thermocouple Input Module Channel Isolated<br>Thermocouple/Micro Voltage Input Module User's Manual (SH(NA)-080141) |
| Q64TDV-GH  | 4 channels, Thermocouple (JIS C1602-1995)<br>Micro voltage input range: -100mV to 100mV<br>Conversion speed: (sampling period × 3)/channel<br>18-point terminal block                     |   |
| Q64TCTT    | 4 channels, Thermocouple (K, J, T, B, S, E, R, N, U, L, PLII, W5Re/W26Re)<br>Without heater disconnection detection<br>Sampling period: 0.5s/4channels<br>18-point terminal block         | Temperature Control Module User's Manual (SH(NA)-080121)  |
| Q64TCTTBW  | 4 channels, Thermocouple (K, J, T, B, S, E, R, N, U, L, PLII, W5Re/W26Re)<br>With heater disconnection detection<br>Sampling period: 0.5s/4channels<br>2 units of 18-point terminal block |   |

## (c) Platinum RTD

| Model name | Remarks  | Reference  |
|------------|--|--|
| Q64TCRT    | 4 channels, Platinum RTD (Pt100, JPt100)<br>Without heater disconnection detection<br>Sampling period: 0.5s/4channels<br>18-point terminal block         | Temperature Control Module User's Manual (SH(NA)-080121) |
| Q64TCRTBW  | 4 channels, Platinum RTD (Pt100, JPt100)<br>With heater disconnection detection<br>Sampling period: 0.5s/4channels<br>2 units of 18-point terminal block |  |

## (d) Loop controller

| Model name | Remarks  | Reference  |
|------------|--|--|
| Q62HLC     | Loop control module<br>Thermocouple input 2ch, 5 modes of PID control<br>Output: 4 to 20mA | Loop Control Module User's Manual (SH(NA)-080573ENG) |

## (12) Channel isolated pulse input module

| Model name | Remarks  | Reference  |
|------------|--|--|
| QD60P8-G   | 8 channels 30kpps/10kpps/1kpps/100pps/50pps/<br>10pps/1pps/0.1pps<br>Count input signal: 5/12 to 24VDC | Channel Isolated Pulse Input<br>Module User's Manual<br>(SH(NA)-080313E) |

## (13) High-speed counter module

| Model name | Remarks  | Reference   |
|------------|--|---|
| QD62       | 2 channels, 200/100/10kpps<br>Count input signal: 5/12/24VDC<br>External input: 5/12/24VDC<br>Coincidence output: transistor (sink type)<br>12/24VDC, 0.5A/point, 2A/common<br>40-pin connector  | High-Speed Counter Module<br>User's Manual<br>(SH(NA)-080036) |
| QD62D      | 2 channels, 500/200/100/10kpps<br>Count input signal: EIA Standard RS-422-A<br>(differential line driver level)<br>External input: 5/12/24VDC<br>Coincidence output: transistor (sink type)<br>12/24VDC, 0.5A/point, 2A/common<br>40-pin connector |   |
| QD62E      | 2 channels, 200/100/10kpps<br>Count input signal: 5/12/24VDC<br>External input: 5/12/24VDC<br>Coincidence output: transistor (source type)<br>12/24VDC, 0.1A/point, 0.4A/common<br>40-pin connector  |   |

## (14) Ethernet

| Model name  | Remarks             | Reference   |
|-------------|---------------------|---|
| QJ71E71-100 | 10BASE-T/100BASE-TX | Q Corresponding MELSEC<br>Communication Protocol<br>Reference Manual<br>(SH(NA)-080008) |
| QJ71E71-B2  | 10BASE2             |   |
| QJ71E71-B5  | 10BASE5             |   |

## (15) Serial communication

| Model name  | Remarks  | Reference  |
|-------------|--|--|
| QJ71C24N    | RS-232 1 channel, RS-422/485 1 channel<br>Transmission rate: 230.4kbps (Total) | Q Corresponding Serial<br>Communication Module<br>User's Manual (Basic)<br>(SH(NA)-080006) |
| QJ71C24N-R2 | RS-232 2 channels<br>Transmission rate: 230.4kbps (Total)                      |  |
| QJ71C24N-R4 | RS-422/485 2 channels<br>Transmission rate: 230.4kbps (Total)                  |  |

(16) MES interface module

| Model name | Remarks  | Reference  |
|------------|--|--|
| QJ71MES96  | 10BASE-T/100BASE-TX 1 channel<br>(Note) MX MESInterface and CF card are separately required. | MES Interface Module User's Manual<br>(SH(NA)-080644ENG) |

(17) MELSECNET/H

(a) SI/QSI optical interface

| Model name   | Remarks   | Reference   |
|--------------|---|---|
| QJ71LP21-25  | SI/QSI/H-PCF/Broad-band H-PCF optical cable,<br>Double loop<br>PLC to PLC network (control/normal station)/<br>Remote I/O net (remote master station)                               | Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(PLC to PLC network)<br>(SH(NA)-080049) |
| QJ71LP21S-25 | SI/QSI/H-PCF/Broad-band H-PCF optical cable,<br>Double loop<br>PLC to PLC network (control/normal station)/<br>Remote I/O net (remote master station)<br>With external supply power | Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(Remote I/O network)<br>(SH(NA)-080124) |
| QJ72LP25-25  | SI/QSI/H-PCF/Broad-band H-PCF optical cable,<br>Double loop<br>Remote I/O net (remote I/O station)  | For QnA/Q4AR<br>MELSECNET/10 Network<br>System Reference Manual<br>(IB(NA)-66690)                           |

(b) GI optical interface

| Model name | Remarks   | Reference   |
|------------|---|---|
| QJ71LP21G  | GI optical cable, Double loop<br>PLC to PLC network (control/normal station)/<br>Remote I/O net (remote master station) | Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(PLC to PLC network)<br>(SH(NA)-080049)<br>Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(Remote I/O network)<br>(SH(NA)-080124)<br>For QnA/Q4AR<br>MELSECNET/10 Network<br>System Reference Manual<br>(IB(NA)-66690) |
| QJ72LP25G  | GI optical cable, Double loop<br>Remote I/O net (remote I/O station)  | Q corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(Remote I/O network)<br>(SH(NA)-080124)   |



## (c) Coaxial interface

| Model name | Remarks   | Reference   |
|------------|---|---|
| QJ71BR11   | 3C-2V/5C-2V coaxial cable, Single bus<br>PLC to PLC network (control/normal station)/<br>Remote I/O net (remote master station) | Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(PLC to PLC network)<br>(SH(NA)-080049)<br>Q Corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(Remote I/O network)<br>(SH(NA)-080124)<br>For QnA/Q4AR<br>MELSECNET/10 Network<br>System Reference Manual<br>(IB(NA)-66690) |
| QJ72BR15   | 3C-2V/5C-2V coaxial cable, Single bus<br>Remote I/O net (remote I/O station)  | Q corresponding<br>MELSECNET/H Network<br>System Reference<br>Manual(Remote I/O network)<br>(SH(NA)-080124)   |

## (18) CC-Link

| Model name | Remarks   | Reference   |
|------------|---|---|
| QJ61BT11N  | For master/local station, For QCPU<br>Compatible with CC-Link Ver.2 | CC-Link System Master/Local<br>Module User's Manual<br>SH(NA)-080394E |

## (19) CC-Link IE controller network

| Model name   | Remarks   | Reference  |
|--------------|---|--|
| QJ71GP21-SX  | CC-Link IE Optical double loop interface module<br>(1000BASE-SX) Control/normal station                               | CC-Link IE Controller Network<br>Reference Manual<br>(SH(NA)-080668) |
| QJ71GP21S-SX | CC-Link IE Optical double loop interface module<br>(1000BASE-SX) Control/normal station<br>With external power supply |  |

## (20) FL-net (OPCN-2)

## (a) Ver.2.00

| Model name      | Remarks             | Reference  |
|-----------------|---------------------|--|
| QJ71FL71-T-F01  | 10BASE-T/100BASE-TX | FL-net(OPCN-2) Interface<br>Module User's Manual<br>(SH(NA)-080350E) |
| QJ71FL71-B2-F01 | 10BASE2             |  |
| QJ71FL71-B5-F01 | 10BASE5             |  |

## (b) Ver.1.00

| Model name  | Remarks  | Reference  |
|-------------|----------|--|
| QJ71FL71-T  | 10BASE-T | FL-net(OPCN-2) Interface<br>Module User's Manual<br>(SH(NA)-080350E) |
| QJ71FL71-B2 | 10BASE2  |  |
| QJ71FL71-B5 | 10BASE5  |  |

## (21) AS-i

| Model name | Remarks        | Reference   |
|------------|----------------|---|
| QJ71AS92   | Master station | AS-i Master Module User's<br>Manual (Hardware)<br>(IB(NA)-0800122E) |

## (22) Extension base

| Model name | Remarks   | Reference  |
|------------|---|--|
| Q63B       | 3 slots; for mounting Q series modules including power supply module  | QCPU User's Manual<br>(Hardware Design,<br>Maintenance and Inspection)<br>(SH(NA)-080483ENG) |
| Q65B       | 5 slots; for mounting Q series modules including power supply module  |  |
| Q68B       | 8 slots; for mounting Q series modules including power supply module  |  |
| Q612B      | 12 slots; for mounting Q series modules including power supply module |  |
| Q52B       | 2 slots; for mounting Q series modules excluding power supply module  |  |
| Q55B       | 5 slots; for mounting Q series modules excluding power supply module  |  |

(23) Spring clamp terminal block

| Model name | Remarks  | Reference  |
|------------|--|--|
| Q6TE-18S   | For 16 points I/O modules, 0.3 to 1.5mm <sup>2</sup> (AWG22 to 16) | Spring Clamp Terminal Block Model Q6TE-18S User's Manual (IB(NA)-0800204E) |

(24) Terminal block adapter

| Model name | Remarks   | Reference   |
|------------|---|---|
| Q6TA32     | For 32 points I/O modules, 0.5mm <sup>2</sup> (AWG20) | Insulation Displacement Connector for MELSEC-Q Series 32-Point I/O Module User's Manual (IB(NA)-0800228E) |
| Q6TA32-TOL | Q6TA32 exclusive tool                                 |   |

(25) Connector/terminal block converter module

| Model name | Remarks   | Reference  |
|------------|---|--|
| A6TBX36-E  | For negative common type input modules (standard type)                              | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| A6TBX54-E  | For negative common type input modules (2-wire type)                                |  |
| A6TBX70    | For positive common type input modules (3-wire type)                                |  |
| A6TBX70-E  | For negative common type input modules (3-wire type)                                |  |
| A6TBY36-E  | For source type output modules (standard type)                                      |  |
| A6TBY54-E  | For source type output modules (2-wire type)  |  |
| A6TBXY36   | For positive common type input modules and sink type output modules (standard type) |  |
| A6TBXY54   | For positive common type input modules and sink type output modules (2-wire type)   |  |

### (26) Cable

#### (a) Cables for CNC CPU

| Cable type | Application   | Max. length | Standard cable length (m)      | Remarks   |
|------------|---|-------------|--------------------------------|---|
| F020       | Manual pulse generator: 1ch   | 45m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 | 12V power supply type can be used.  |
| F021       | Manual pulse generator: 2ch   | 45m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 | For Signal splitter   |
| F022       | Manual pulse generator: 3ch   | 45m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 |   |
| G020       | Manual pulse generator: 1ch   | 15m         | 0.5, 1, 2, 3, 5, 7, 10, 15     | 5V power supply type can be used.   |
| G021       | Manual pulse generator: 2ch   | 15m         | 0.5, 1, 2, 3, 5, 7, 10, 15     | For Signal splitter   |
| G022       | Manual pulse generator: 3ch   | 15m         | 0.5, 1, 2, 3, 5, 7, 10, 15     |   |
| G302       | Display module communication (STP cross)  | 20m         | 1, 2, 3, 5, 10, 15, 20         | For panel external wiring   |
| G303       | Display module communication (STP straight)   | 20m         | 1, 2, 3, 5, 10, 15, 20         | For panel external wiring, when using a HUB.  |
| G380       | Optical communication cable   | 20m         | 5, 10, 12, 15, 20              | For wiring between drive units (outside panel)<br>For optical communication repeater unit |
| G395       | Optical communication cable   | 10m         | 1, 2, 3, 5, 7, 10              | For wiring between drive units (outside panel)<br>For wiring between NC-drive units       |
| G396       | Optical communication cable   | 10m         | 0.3, 0.5, 1, 2, 3, 5           | For wiring between drive units (inside panel)   |
| H010       | Signal splitter connection  | 5m          | 0.5, 1, 2, 3, 5                |   |
| H100       | Emergency stop  | 30m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 |   |
| H200       | Display module communication (UTP cross)  | 20m         | 1, 2, 3, 5, 10, 15, 20         | For panel internal wiring.  |
| H300       | SKIP/manual pulse generator input   | 20m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 |   |
| H310       | SKIP connection   | 15m         | 0.5, 1, 2, 3, 5, 7, 10, 15     | For Signal splitter   |
| H400       | Manual pulse generator: 1ch for 5V  | 20m         | 0.5, 1, 2, 3, 5, 7, 10, 15, 20 |   |
| H500       | Dual-signal module communication  | 0.5m        | 0.1, 0.2, 0.3, 0.5             |   |
| H810       | Connection cable between I/O extension connector unit (FCU7-HN831) and external Input/output unit (GT15-DIOR) | 1m          | 0.5, 0.75, 1                   |   |

**(Note)** The Standard cable length column shows the lengths of the cable available from MITSUBISHI.

(b) Cable for connector and terminal block changeover unit

| Model name | Remarks  | Reference  |
|------------|--|--|
| AC05TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 0.5m                                      | I/O module Type Building Block User's Manual (SH(NA)-080042) |
| AC10TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 1m  |  |
| AC20TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 2m  |  |
| AC30TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 3m  |  |
| AC50TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 5m  |  |
| AC80TB     | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 8m<br>*Common current not exceeding 0.5A  |  |
| AC100TB    | For A6TBXY36/A6TBXY54/A6TBX70 (positive common/sink type modules), 10m<br>*Common current not exceeding 0.5A |  |
| AC05TB-E   | For A6TBX36-E/A6TBY36-E/A6TBX54-E /A6TBY54-E/A6TBX70-E (negative common, source type modules), 0.5m          |  |
| AC10TB-E   | For A6TBX36-E/A6TBY36-E/A6TBX54-E /A6TBY54-E/A6TBX70-E (negative common, source type modules), 1m            |  |
| AC20TB-E   | For A6TBX36-E/A6TBY36-E/A6TBX54-E /A6TBY54-E/A6TBX70-E (negative common, source type modules), 2m            |  |
| AC30TB-E   | For A6TBX36-E/A6TBY36-E/A6TBX54-E /A6TBY54-E/A6TBX70-E (negative common, AC30TB-E source type modules), 3m   |  |
| AC50TB-E   | For A6TBX36-E/A6TBY36-E/A6TBX54-E /A6TBY54-E/A6TBX70-E (negative common, source type modules), 5m            |  |

### (c) Cable for drive unit

| Cable type        | Application   | Max. length | Standard cable length (m)             | Remarks  |
|-------------------|---|-------------|---------------------------------------|--|
| CNP2E-1-□M        | Motor side PLG cable<br>Spindle side accuracy detector<br>TS5690 cable  | 30m         | 2, 3, 4, 5, 7, 10, 15, 20, 25, 30     |  |
| CNV22J-K1P-0.3M   | For HF-KP (Servo) Motor side detector relay cable (motor side)<br>Compatible with only IP65   | 0.3m        | 0.3                                   | (load side angle)  |
| CNV22J-K2P-0.3M   | For HF-KP (Servo) Motor side detector relay cable (motor side)<br>Compatible with only IP65   | 0.3m        | 0.3                                   | (reverse load side angle)  |
| CNV2E-8P-□M       | For HF/HF-H, HF-KP (Tool spindle) Motor side detector cable (for A48/A51/A74N(/A74)) /<br>For HF-KP (Servo) Motor side detector relay cable (Drive unit side) | 30m         | 2, 3, 4, 5, 7, 10, 15, 20, 25, 30     |  |
| CNV2E-9P-□M       | For HF/HF-H, HF-KP (Tool spindle) Motor side detector cable (for A48/A51/A74N(/A74))  | 30m         | 2, 3, 4, 5, 7, 10, 15, 20, 25, 30     |  |
| CNV2E-D-□M        | MDS-B-SD unit cable   | 30m         | 2, 3, 4, 5, 7, 10, 15, 20, 25, 30     |  |
| CNV2E-HP-□M       | MDS-B-HR unit cable   | 30m         | 2,3,4,5,7,10,15,20,25,30              |  |
| CNV2E-K1P-□M      | For HF-KP (Servo) Motor side detector cable<br>Compatible with only IP65  | 10m         | 2, 3, 5, 7, 10                        | (load side angle)  |
| CNV2E-K2P-□M      | For HF-KP (Servo) Motor side detector cable<br>Compatible with only IP65  | 10m         | 2, 3, 5, 7, 10                        | (reverse load side angle)  |
| DG21-□M           | Battery cable   | 5m          | 0.3, 0.5, 1, 5                        | (For drive unit (except MDS-DJ Series) - battery unit)   |
| DG22-□M           | Battery cable   | 5m          | 0.3, 0.5, 1, 5                        | (For servo drive unit - servo drive unit (except MDS-DJ Series))<br>(Note) This cable is required to supply the power from the battery unit to multiple drive units. |
| DG23-□M           | Battery cable   | 5m          | 0.3, 0.5, 1, 5                        | (For servo drive unit (except MDS-DJ Series) -battery box)<br>(Note) The battery box side is connected using a bare conductor or a terminal bar.                     |
| DG24-□M           | 5V supply/DO output cable   | 5m          | 0.3, 0.5, 1, 5                        | (For servo drive unit (except MDS-DJ Series) -battery box)<br>(Note) The battery box side is connected using a bare conductor or a terminal bar.                     |
| MR-BKS1CBL□M-A1-H | <200V Series><br>Brake cable for HF-KP  | 10m         | 2, 3, 5, 7, 10                        | (load side angle)  |
| MR-BKS1CBL□M-A2-H | <200V Series><br>Brake cable for HF-KP  | 10m         | 2, 3, 5, 7, 10                        | (reverse load side angle)  |
| MR-PWS1CBL□M-A1-H | <200V Series><br>Power cable for HF-KP  | 10m         | 2, 3, 5, 7, 10                        | (load side angle)  |
| MR-PWS1CBL□M-A2-H | <200V Series><br>Power cable for HF-KP  | 10m         | 2, 3, 5, 7, 10                        | (reverse load side angle)<br>(Note) It can not be used with HF-KP13.   |
| SH21              | Power supply communication cable<br>Power backup unit communication cable<br>Cable for Auxiliary axis/Servo drive unit  | 30m         | 0.35, 0.5, 1, 2, 3, 5, 10, 15, 20, 30 |  |

**(Note)** The Standard cable length column shows the lengths of the cable available from MITSUBISHI.

### (27) Relay terminal unit

#### (a) Unit

| Model name  | Remarks   | Reference   |
|-------------|---|---|
| A6TE2-16SRN | 40 pin connector<br>For 24VDC Transistor output unit (sink type module) | Relay Terminal Module User's Manual (Hardware)<br>A6TE2-16SRN<br>(IB(NA)-66833) |

#### (b) Cable

| Model name | Remarks              | Reference  |
|------------|----------------------|--|
| AC06TE     | For A6TE2-16SRN 0.6m | Relay Terminal Module User's Manual (Hardware)<br>A6TE2-16SRN<br>(IBNA)-66833) |
| AC10TE     | For A6TE2-16SRN 1m   |  |
| AC30TE     | For A6TE2-16SRN 3m   |  |
| AC50TE     | For A6TE2-16SRN 5m   |  |
| AC100TE    | For A6TE2-16SRN 10m  |  |

### (28) Extension cable

| Model name | Remarks     | Reference  |
|------------|-------------|--|
| QC05B      | 0.45m cable | QCPU User's Manual (Hardware Design, Maintenance and Inspection)<br>(SH(NA)-080483ENG) |
| QC06B      | 0.6m cable  |  |
| QC12B      | 1.2m cable  |  |
| QC30B      | 3m cable    |  |
| QC50B      | 5m cable    |  |
| QC100B     | 10m cable   |  |

### (29) Connector

| Model name | Remarks  | Reference   |
|------------|--|---|
| A6CON1     | Soldering type 32 point-connector (40-pin connector)                               | I/O module Type Building Block User's Manual<br>(SH(NA)-080042) |
| A6CON2     | Crimp-contact type 32 point-connector (40-pin connector)                           |   |
| A6CON3     | Flat cable pressure displacement type 32-point connector (40-pin connector)        |   |
| A6CON4     | Soldering type 32 point-connector (40-pin connector; two-way cable can be mounted) |   |
| A6CON1E    | Soldering type 32 point-connector (37-pin D sub-connector)                         |   |
| A6CON2E    | Crimp-contact type 32 point-connector (37-pin D sub-connector)                     |   |
| A6CON3E    | Flat cable pressure displacement type 32-point connector (37-pin D sub-connector)  |   |

## (30) Memory card

| Model name | Remarks                    | Reference   |
|------------|----------------------------|---|
| Q2MEM-2MBS | Small SRAM memory card 2MB | QCPU user manual (hard ware designing/maintenance)(SH-080472) |

## (31) CC-Link Remote I/O unit

## (a) Thread terminal block type

| Model name      | Remarks   | Reference  |
|-----------------|---|--|
| AJ65SBTB1-32D   | Input 32 points: 24VDC (positive/negative common shared type),<br>1- wire, terminal block type, response time: 1.5 ms | CC-Link System Compact Type Remote I/O Module User's Manual(SH-4007) |
| AJ65SBTB1-32TE1 | Output 32 points: 12/24VDC (0.5A), transistor output (source type), 1-wire, terminal block type                       |  |

## (b) Waterproof connector type

| Model name     | Remarks  | Reference  |
|----------------|--|--|
| AJ65FBTA4-16DE | Input 16 points: 24VDC (negative common ), 4-wire, super-slim waterproof type, response time: 1.5 ms   | CC-Link System Compact Type Remote I/O Module User's Manual(SH-4007) |
| AJ65FBTA2-16TE | Output 16 points: 12/24VDC (1.0A), transistor output (source type), 2-wire, super-slim waterproof type |  |



1.3.2 GOT

1.3.2.1 GT27

- (1) GOT
- (a) GT2712

| Model name  | Remarks   | Reference                             |
|-------------|---|---------------------------------------|
| GT2712-STBA | 12.1-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>100-240VAC, user memory, memory for storage(ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later. | GT27 General Description (IB-0800502) |
| GT2712-STBD | 12.1-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>24VDC, user memory, storage memory (ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later.         |                                       |

- (b) GT2710

| Model name  | Remarks   | Reference                            |
|-------------|---|--------------------------------------|
| GT2710-STBA | 10.4-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>100-240VAC, user memory, memory for storage(ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later. | GT27 General Description(IB-0800502) |
| GT2710-STBD | 10.4-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>24VDC, user memory, memory for storage(ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later.      |                                      |

## (c) GT2708

| Model name  | Remarks  | Reference                            |
|-------------|--|--------------------------------------|
| GT2708-STBA | 8.4-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>100-240VAC, user memory, memory for storage(ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later. | GT27 General Description(IB-0800502) |
| GT2708-STBD | 8.4-type SVGA[800 × 600 dots] TFT color liquid crystal display, 65536 colors<br><Multimedia and video/RGB and multi-touch supported><br>24VDC, user memory, memory for storage(ROM):57MB, operation memory (RAM):128MB<br>- Requiring GT Designer3 Version1(GOT2000) 1.117X or later.      |                                      |

## (2) SD card

| Model name  | Remarks                    | Reference |
|-------------|----------------------------|-----------|
| L1MEM-2GBSD | 2GB SD memory card for GOT |           |

## (3) Protection sheet

| Model name  | Remarks   | Reference   |
|-------------|---|---|
| GT25-12PSCC | Protection sheet for 12.1-type (Clear, 5 sheets)  | GOT2000 Series Protective Sheet for GT27/GT25/GT23 User's Manual (IB-0800499) |
| GT25-10PSCC | Protection sheet for 10.4-type ((Clear, 5 sheets) |   |
| GT25-08PSCC | Protection sheet for 8.4-type (Clear, 5 sheets)   |   |

1.3.2.2 GT16

- (1) GOT
- (a) GT1695M

| Model name   | Remarks  | Reference                                     |
|--------------|--|---|
| GT1695M-XTBA | 15.0 type, XGA [1024 × 768 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi-media and video/RGB supported><br>100-240VAC, built-in flash memory 15MB | GT16 General Description<br>(IB(NA)-0800434E) |
| GT1695M-XTBD | 15.0 type, XGA [1024 × 768 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi-media and video/RGB supported><br>24VDC, built-in flash memory 15MB      |   |

- (b) GT1685M

| Model name   | Remarks  | Reference                                     |
|--------------|--|---|
| GT1685M-STBA | 12.1 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi-media and video/RGB supported><br>100-240VAC, built-in flash memory 15MB | GT16 General Description<br>(IB(NA)-0800434E) |
| GT1685M-STBD | 12.1 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi-media and video/RGB supported><br>24VDC, built-in flash memory 15MB      |   |

- (c) GT1675M

| Model name   | Remarks  | Reference                                     |
|--------------|--|---|
| GT1675M-STBA | 10.4 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi media and video/RGB supported><br>100-240VAC, built-in flash memory 15MB | GT16 General Description<br>(IB(NA)-0800434E) |
| GT1675M-STBD | 10.4 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi media and video/RGB supported><br>24VDC, built-in flash memory 15MB      |   |

(d) GT1665M

| Model name   | Remarks   | Reference                                     |
|--------------|---|---|
| GT1665M-STBA | 8.4 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi media and video/RGB supported><br>100-240VAC, built-in flash memory 15MB | GT16 General Description<br>(IB(NA)-0800434E) |
| GT1665M-STBD | 8.4 type, SVGA [800 × 600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Multi media and video/RGB supported><br>24VDC, built-in flash memory 15MB      |   |

(2) Option function board

| Model name | Remarks                    | Reference  |
|------------|----------------------------|--|
| GT16-MESB  | For MES interface function | GT16 MES Interface Function Board User's Manual<br>(IB(NA)-0800427E) |

(3) CF card

| Model name     | Remarks         | Reference   |
|----------------|-----------------|---|
| GT05-MEM-128MC | Flash ROM 128MB | GOT1000 Series CF Card/<br>Memory Card Adaptor User's<br>Manual (IB-800302) |
| GT05-MEM-256MC | Flash ROM 256MB |   |
| GT05-MEM-512MC | Flash ROM 512MB |   |
| GT05-MEM-1GC   | Flash ROM 1GB   |   |
| GT05-MEM-2GC   | Flash ROM 2GB   |   |

(4) Protection sheet

| Model name  | Remarks   | Reference   |
|-------------|---|---|
| GT16-90PSCB | Protection sheet for 15.0 type (Clear, 5 sheets)      | GT16 Protective Sheet User's<br>Manual<br>(IB(NA)-0800426E) |
| GT16-90PSGB | Protection sheet for 15.0 type (Anti-glare, 5 sheets) |   |
| GT16-80PSCB | Protection sheet for 12.1 type (Clear, 5 sheets)      |   |
| GT16-80PSGB | Protection sheet for 12.1 type (Anti-glare, 5 sheets) |   |
| GT16-70PSCB | Protection sheet for 10.4 type (Clear, 5 sheets)      |   |
| GT16-70PSGB | Protection sheet for 10.4 type (Anti-glare, 5 sheets) |   |
| GT16-60PSCB | Protection sheet for 8.4 type (Clear, 5 sheets)       |   |
| GT16-60PSGB | Protection sheet for 8.4 type (Anti-glare, 5 sheets)  |   |

1.3.2.3 GT15

(1) GOT

(a) GT1595

| Model name  | Remarks   | Reference                                     |
|-------------|---|---|
| GT1595-XTBA | 15.0 type, XGA [1024×768 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors,<br>100-240VAC, built-in flash memory 9MB<br>(Note) Out of production | GT15 General Description<br>(IB(NA)-0800322E) |
| GT1595-XTBD | 15.0 type, XGA [1024×768 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors,<br>24VDC, built-in flash memory 9MB<br>(Note) Out of production      |   |

(b) GT1585

| Model name   | Remarks   | Reference                                     |
|--------------|---|---|
| GT1585V-STBA | 12.1 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Video/RGB supported><br>100-240VAC, built-in flash memory 9MB | GT15 General Description<br>(IB(NA)-0800322E) |
| GT1585V-STBD | 12.1 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Video/RGB supported><br>24VDC, built-in flash memory 9MB      |   |
| GT1585-STBA  | 12.1 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br>100-240VAC, built-in flash memory 9MB                          |   |
| GT1585-STBD  | 12.1 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br>24VDC, built-in flash memory 9MB                               |   |

(c) GT1575

| Model name   | Remarks   | Reference                                     |
|--------------|---|---|
| GT1575V-STBA | 10.4 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Video/RGB supported><br>100-240VAC, built-in flash memory 9MB | GT15 General Description<br>(IB(NA)-0800322E) |
| GT1575V-STBD | 10.4 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br><Video/RGB supported><br>24VDC, built-in flash memory 9MB      |   |
| GT1575-STBA  | 10.4 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br>100-240VAC, built-in flash memory 9MB                          |   |
| GT1575-STBD  | 10.4 type, SVGA [800×600 dots]<br>TFT color liquid crystal display (High intensity and wide angle view), 65536 colors<br>24VDC, built-in flash memory 9MB                               |   |

### (2) Communication unit

#### (a) Ethernet communication unit

| Model name      | Remarks  | Reference  |
|-----------------|--|--|
| GT15-J71E71-100 | Ethernet (100Base-TX/10Base-T) unit<br>Necessary for connecting to Q173NCCPU | GT15 Ethernet communication unit User's Manual (IB(NA)-0800314E) |

### (3) Option function board

| Model name   | Remarks  | Reference  |
|--------------|--|--|
| GT15-QFNB    | Select either of these models when using GOT options (MELSEC-Q/QnA circuit monitor functions). | GT15 Option Function Board/ Option Function Board with Add-on Memory User's Manual (IB(NA)-0800301E) |
| GT15-QFNB16M |  |  |
| GT15-QFNB32M |  |  |
| GT15-QFNB48M |  |  |
| GT15-MESB48M |  |  |

### (4) Protection sheet

| Model name  | Remarks   | Reference   |
|-------------|---|---|
| GT15-90PSCB | Protection sheet for 15.0 type (Clear/5 sheets)<br>(Note) Out of production | GT15 Protective Sheet User's Manual (IB(NA)-0800295E) |
| GT15-80PSCB | Protection sheet for 12.1 type (Clear/5 sheets)                             |   |
| GT15-70PSCB | Protection sheet for 10.4 type (Clear/5 sheets)                             |   |

### 1.3.2.4 Option

#### (1) CF card extension interface

| Model name        | Remarks                             | Reference   |
|-------------------|-------------------------------------|---|
| GT15-CFEX-C08-SET | CF card extension interface (front) | GT15 CF card extension unit User's Manual (IB(NA)-0800367E) |

#### (2) External input/output unit

| Model name | Remarks  | Reference  |
|------------|--|--|
| GT15-DIOR  | (Input)16 points/Output for scan 8 points 24VDC about 4mA<br>(Output)16 points+1 point (RUN output) 24VDC 0.1A/point<br>(Negative common input/source type output) | GT15 External I/O Unit (Negative Common Input/ Source Type Output) User's Manual (IB(NA)-0800425E) |
| GT15-DIO   | (Input)16 points/Output for scan 8 points 24VDC about 4mA<br>(Output)16 points+1 point (RUN output) 24VDC 0.1A/point<br>(Positive common input/sink type output)   | GT15 External I/O Unit (Positive Common Input/Sink Type Output) User's Manual (IB(NA)-0800382E)    |

### 1.3.3 Peripheral Device

#### (1) Signal splitter

| Model name | Remarks  |
|------------|--|
| FCU7-HN387 | Option (Manual pulse generator is required for 2 or 3 axes specifications) |

#### (2) Manual pulse generator

| Model name | Remarks  |
|------------|--|
| UFO-01-2Z9 | 5V specifications  |
| HD60C      | 12V specifications, for connection to operation panel I/O module<br>12V power supply is separately required. |

#### (3) I/O extension connector unit

| Model name | Remarks  |
|------------|--|
| FCU7-HN831 | Point extension unit of external input/output unit GT15-DIOR |

### 1.3.4 Dual Signal Module

#### (1) Dual signal module

| Model name | Remarks   |
|------------|---|
| Q173SXY    | I/O duplication monitoring module (Maximum 3 modules)                   |
| Q173SXY-2  | I/O duplication monitoring module (High speed type) (Maximum 3 modules) |

#### (2) Terminal block

| Model name | Remarks  |
|------------|--|
| FA-LTB40P  | Terminal block converter module<br>(Arrangement : MITSUBISHI ELECTRIC ENGINEERING COMPANY LIMITED) |

#### (3) Cable

| Model name    | Remarks  |
|---------------|--|
| FA-CBL□□FMV-M | Cable for terminal block converter module<br>(Cable length□□ = 05:0.5m, 10:1m, 20:2m, 30:3m, 50:5m)<br>(Arrangement : MITSUBISHI ELECTRIC ENGINEERING COMPANY LIMITED) |

## 2. General Specifications

For the specifications of GOT, CNC servo/spindle drive unit and I/O module, refer to the manuals written in “System Configuration: Component Modules”.

### 2.1 Installation Environment Conditions

C70, which is an open equipment, must be installed within a sealed metal control panel (IP54 or higher). C70 must also be used and stored under the conditions listed in the table of specifications below.

| Item                                 | Specification   |             |                     |           |   |
|--------------------------------------|---|-------------|---------------------|-----------|---|
| Operating ambient Temperature        | 0 to 55°C<br>(32 to 131°F)                                    |             |                     |           |   |
| Storage ambient Temperature          | -25 to 75°C<br>(-13 to 167°F)                                 |             |                     |           |   |
| Operating ambient Humidity           | 5 to 95%RH non-condensing                                     |             |                     |           |   |
| Storage ambient Humidity             | 5 to 95%RH non-condensing                                     |             |                     |           |   |
| Vibration resistance                 | Under intermittent vibration                                  | Frequency   | Acceleration        | Amplitude | Sweep count<br>10 times each in X, Y, Z directions<br>(For 80 min.) |
|                                      |   | 10 to 57Hz  | -                   | 0.075mm   |   |
|                                      | Under continuous vibration                                    | 57to 150Hz  | 9.8m/s <sup>2</sup> | -         |   |
|                                      |   | 10 to 57Hz  | -                   | 0.035mm   |   |
|                                      |   | 57 to 150Hz | 4.9m/s <sup>2</sup> | -         |   |
| Shock resistance                     | 147m/s <sup>2</sup> , 3 times in each of 3 directions X, Y, Z |             |                     |           |   |
| Operating ambience                   | No corrosive gases nor inflammable gases                      |             |                     |           |   |
| Operating altitude                   | 2000m(6561.68ft.) or less <b>(Note 3)</b>                     |             |                     |           |   |
| Installation location                | Inside control panel  |             |                     |           |   |
| Overvoltage category <b>(Note 1)</b> | II or less  |             |                     |           |   |
| Pollution level <b>(Note 2)</b>      | 2 or less   |             |                     |           |   |

**(Note 1)** This indicates the section of the power supply to which the equipment is assumed to be connected between the public electrical power distribution network and the machinery within premises. Category II applies to equipment for which electrical power is supplied from fixed facilities. The surge voltage withstand level for up to the rated voltage of 300V is 2500V.

**(Note 2)** This index indicates the degree to which conductive material is generated in terms of the environment in which the equipment is used. Pollution level 2 is when only non-conductive pollution occurs. A temporary conductivity caused by condensing must be expected occasionally.

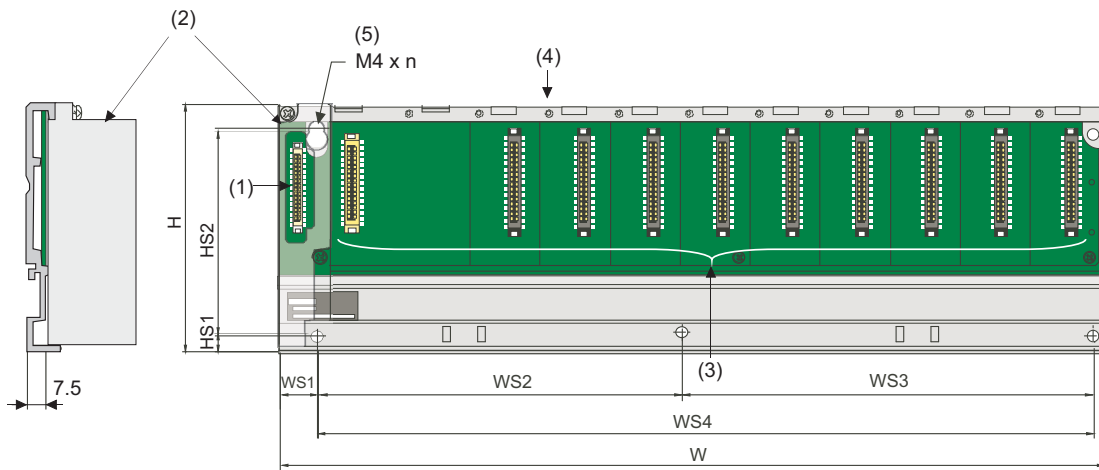
**(Note 3)** Do not use or store C70 under pressure higher than the atmospheric pressure of altitude 0m. Doing so can cause an operation failure.

**(Note 4)** The following environment conditions are also required for the layout design.

- No large amount of conductible dust, iron filings, oil mist, salt, or organic solvents
- No direct sunlight
- No strong electrical or magnetic fields
- No direct vibrations nor shocks on C70



2.2 Base Unit



|     | Q35DB       | Q38DB     | Q312DB    | Q63B      | Q65B        | Q68B      | Q612B     |
|-----|-------------|-----------|-----------|-----------|-------------|-----------|-----------|
| n   | 4           | 5         | 5         | 4         | 4           | 5         | 5         |
| W   | 245         | 328       | 439       | 189       | 245         | 328       | 439       |
| WS1 | 15.5        |           |           |           |             |           |           |
| WS2 | -           | 170 ± 0.3 | 170 ± 0.3 | -         | -           | 190 ± 0.3 | 190 ± 0.3 |
| WS3 | -           | 138 ± 0.3 | 249 ± 0.3 | -         | -           | 116 ± 0.3 | 227 ± 0.3 |
| WS4 | 224.5 ± 0.3 | -         | -         | 167 ± 0.3 | 222.5 ± 0.3 | -         | -         |
| H   | 98          |           |           |           |             |           |           |
| HS1 | 7           |           |           |           |             |           |           |
| HS2 | 80 ± 0.3    |           |           |           |             |           |           |

[mm]

| No. | Name                      | Application  |
|-----|---------------------------|--|
| (1) | Extension cable connector | Connector to which the extension cables are connected for sending and receiving signals from the extension base unit.  |
| (2) | Base cover                | Protective cover of extension cable connector. Before an extension cable is connected, the area of the base cover surrounded by the groove under the word "OUT" on the base cover must be removed with a tool such as nippers.   |
| (3) | Module connector          | Connector for installing the Q series power supply module, CPU module, I/O modules, and intelligent function module.<br>To the connectors located in the spare space where these modules are not installed, attach the supplied connector cover or the blank cover module QG60 to prevent entry of dirt. |
| (4) | Module fixing screw hole  | Screw hole for fixing the module to the base unit. Screw size: M3×12   |
| (5) | Base fixing hole          | Hole for fixing this base unit onto the panel of the control panel.<br>(for M4 screw)  |

(Note) DIN rail installation is not available when installing the CNC CPU module onto the basic base unit.  
The installation may cause the module's malfunction due to vibration.

## 2.3 Power Supply

C70 uses Q61P (100-240VAC input, 5VDC 6A output), Q63P (24VDC input, 5VDC 6A output), Q64PN (100-240VAC input, 5VDC 8.5A output), or Q64P (100-120VAC/200-240VAC input, 5VDC 8.5A output).

(Note) Q64P has gone out of production.

## Specifications

| Item   |                                 | Q61P  |
|--|---------------------------------|---|
| Base loading position                                  |                                 | Q series power supply module loading slot   |
| Applicable base unit                                   |                                 | Q38DB, Q312DB, Q63B, Q65B, Q68B, Q612B  |
| Input power supply                                     |                                 | 100 - 240VAC+10%-15%<br>(85 - 264VAC)   |
| Input frequency  |                                 | 50/60Hz ± 5%  |
| Input voltage distortion factor                        |                                 | 5% or less  |
| Max. input apparent power                              |                                 | 130VA   |
| Inrush current   |                                 | 20A 8ms or less <sup>*4</sup>   |
| Rated output current                                   | 5VDC                            | 6A  |
|  | 24VDC                           | -   |
| Overcurrent protection <sup>*1</sup>                   | 5VDC                            | 6.6A or more  |
|  | 24VDC                           | -   |
| Overvoltage protection <sup>*2</sup>                   | 5VDC                            | 5.5 to 6.5V   |
| Efficiency   |                                 | 70% or more   |
| Permissible instantaneous power off time <sup>*3</sup> |                                 | 20ms or less  |
| Dielectric withstand voltage                           |                                 | Across inputs/LG and outputs/FG<br>2830VAC rms/3 cycles<br>(Altitude: 2000m)  |
| Insulation resistance                                  |                                 | Across inputs and outputs<br>(LG and FG separated),<br>across inputs for LG/FG,<br>across outputs for LG/FG<br>10MΩ or more by insulation<br>resistance tester (500VDC) |
| Noise immunity   |                                 | By noise simulator of 1500Vp-p noise<br>voltage, 1 μs noise width and 25 to<br>60Hz noise frequency<br>Noise voltage IEC61000-4-4, 2kV                                  |
| Operation display                                      |                                 | LED display (Normal: ON(Green), Error: OFF)   |
| Fuse   |                                 | Built-in (Unchangeable by user)   |
| Contact<br>output<br>section                           | Application                     | ERR contact   |
|  | Rated switching voltage/current | 24VDC, 0.5A   |
|  | Minimum switching load          | 5VDC, 1mA   |
|  | Response time                   | OFF to ON:10ms or less, ON to OFF:12ms or less  |
|  | Life time                       | Mechanical: 20 million times or more<br>Electrical: 100 thousand times or more at rated<br>switching voltage/current  |
|  | Surge suppressor                | None  |
| Fuse   |                                 | None  |
| Terminal screw size                                    |                                 | M3.5 screw  |
| Applicable size of wire                                |                                 | 0.75 to 2mm <sup>2</sup>  |
| Applicable crimping terminal                           |                                 | RAV1.25-3.5, RAV2-3.5   |
| Applicable tightening torque                           |                                 | 0.66 to 0.89N m   |
| Mass [kg]  |                                 | 0.4   |

## 2. General Specifications

### 2.3 Power Supply

| Item  | Q63P  | Q64PN  | Q64P<br>(discontinued)   |
|---|---|--|--|
| Base loading position                                     | Q series power supply module loading slot   |  |  |
| Applicable base unit                                      | Q38DB, Q312DB, Q63B, Q65B, Q68B, Q612B  |  |  |
| Input power supply  | 24VDC+30%-35%<br>(15.6 to 31.2VDC)  | 100 to 240VAC+10%-15%<br>(85 to 264VAC)  | 100 to 120VAC+10%-15%<br>/200 to 240VAC+10%-15%<br>(85 to 132VAC/170 to<br>264VAC) |
| Input frequency   | -   | 50/60Hz ± 5%   |  |
| Input voltage distortion factor                           | -   | 5% or less   |  |
| Max. input apparent power                                 | 45W   | 160VA  |  |
| Input current   | at 24VDC input: 1.82A or less<br>at 15.6VDC input: 2.8A or less   | at 100VAC input: 1.3A or less<br>at 200VAC input: 0.75A or less  |  |
| Repetitive peak current                                   | -   | 4A or less   |  |
| Inrush current  | 100A 1ms or less (at 24VDC<br>input)  | 20A 8ms or less* <sup>4</sup>  |  |
| Rated output current                                      | 5VDC  | 6A   | 8.5A   |
|   | 24VDC   | -  | -  |
| Overcurrent<br>protection* <sup>1</sup>                   | 5VDC  | 6.6A or more   | 9.9A or more   |
|   | 24VDC   | -  | -  |
| Overvoltage<br>protection* <sup>2</sup>                   | 5VDC  | 5.5 to 6.5V  |  |
| Efficiency  | 70% or more   |  |  |
| Permissible instantaneous<br>power off time* <sup>3</sup> | 10ms or less (at 24VDC input)   | 20ms or less   |  |
| Dielectric withstand voltage                              | 500VAC across primary and<br>5VDC   | Across inputs/LG and outputs/FG<br>2,830VAC rms/3 cycles<br>(Altitude: 2,000m (6,561.68ft.))   |  |
| Insulation resistance                                     | 10MΩ or more<br>(measured with an insulation<br>resistance tester)                                      | Input and LG batched, output and FG batched,<br>batch input-LG, batch output-FG<br>10MΩ or more by insulation resistance tester (500VDC) |  |
| Noise immunity  | By noise simulator of 500Vp-p<br>noise voltage, 1 μs noise width<br>and 25 to 60Hz noise frequen-<br>cy | By noise simulator of 1,500Vp-p noise voltage, 1 μs noise<br>width and 25 to 60Hz noise frequency<br><br>Noise voltage IEC61000-4-4, 2kV |  |
| Operation display   | LED display (Normal:<br>ON(Green), Error: OFF)  | LED display (Normal:<br>ON(Green), Error: OFF)   | LED display (Normal:<br>ON(Green), Error: OFF)* <sup>5</sup>                       |
| Fuse  | Built-in (Unchangeable by user)   |  |  |
| Contact output section                                    | Application   | ERR contact  |  |
|   | Rated switching<br>voltage/current  | 24VDC, 0.5A  |  |
|   | Minimum switching<br>load   | 5VDC, 1mA  |  |
|   | Response time   | OFF to ON: 10ms or less , ON to OFF: 12ms or less  |  |
|   | Life time   | Mechanical: 20 million times or more<br>Electrical: 100 thousand times or more at rated switching voltage/current                        |  |
|   | Surge suppressor  | None   |  |
|   | Fuse  | None   |  |
| Terminal screw size                                       | M3.5 screw  |  |  |
| Applicable size of wire                                   | 0.75 to 2mm <sup>2</sup>  |  |  |
| Applicable crimping terminal                              | RAV1.25-3.5, RAV2-3.5   |  |  |
| Applicable tightening torque                              | 0.66 to 0.89 N m  |  |  |
| Mass [kg]   | 0.33  | 0.47   | 0.4  |

**\*1: Overcurrent protection**

The overcurrent protection device shuts off the 5V, 24VDC circuit and stops the system if the current flowing in the circuit exceeds the specified value.

The LED of the power supply module is turned off or lights up in dim green when voltage is lowered.

If this device is activated, switch the input power supply off and eliminate the cause such as insufficient current capacity or short. Then, a few minutes later, switch it on to restart the system.

The initial start for the system takes place when the current value becomes normal.

**\*2: Overvoltage protection**

The overvoltage protection device shuts off the 5VDC circuit and stops the system if a voltage of 5.5VDC or more is applied to the circuit.

When this device is activated, the power supply module LED is switched OFF.

To restart the system, switch the input power OFF, then a few minutes later ON.

The initial start for the system will take place.

The power supply module must be changed if the system is not booted and the LED remains OFF.

**\*3: Permissible instantaneous power off time**

(1) For AC input power supply

(a) An instantaneous power failure lasting less than 20ms will cause AC down to be detected, but operation will continue.

(b) An instantaneous power failure lasting in excess of 20ms may cause the operation to continue or initial start to take place depending on the power supply load.

Further, when the AC supply of the AC input module is the same as that of the power supply module, it prevents the sensor connected to the AC input module, which is ON at power-off, from turning OFF by switching off the power supply.

However, if only the AC input module is connected to the AC line, which is connected to the power supply, detection of the AC down for the power supply module may be delayed by the capacitor in the AC input module. Thus, connect a load of approx. 30mA per AC input module to the AC line.

(2) For DC input power supply

(a) An instantaneous power failure lasting less than 10ms\* will cause 24VDC down to be detected, but operation will continue.

(b) An instantaneous power failure lasting in excess of 10ms\* may cause the operation to continue or initial start to take place depending on the power supply load.

\*: This is for a 24VDC input. This is 10ms or less for less than 24VDC.

**\*4: Inrush current**

When power is switched on again immediately (within 5 seconds) after power-off, an inrush current of more than the specified value (2ms or less) may flow. Reapply power 5 seconds after power-off.

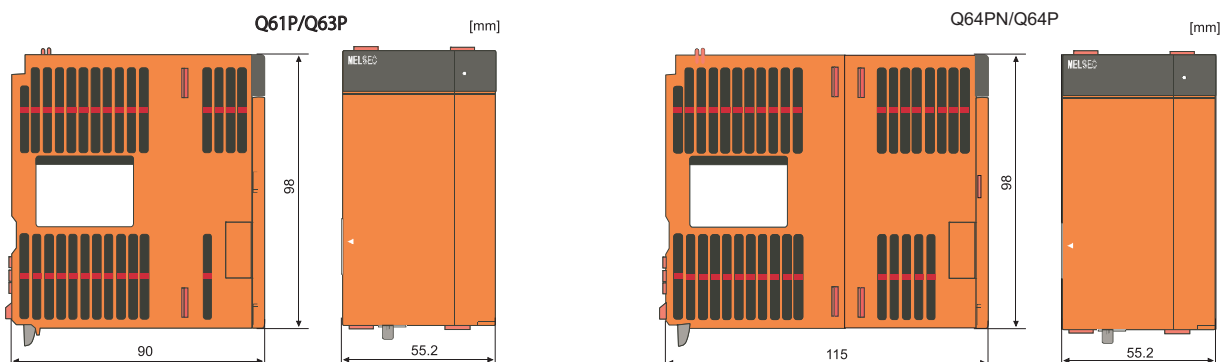
When selecting a fuse and breaker in the external circuit, take account of the blow out, detection characteristics and above matters.

**\*5: Operation indication**

During the operation, do not allow the input voltage to change from 200VAC level (170 to 264VAC) to 100VAC level (85 to 132VAC).

(If changed, the POWER LED of the module turns off and the system operation stops.)

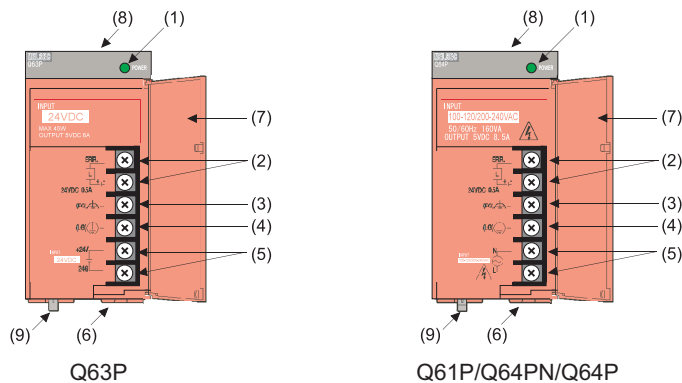
### Outline dimension



#### Names of parts

The following shows the names of the parts of each power module.

- Q63P (24VDC input, 5VDC 6A output)
- Q61P (100 - 240VAC input, 5VDC 6A output)
- Q64PN(100-240VAC input, 5VDC 8.5A output)
- Q64P (100 to 120VAC/200 to 240VAC input, 5VDC 8.5A output)



#### (1) POWER LED

##### Q61P/Q64PN/Q64P

ON(green): Normal (5VDC output, instantaneous power failure within 20ms)

OFF:

- The power supply module is out of order while AC power supply is ON. (5VDC error, internal circuit failure, blown fuse)
- Over current protection or over voltage protection operated.
- AC power supply is not ON
- Power failure (including an instantaneous power failure of more than 20ms)

##### Q63P

ON(green): Normal (5VDC output, instantaneous power failure within 10ms)

OFF:

- The power supply module is out of order while DC power supply is ON. (5VDC error, internal circuit failure, blown fuse)
- Over current protection or over voltage protection operated.
- DC power supply is not ON
- Power failure (including an instantaneous power failure of more than 10ms)

#### (2) ERR terminal

##### Q61P/Q64PN/Q64P

- Turned ON when the whole system operates normally.
- This terminal turns OFF (opens) when the AC power is not input, a stop error (including a reset) occurs in the CPU module, or the fuse is blown.
- In a Multiple CPU system configuration, turned OFF when a stop error occurs in any of the CPU modules.
- Normally OFF when loaded in an extension base unit.

##### Q63P

- Turned ON when the whole system operates normally.
- This terminal turns OFF (opens) when the DC power is not input, a stop error (including a reset) occurs in the CPU module, or the fuse is blown.
- In a Multiple CPU system configuration, turned OFF when a stop error occurs in any of the CPU modules.
- Normally OFF when loaded in an extension base unit.

(3) FG terminal

Ground terminal connected to the shield pattern of the printed circuit board.

(4) LG terminal

- Grounding for the power supply filter.
- This terminal has potential of 1/2 of the input voltage for AC input (Q61P, Q64PN and Q64P).
- This is also a protective earth terminal (PE).

(5) Power input terminals

- Power input terminals connected to a power supply of 100VAC or 200VAC. (Q64PN and Q64P)
- Power input terminals connected to a power supply of 24VDC. (Q63P)
- Power input terminals connected to a power supply of 100-200VAC.(Q61P)

(6) Terminal screw

M3.5 × 7 screw

(7) Terminal cover

Protective cover of the terminal block

(8) Module fixing screw hole

Used to fix the module to the base unit.

M3 × 12 screw (user-prepared) (Tightening torque: 0.36 to 0.48 N m)

(9) Module loading lever

Used to load the module into the base unit.

(Note 1) Q63P is dedicated for inputting a voltage of 24VDC. Q63P may break down unless connected to 24VDC for inputting or with reversed polarity.

(Note 2) Ensure that the earth terminals LG and FG are grounded. (Ground resistance: 100 or less)

Since the LG terminals have potential of 1/2 input voltage, the operator may receive an electric shock when touching metal parts.

(Note 3) When Q61P, Q63P, Q64PN or Q64P is loaded on the extension base unit, a system error cannot be detected by the  $\overline{\text{ERR}}$  terminal. ( $\overline{\text{ERR}}$  terminal is always OFF.)

(Note 4) Q64P automatically switches the input range 100/200VAC.

Therefore, it is not compatible with the intermediate voltage (133 to 169VAC).

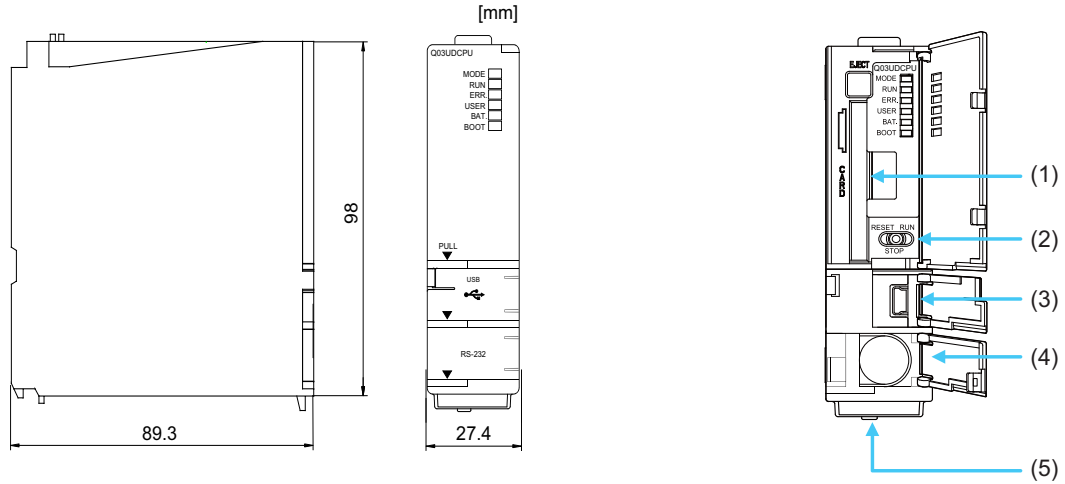
The CPU module may not work normally if the above intermediate voltage is applied.

Also note that Q64P may break down when connected to the power supply whose voltage or frequency is out of the specifications.

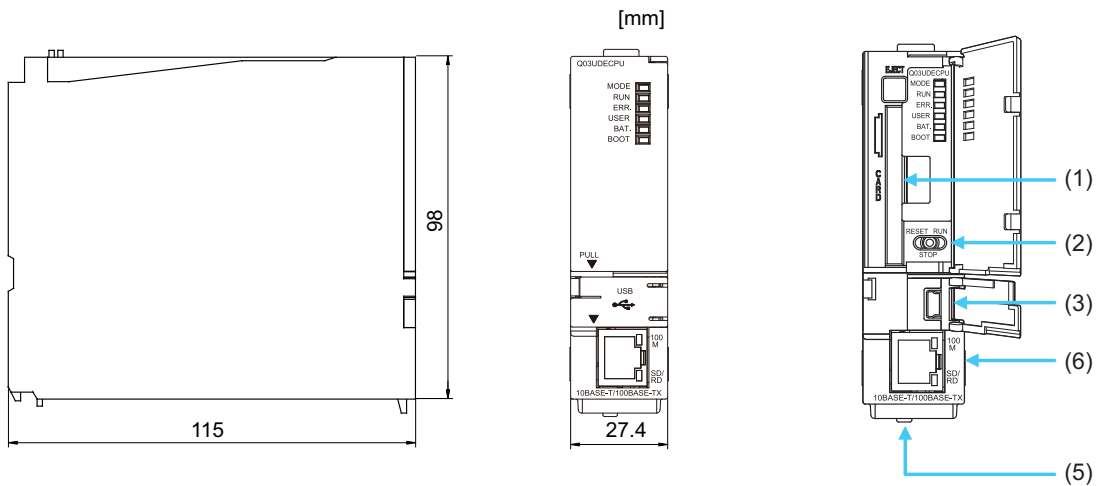
2.4 PLC CPU

For the further details than the following descriptions, refer to "QCPU User's Manual (Hardware Design, Maintenance and Inspection)" (SH(NA)-080483ENG).

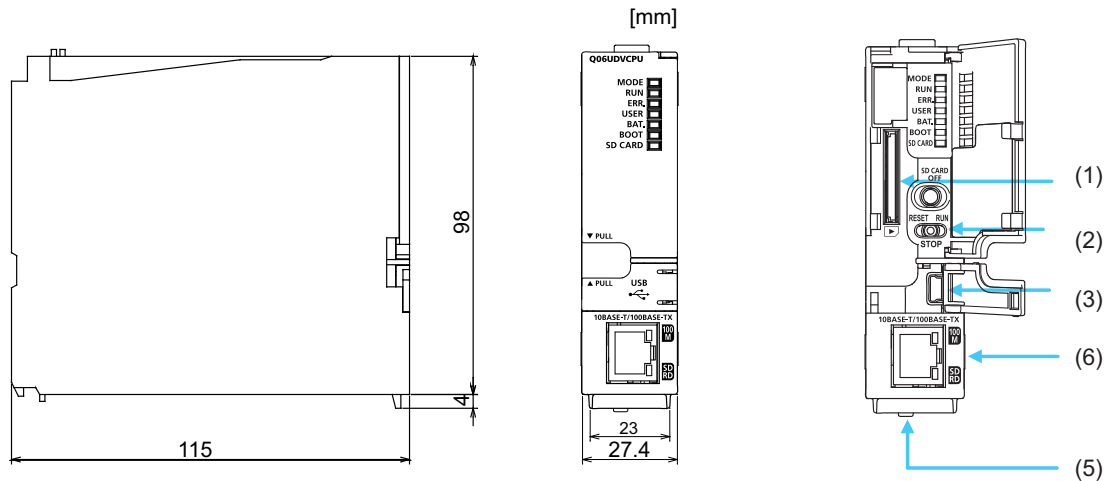
Dimension and Names of parts



[Q03UDCPU / Q04UDHCPU / Q06UDHCPU / Q13UDHCPU / Q26UDHCPU]



[Q03UDECPU / Q04UDEHCPU / Q06UDEHCPU / Q10UDEHCPU / Q13UDEHCPU / Q26UDEHCPU]



[Q03UDVCPU / Q04UDVCPU / Q06UDVCPU / Q13UDVCPU / Q26UDVCPU]

- (1) CARD : Memory card slot for C70
- (2) SW : RUN, STOP and RESET switches
- (3) USB : USB connector for the connection of a tool
- (4) RS232C : RS-232C connector for the connection of a tool
- (5) BAT : Battery

| PLC CPU module type | Frequency of battery usage*1 | Power-ON time ratio*2 | Life time of the battery   |                                |                           |
|---------------------|------------------------------|-----------------------|----------------------------|--------------------------------|---------------------------|
|                     |                              |                       | Guaranteed value*3 (70 °C) | Actual service value*4 (40 °C) | Backup time after alarm*5 |
| Q03UD(E)CPU         | 1                            | 0%                    | 30,100hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 30%                   | 43,000hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 50%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 70%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 100%                  | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     | 2                            | 0%                    | 25,300hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 30%                   | 36,100hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 50%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 70%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 100%                  | 43,800hr                   | 43,800hr                       | 600hr                     |
| Q04UD(E)HCPU        | 1                            | 0%                    | 30,100hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 30%                   | 43,000hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 50%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 70%                   | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     |                              | 100%                  | 43,800hr                   | 43,800hr                       | 600hr                     |
|                     | 2                            | 0%                    | 4,300hr                    | 32,100hr                       | 384hr                     |
|                     |                              | 30%                   | 6,100hr                    | 43,800hr                       | 384hr                     |
|                     |                              | 50%                   | 8,600hr                    | 43,800hr                       | 384hr                     |
|                     |                              | 70%                   | 14,300hr                   | 43,800hr                       | 384hr                     |
|                     |                              | 100%                  | 43,800hr                   | 43,800hr                       | 384hr                     |



| PLC CPU module type  | Frequency of battery usage*1 | Power-ON time ratio*2 | Life time of the battery    |                                 |                           |
|--|------------------------------|-----------------------|-----------------------------|---------------------------------|---------------------------|
|  |                              |                       | Guaranteed value*3 (70 °C ) | Actual service value*4 (40 °C ) | Backup time after alarm*5 |
| Q06UD(E)HCPU   | 1                            | 0%                    | 25,300hr                    | 43,800hr                        | 600hr                     |
|  |                              | 30%                   | 36,100hr                    | 43,800hr                        | 600hr                     |
|  |                              | 50%                   | 43,800hr                    | 43,800hr                        | 600hr                     |
|  |                              | 70%                   | 43,800hr                    | 43,800hr                        | 600hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 600hr                     |
|  | 2                            | 0%                    | 4,200hr                     | 32,100hr                        | 384hr                     |
|  |                              | 30%                   | 6,000hr                     | 43,800hr                        | 384hr                     |
|  |                              | 50%                   | 8,400hr                     | 43,800hr                        | 384hr                     |
|  |                              | 70%                   | 14,000hr                    | 43,800hr                        | 384hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 384hr                     |
|  | 3                            | 0%                    | 2,300hr                     | 19,200hr                        | 192hr                     |
|  |                              | 30%                   | 3,200hr                     | 27,400hr                        | 192hr                     |
|  |                              | 50%                   | 4,600hr                     | 38,400hr                        | 192hr                     |
|  |                              | 70%                   | 7,600hr                     | 43,800hr                        | 192hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 192hr                     |
| Q10UD(E)HCPU<br>Q13UD(E)HCPU<br>Q20UD(E)HCPU<br>Q26UD(E)HCPU | 1                            | 0%                    | 22,600hr                    | 43,800hr                        | 600hr                     |
|  |                              | 30%                   | 32,200hr                    | 43,800hr                        | 600hr                     |
|  |                              | 50%                   | 43,800hr                    | 43,800hr                        | 600hr                     |
|  |                              | 70%                   | 43,800hr                    | 43,800hr                        | 600hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 600hr                     |
|  | 2                            | 0%                    | 4,100hr                     | 26,200hr                        | 384hr                     |
|  |                              | 30%                   | 5,800hr                     | 37,400hr                        | 384hr                     |
|  |                              | 50%                   | 8,200hr                     | 43,800hr                        | 384hr                     |
|  |                              | 70%                   | 13,600hr                    | 43,800hr                        | 384hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 384hr                     |
|  | 3                            | 0%                    | 2,300hr                     | 18,600hr                        | 192hr                     |
|  |                              | 30%                   | 3,200hr                     | 26,500hr                        | 192hr                     |
|  |                              | 50%                   | 4,600hr                     | 37,200hr                        | 192hr                     |
|  |                              | 70%                   | 7,600hr                     | 43,800hr                        | 192hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 192hr                     |
|  | 4                            | 0%                    | 1,500hr                     | 13,800hr                        | 144hr                     |
|  |                              | 30%                   | 2,100hr                     | 19,700hr                        | 144hr                     |
|  |                              | 50%                   | 3,000hr                     | 27,600hr                        | 144hr                     |
|  |                              | 70%                   | 5,000hr                     | 43,800hr                        | 144hr                     |
|  |                              | 100%                  | 43,800hr                    | 43,800hr                        | 144hr                     |

| PLC CPU module type | Extended SRAM cassette | Power-ON time ratio *2     | Battery life               |   |                                     |
|---------------------|------------------------|----------------------------|----------------------------|---|-------------------------------------|
|                     |                        |                            | Guaranteed value *3        | Actual service value (Reference value) *4 | Backup power time after an alarm *5 |
| Q03UDVCPU           | Unused                 | 0%                         | 41,400 hours<br>4.72 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 50%                        |                            |   |                                     |
|                     |                        | 70%                        |                            |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-1MBS             | 0%                         | 26,600 hours<br>3.03 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 38,000 hours<br>4.33 years |   |                                     |
|                     |                        | 50%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 70%                        |                            |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-2MBS             | 0%                         | 23,100 hours<br>2.63 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 33,000 hours<br>3.76 years |   |                                     |
|                     |                        | 50%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 70%                        |                            |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-4MBS             | 0%                         | 17,400 hours<br>1.98 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 24,800 hours<br>2.83 years |   |                                     |
|                     |                        | 50%                        | 34,800 hours<br>3.97 years |   |                                     |
|                     |                        | 70%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
| Q4MCA-8MBS          | 0%                     | 11,000 hours<br>1.25 years | 43,800 hours<br>5.00 years | 600 hours<br>25 days                      |                                     |
|                     | 30%                    | 15,700 hours<br>1.79 years |                            |   |                                     |
|                     | 50%                    | 22,000 hours<br>2.51 years |                            |   |                                     |
|                     | 70%                    | 36,600 hours<br>4.17 years |                            |   |                                     |
|                     | 100%                   | 43,800 hours<br>5.00 years |                            |   |                                     |

| PLC CPU module type | Extended SRAM cassette | Power-ON time ratio *2     | Battery life               |   |                                     |
|---------------------|------------------------|----------------------------|----------------------------|---|-------------------------------------|
|                     |                        |                            | Guaranteed value *3        | Actual service value (Reference value) *4 | Backup power time after an alarm *5 |
| Q04UDVCPU           | Not used               | 0%                         | 31,700 hours<br>3.61 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 50%                        |                            |   |                                     |
|                     |                        | 70%                        |                            |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-1MBS             | 0%                         | 22,000 hours<br>2.51 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 31,400 hours<br>3.58 years |   |                                     |
|                     |                        | 50%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 70%                        |                            |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-2MBS             | 0%                         | 19,600 hours<br>2.23 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 28,000 hours<br>3.19 years |   |                                     |
|                     |                        | 50%                        | 39,200 hours<br>4.47 years |   |                                     |
|                     |                        | 70%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
|                     | Q4MCA-4MBS             | 0%                         | 15,300 hours<br>1.74 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                     |                        | 30%                        | 21,800 hours<br>2.48 years |   |                                     |
|                     |                        | 50%                        | 30,600 hours<br>3.49 years |   |                                     |
|                     |                        | 70%                        | 43,800 hours<br>5.00 years |   |                                     |
|                     |                        | 100%                       |                            |   |                                     |
| Q4MCA-8MBS          | 0%                     | 10,100 hours<br>1.15 years | 43,800 hours<br>5.00 years | 600 hours<br>25 days                      |                                     |
|                     | 30%                    | 14,400 hours<br>1.64 years |                            |   |                                     |
|                     | 50%                    | 20,200 hours<br>2.30 years |                            |   |                                     |
|                     | 70%                    | 33,600 hours<br>3.83 years |                            |   |                                     |
|                     | 100%                   | 43,800 hours<br>5.00 years |                            |   |                                     |

| PLC CPU module type                 | Extended SRAM cassette | Power-ON time ratio *2     | Battery life               |   |                                     |
|-------------------------------------|------------------------|----------------------------|----------------------------|---|-------------------------------------|
|                                     |                        |                            | Guaranteed value *3        | Actual service value (Reference value) *4 | Backup power time after an alarm *5 |
| Q06UDVCPU<br>Q13UDVCPU<br>Q26UDVCPU | Not used               | 0%                         | 30,600 hours<br>3.49 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                                     |                        | 30%                        | 43,700 hours<br>4.98 years |   |                                     |
|                                     |                        | 50%                        | 43,800 hours<br>5.00 years |   |                                     |
|                                     |                        | 70%                        |                            |   |                                     |
|                                     |                        | 100%                       |                            |   |                                     |
|                                     | Q4MCA-1MBS             | 0%                         | 21,500 hours<br>2.45 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                                     |                        | 30%                        | 30,700 hours<br>3.50 years |   |                                     |
|                                     |                        | 50%                        | 43,000 hours<br>4.90 years |   |                                     |
|                                     |                        | 70%                        | 43,800 hours               |   |                                     |
|                                     |                        | 100%                       | 5.00 years                 |   |                                     |
|                                     | Q4MCA-2MBS             | 0%                         | 19,100 hours<br>2.18years  | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                                     |                        | 30%                        | 27,200 hours<br>3.10 years |   |                                     |
|                                     |                        | 50%                        | 38,200 hours<br>4.36 years |   |                                     |
|                                     |                        | 70%                        | 43,800 hours               |   |                                     |
|                                     |                        | 100%                       | 5.00 years                 |   |                                     |
|                                     | Q4MCA-4MBS             | 0%                         | 15,000 hours<br>1.71 years | 43,800 hours<br>5.00 years                | 600 hours<br>25 days                |
|                                     |                        | 30%                        | 21,400 hours<br>2.44 years |   |                                     |
|                                     |                        | 50%                        | 30,000 hours<br>3.42years  |   |                                     |
|                                     |                        | 70%                        | 43,800 hours               |   |                                     |
|                                     |                        | 100%                       | 5.00 years                 |   |                                     |
| Q4MCA-8MBS                          | 0%                     | 10,000 hours<br>1.14 years | 43,800 hours<br>5.00 years | 600 hours<br>25 days                      |                                     |
|                                     | 30%                    | 14,200 hours<br>1.62 years |                            |   |                                     |
|                                     | 50%                    | 20,000 hours<br>2.28 years |                            |   |                                     |
|                                     | 70%                    | 33,300 hours<br>3.80 years |                            |   |                                     |
|                                     | 100%                   | 43,800 hours<br>5.00 years |                            |   |                                     |

- \*1: The frequency of battery usage indicated battery consumption of PLC CPU. (Target CPU modules for Q03UDCPU, Q04UDHCPU, and Q06UDHCPU are the first 5 digits of the serial No. is "10012" or later.) The bigger the frequency of battery usage is, the higher amount of battery per unit time is consumed. The frequency of battery usage depends on the elements (a) and (b). The following table shows the relationship between the combination pattern of (a) and (b) and the frequency of battery usage.

| Elements to decide how much battery is used |  | Frequency of battery usage |
|---|--|----------------------------|
| (a) Battery long-life function (Note)       | (b) State of a file storage during standard RAM<br>Size of a register file during RAM (SR) < Unit:<br>word |                            |
| With setting                                | -  | 1                          |
| Without setting                             | No file register or $0k < SR \leq 128k$  | 2                          |
|   | $128k < SR \leq 384k$  | 3                          |
|   | $384k < SR$  | 4                          |

(Note) Refer to the following manual for battery long-life function.

QnUCPU User's Manual (Function Explanation, Program Fundamentals) SH-080807(ENG)

- \*2: The power-on time ratio indicates the ratio of PLC power-on time to one day (24 hours). (When the total power-on time is 12 hours and the total power-off time is 12 hours, the power-on time ratio is 50%.)
- \*3: The guaranteed value; equivalent to the total power failure time that is calculated based on the characteristics value of the memory (SRAM) supplied by the manufacturer and under the storage ambient temperature range of -25 to 75 (operating ambient temperature of 0 to 55).
- \*4: The actual service value; equivalent to the total power failure time that is calculated based on the measured value and under the storage ambient temperature of 40. This value is intended for reference only, as it varies with characteristics of the memory.

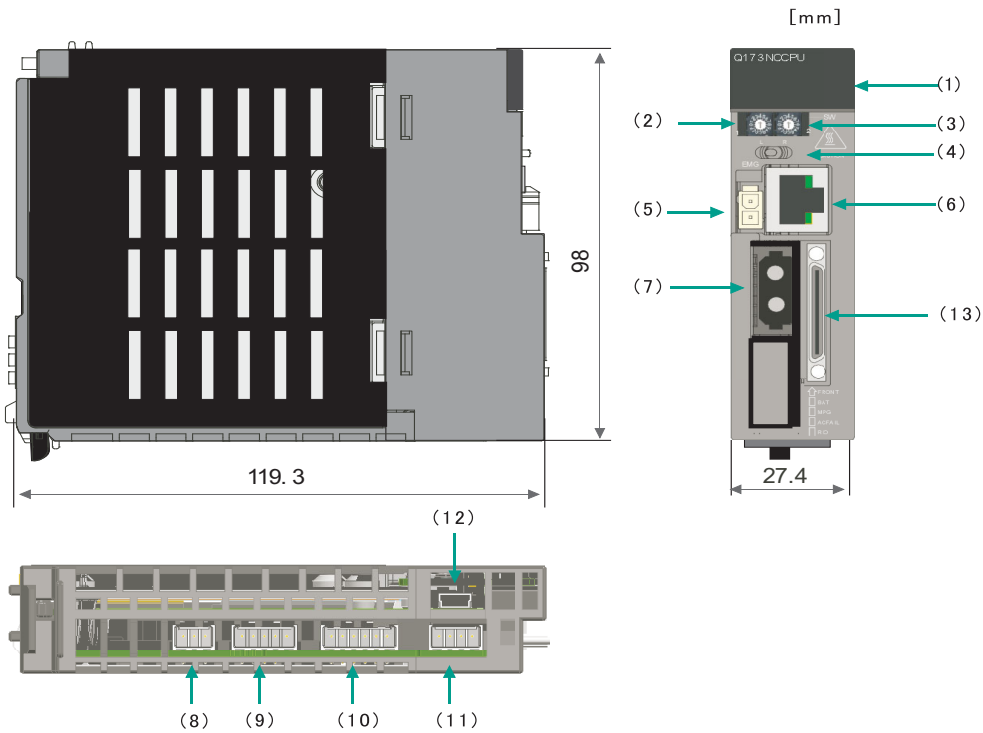
\*5: In the following status, the backup time after power OFF is 3 minutes.

- The battery connector is disconnected.
- The lead wire of the battery is broken.

(6) Ethernet: Ethernet connector

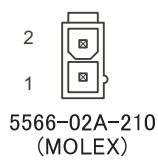
2.5 CNC CPU Module

Dimension and Names of parts

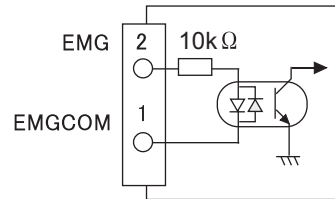


- (1) LED : Display of state/alarm code (with 3 digits)
- (2) SW1 : Rotary switch for maintenance (usually set to “0” )
- (3) SW2 : Rotary switch for maintenance (usually set to “0” )
- (4) SW : (Not used)

(5) EMG : Connector for the emergency stop signal input



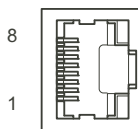
|   |    |        |
|---|----|--------|
| 1 | IN | EMGCOM |
| 2 | IN | EMG    |



Input type : Current sinking/sourcing  
 Insulation method : Photocoupler insulation  
 Input voltage : 24VDC (+10/-15%, ripple ratio within 5%)  
 OFF voltage/current : 17.5VDC or more / 3.0mA or less  
 ON voltage/current : 1.8VDC or less / 0.18mA or less  
 Input resistance : Approximate 10k  
 Response time (OFF -> ON or ON -> OFF): 1ms  
 Applicable size of wire : 0.3mm<sup>2</sup>

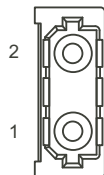
(Note) The emergency stop function suits "Stop category 1" of European safety standard "EN60204-1".

(6) DISPLAY I/F : Connector for display (GOT)



|   |     |      |
|---|-----|------|
| 1 | OUT | TD+  |
| 2 | OUT | TD-  |
| 3 | IN  | RD+  |
| 4 |     | CMTR |
| 5 |     | CMTR |
| 6 | IN  | RD-  |
| 7 |     | CMTT |
| 8 |     | CMTT |

(7) CN1 : Connector for servo/spindle drive unit



|   |     |    |
|---|-----|----|
| 1 | IN  | RD |
| 2 | OUT | TD |

(8) RIO : Connector for Dual signal module

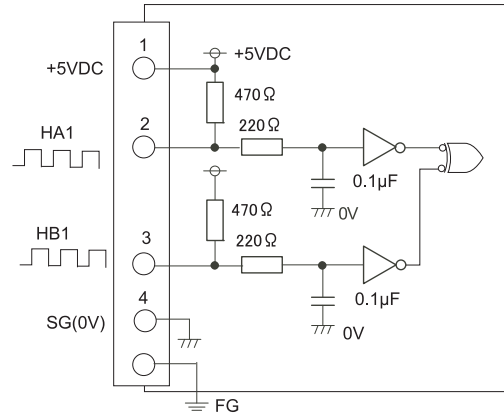
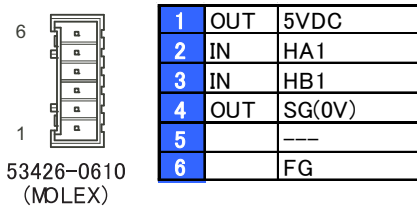


|   |        |       |
|---|--------|-------|
| 1 | IN/OUT | RXTXH |
| 2 | IN/OUT | RXTXL |
| 3 |        | SG(V) |

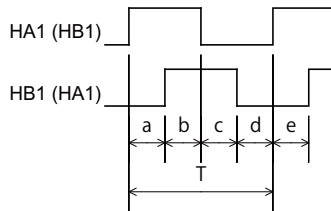
(9) AC FAIL : (Not used)



(10) MPG : Connector for 5V manual pulse generator

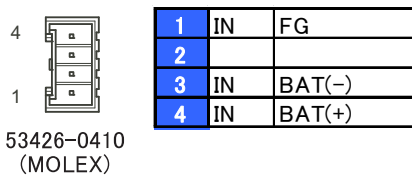


- Input pulse signal type : 90° phase difference between HA1 and HB1.
- Max. input pulse frequency : 5kHz
- Number of pulses per rotation : 100pulse/rev
- Input signal voltage : H level 3.5V to 5.25V, L level 0V to 0.5V
- Power voltage for pulse generators : 5VDC±10%
- Max. output current for pulse generators: :100mA



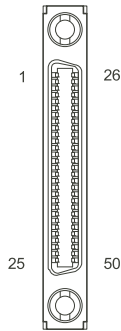
a.b.c.d.e: HA1 or HB1 rising edge (falling edge) phase difference =  $T/4 \pm T/10$   
 T: Ha1 or HB1 phase cycle (Min. 10 μ s)

(11) BAT : Connector for battery



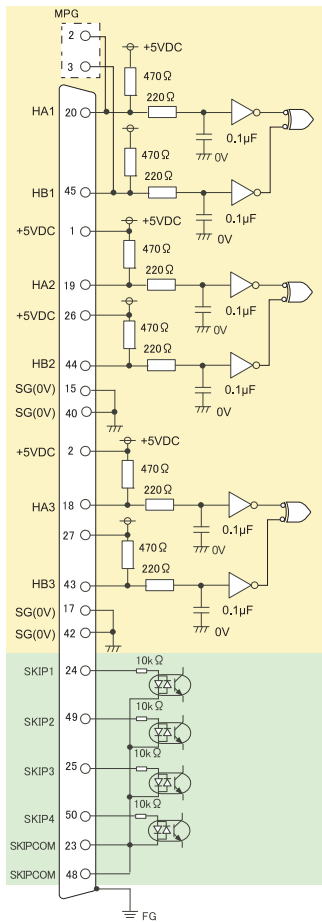
(12) Service : Connector for MITSUBISHI's servicing (Do not connect any object. It damages NC unit or PC.)

(13) EXT I/F : Connector for the expansion connection of skip signal/ 5V manual pulse generator



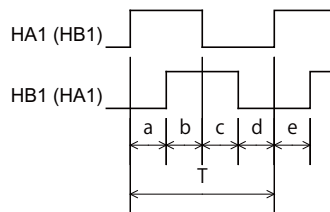
HDR-EC50LFD1-SDL+ (HONDA)

|    |           |         |    |           |         |
|----|-----------|---------|----|-----------|---------|
| 1  | OUT       | 5V      | 26 | OUT       | 5V      |
| 2  | OUT       | 5V      | 27 | OUT       | 5V      |
| 3  | OUT       | SG(0V)  | 28 | OUT       | SG(0V)  |
| 4  | (Reserve) |         | 29 | OUT       |         |
| 11 | (Reserve) |         | 30 | (Reserve) |         |
| 12 | OUT       | SG(0V)  | 36 | (Reserve) |         |
| 13 | (Reserve) |         | 37 | OUT       | SG(0V)  |
| 14 | (Reserve) |         | 38 | (Reserve) |         |
| 15 | OUT       | SG(0V)  | 39 | (Reserve) |         |
| 16 | (Reserve) |         | 40 | OUT       | SG(0V)  |
| 17 | OUT       | SG(0V)  | 41 | (Reserve) |         |
| 18 | IN        | HA3     | 42 | OUT       | SG(0V)  |
| 19 | IN        | HA2     | 43 | IN        | HB3     |
| 20 | IN        | HA1     | 44 | IN        | HB2     |
| 21 | (Reserve) |         | 45 | IN        | HB1     |
| 22 | (Reserve) |         | 46 | (Reserve) |         |
| 23 | IN        | SKIPCOM | 47 | (Reserve) |         |
| 24 | IN        | SKIP1   | 48 | IN        | SKIPCOM |
| 25 | IN        | SKIP3   | 49 | IN        | SKIP2   |
|    |           |         | 50 | IN        | SKIP4   |



---Manual pulse generator I/F specification---

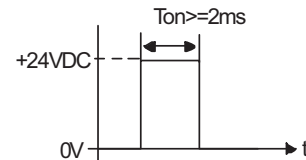
- Input pulse signal type: 90° phase difference between HA1 and HB1.
- Max. input pulse frequency : 5kHz
- Number of pulses per rotation: 100pulse/rev
- Input signal voltage : H level 3.5V to 5.25V, L level 0V to 0.5V
- Output power voltage : +5VDC -10% -10%
- Max. output current : 100mA
- (Note) The connector MPG and EXT I/F have input pins for HA1 and HB1. Use either of the connectors.



a.b.c.d.e: HA1 or HB1 rising edge (falling edge) phase difference =  $T/4 \pm T/10$   
 T: HA1 or HB1 cycle (Min. 10 μs)

---SKIP I/F specification---

- Input ON voltage : 18V or more to 25.2V or less
- Input ON current : 2mA or more
- Input OFF voltage : 4V or less
- Input OFF current : 0.4mA or less
- Input signal holding time (Ton) : 2ms or more
- Internal response time : 0.08ms or less

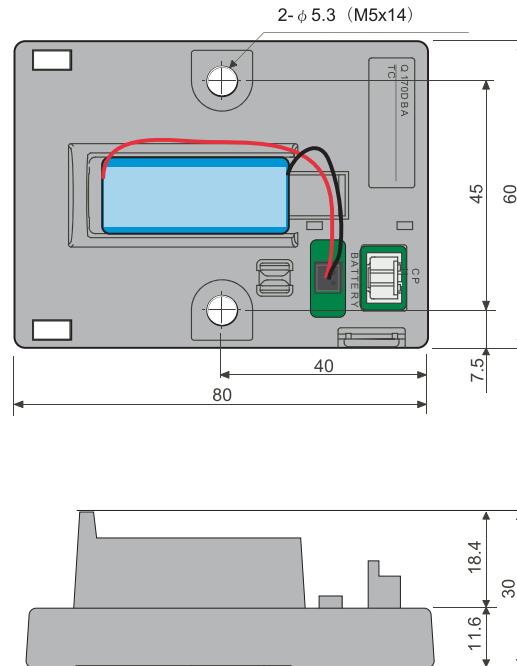


(Note) NC recognizes input signals of 2ms or more as the valid skip signals. If machine contacts (relay, etc.) are used, malfunctions will occur due to chattering. Use semiconductor contacts (transistor, etc.).

2.6 Battery Box for CNC CPU (Q173NCCPU)

Set the battery (Q6BAT) in the battery holder unit (Q173NCBATC).

Dimension



Life time of the battery

| CNC CPU module type | Power-on time ratio *1 | Life time of the battery (Q6BAT) |                                |                              |
|---------------------|------------------------|----------------------------------|--------------------------------|------------------------------|
|                     |                        | Guaranteed value *2 (75C°)       | Actual service value *3 (40C°) | Backup time after alarm *4   |
| Q173NCCPU           | 0%                     | 20,000hr                         | 43,800hr                       | 90hr (after SM51 or SM52 ON) |
|                     | 30%                    | 27,000hr                         |                                |                              |
|                     | 50%                    | 31,000hr                         |                                |                              |
|                     | 70%                    | 36,000hr                         |                                |                              |
|                     | 100%                   | 43,800hr                         |                                |                              |

- \*1: The power-on time ratio indicates the ratio of C70 power-on time to one day (24 hours). (When the total power-on time is 12 hours and the total power-off time is 12 hours, the power-on time ratio is 50%.)
- \*2: The guaranteed value; equivalent to the total power failure time that is calculated based on the characteristics value of the memory (SRAM) supplied by the manufacturer and under the storage ambient temperature range of -25 to 75 (operating ambient temperature of 0 to 55).
- \*3: The actual service value; equivalent to the total power failure time that is calculated based on the measured value and under the storage ambient temperature of 40. This value is intended for reference only, as it varies with characteristics of the memory.
- \*4: In the following status, the backup time after power OFF is 3 minutes.
  - The battery connector is disconnected.
  - The lead wire of the battery is broken.
- \*5: The battery should be changed after 5 years of use even an alarm has not occurred.

## 2.7 Dual Signal Module

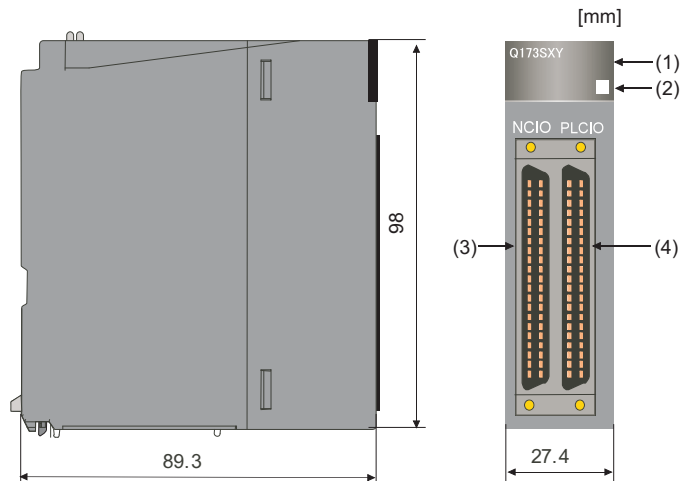
Use the dual signal module within the following specifications.

| Items                        | Specifications   |  |
|------------------------------|--|--|
|                              | Q173SXY  | Q173SXY-2  |
| Number of input points       | 32 points x 2 systems (32 points for PLC CPU control + 32 points for CNC CPU control, 20 points x 2 systems for safety input, 12 points x 2 systems for feedback input for output) |  |
| Input insulation method      | Photocoupler insulation  |  |
| Rated input voltage          | 24VDC (+20/-15%, ripple ratio within 5%)   |  |
| Rated input current          | Approximate 4mA  |  |
| Input derating               | Refer to the derating figure   |  |
| ON voltage / ON current      | 19V or more / 3mA or more  |  |
| OFF voltage / OFF current    | 11V or less / 1.7mA or less  |  |
| Input resistance             | Approximate 5.6k $\Omega$  |  |
| Input response time          | PLC CPU control input: 10ms (default value for digital filter)<br>CNC CPU control input: 10ms (for CR filter)  | PLC CPU control input: 10ms (default value for digital filter)<br>CNC CPU control input: 2ms (for CR filter) |
| Input common method          | 32 points/common<br>(Common terminal 1A01, 1A02, 2A01, 2A02)<br>(NCIO connector and PLCIO connector have each different common)  |  |
| Input type                   | Type 1, Current sinking  |  |
| Number of output points      | 12 points x 2 systems<br>(12 points for PLC CPU control + 12 points for CNC CPU control)   |  |
| Output insulation method     | Photocoupler insulation  |  |
| Rated load voltage           | 24VDC(+20/-15%)  |  |
| Maximum load current         | (0.1A x 8 points, 0.2A x 4 points) x 2 systems<br>Common current: 1.6A or less for each connector  |  |
| Utilisation category         | DC12/DC13  |  |
| Maximum rush current         | 0.7A, 10ms or less (1.4A, 10ms or less for 0.2A output pin)  |  |
| OFF-time leakage current     | 0.1mA or less  |  |
| ON-time maximum voltage drop | 0.1VDC(TYP.)0.1A, 0.2VDC(MAX.)0.1A   |  |
| Output response time         | 1ms or less (at rated load and resistance load)  |  |
| Output common method         | 12 points/common<br>(Common terminal 1B01, 1B02, 2B01, 2B02)<br>(NCIO connector and PLCIO connector have each different common)  |  |
| Output                       | Current sourcing   |  |
| Surge killer                 | Zener diode  |  |
| Fuse                         | Not provided   |  |
| External power supply        | 24VDC (+20/-15%, ripple ratio within 5%)   |  |
| Protection                   | Provided (thermal protection and short circuit protection)<br>Thermal protection works for each 2 points.<br>Short circuit protection works for each 1 point. (1 to 3A/point)      |  |
| Withstand voltage            | 560VAC rms/3cycles (at 2000m elevation)  |  |
| Insulation resistance        | 10M $\Omega$ or more (measured with an insulation resistance tester)   |  |
| Noise withstand level        | Simulator noise 500Vp-p, Noise width 1 $\mu$ s<br>measured with a noise simulator with noise frequency 25 to 60Hz<br>First transient noise IEC61000-4-4: 1kV                       |  |
| Protection degree            | IP2X   |  |

Use the dual signal module within the following specifications.

| Items                             | Specifications   |           |
|-----------------------------------|--|-----------|
|                                   | Q173SXY  | Q173SXY-2 |
| Protection degree                 | IP2X   |           |
| Number of I/O occupational points | 32 points (with I/O assignments as 32 points I/O mixed unit)     |           |
| Operation display                 | ON display (LED) and 32 input points display for PLC CPU control |           |
| External connection method        | 40-pin connector   |           |
| Applicable size of wire           | 0.3mm <sup>2</sup> (for A6CON1 and A6CON4)                       |           |
| Connector for external wiring     | A6CON1, A6CON2, A6CON3, A6CON4 (sold separately)                 |           |
| Terminal block changeover unit    | FA-LTB40P (Cable FA-CBL □□ FMV-M)                                |           |
| 5VDC internal power dissipation   | 200mA (TYP. when all points are ON)                              |           |
| Mass                              | 0.15kg   |           |

### Names of parts



(1) LED:

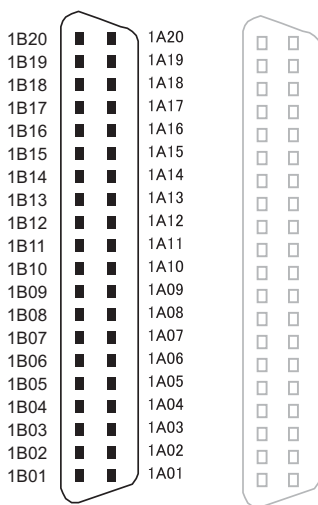
Shows the input signal state of PLCIO.

(2) Module No. sticker:

Module Nos. (1 to 3) should be written on this sticker when multiple dual signal modules are mounted.

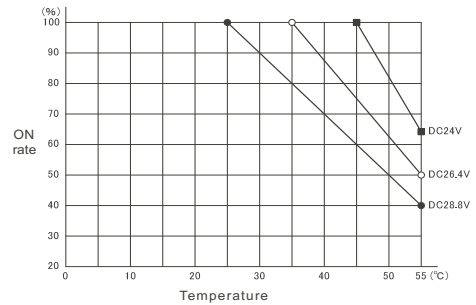
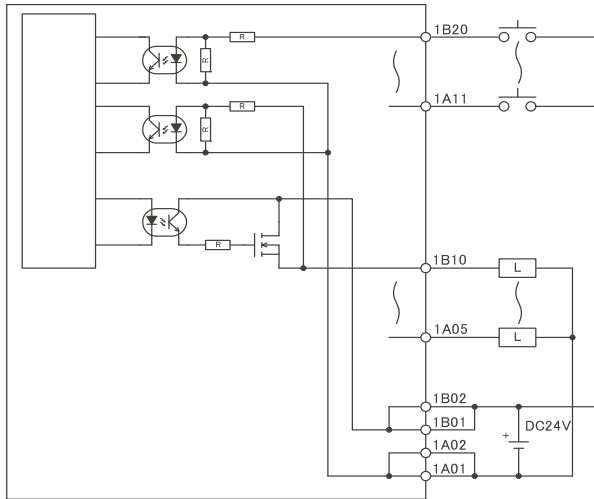
(3) NCIO:

Connector for I/O signals controlled by NCCPU (Q173NCCPU)



|         |        |             |
|---------|--------|-------------|
| 1B20    | IN     | NC-X00      |
| 1B19    | IN     | NC-X01      |
| 1B18    | IN     | NC-X02      |
| 1B17    | IN     | NC-X03      |
| 1B16    | IN     | NC-X04      |
| 1B15    | IN     | NC-X05      |
| 1B14    | IN     | NC-X06      |
| 1B13    | IN     | NC-X07      |
| 1B12    | IN     | NC-X08      |
| 1B11    | IN     | NC-X09      |
| 1B10(*) | IN/OUT | NC-Y0A/X0A  |
| 1B09(*) | IN/OUT | NC-Y0B/X0B  |
| 1B08    | IN/OUT | NC-Y0C/X0C  |
| 1B07    | IN/OUT | NC-Y0D/X0D  |
| 1B06    | IN/OUT | NC-Y0E/X0E  |
| 1B05    | IN/OUT | NC-Y0F/X0F  |
| 1B04    |        | ---         |
| 1B03    |        | ---         |
| 1B02    |        | 24VDC(COM1) |
| 1B01    |        | 24VDC(COM1) |

|         |        |            |
|---------|--------|------------|
| 1A20    | IN     | NC-X10     |
| 1A19    | IN     | NC-X11     |
| 1A18    | IN     | NC-X12     |
| 1A17    | IN     | NC-X13     |
| 1A16    | IN     | NC-X14     |
| 1A15    | IN     | NC-X15     |
| 1A14    | IN     | NC-X16     |
| 1A13    | IN     | NC-X17     |
| 1A12    | IN     | NC-X18     |
| 1A11    | IN     | NC-X19     |
| 1A10(*) | IN/OUT | NC-Y1A/X1A |
| 1A09(*) | IN/OUT | NC-Y1B/X1B |
| 1A08    | IN/OUT | NC-Y1C/X1C |
| 1A07    | IN/OUT | NC-Y1D/X1D |
| 1A06    | IN/OUT | NC-Y1E/X1E |
| 1A05    | IN/OUT | NC-Y1F/X1F |
| 1A04    |        | ---        |
| 1A03    |        | ---        |
| 1A02    |        | 0V(COM2)   |
| 1A01    |        | 0V(COM2)   |



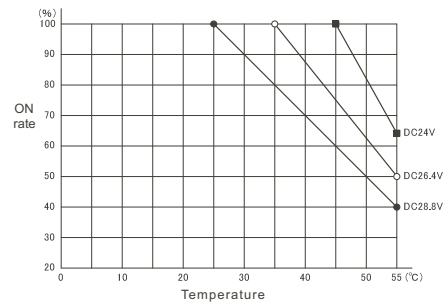
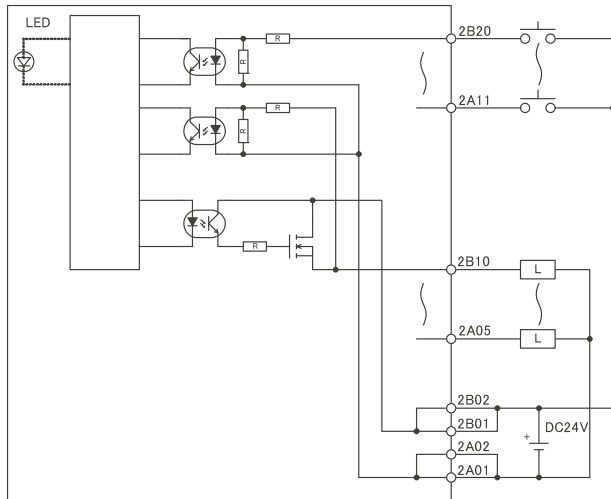
**(Note 1)** Output pins with (\*) allow 0.2A output. Other pins have 0.1A output.

**(Note 2)** Pins with signal names "NC-Y0A" and "NC-X0A" are the output signals controlled by CNC CPU. When any of the signals is output to Y0A, the signal is input to X0A as a feedback signal.

**(Note 3)** The device Nos. written above are for the assignment on hardware. These Nos. are different from the device Nos. to be actually used.

(4) PLCIO: Connector for I/O signals controlled by PLC CPU (QnUDHCPU).

|      |      |         |        |             |         |        |             |
|------|------|---------|--------|-------------|---------|--------|-------------|
| 2B20 | 2A20 | 2B20    | IN     | PLC-X00     | 2A20    | IN     | PLC-X10     |
| 2B19 | 2A19 | 2B19    | IN     | PLC-X01     | 2A19    | IN     | PLC-X11     |
| 2B18 | 2A18 | 2B18    | IN     | PLC-X02     | 2A18    | IN     | PLC-X12     |
| 2B17 | 2A17 | 2B17    | IN     | PLC-X03     | 2A17    | IN     | PLC-X13     |
| 2B16 | 2A16 | 2B16    | IN     | PLC-X04     | 2A16    | IN     | PLC-X14     |
| 2B15 | 2A15 | 2B15    | IN     | PLC-X05     | 2A15    | IN     | PLC-X15     |
| 2B14 | 2A14 | 2B14    | IN     | PLC-X06     | 2A14    | IN     | PLC-X16     |
| 2B13 | 2A13 | 2B13    | IN     | PLC-X07     | 2A13    | IN     | PLC-X17     |
| 2B12 | 2A12 | 2B12    | IN     | PLC-X08     | 2A12    | IN     | PLC-X18     |
| 2B11 | 2A11 | 2B11    | IN     | PLC-X09     | 2A11    | IN     | PLC-X19     |
| 2B10 | 2A10 | 2B10(*) | IN/OUT | PLC-Y0A/X0A | 2A10(*) | IN/OUT | PLC-Y1A/X1A |
| 2B09 | 2A09 | 2B09(*) | IN/OUT | PLC-Y0B/X0B | 2A09(*) | IN/OUT | PLC-Y1B/X1B |
| 2B08 | 2A08 | 2B08    | IN/OUT | PLC-Y0C/X0C | 2A08    | IN/OUT | PLC-Y1C/X1C |
| 2B07 | 2A07 | 2B07    | IN/OUT | PLC-Y0D/X0D | 2A07    | IN/OUT | PLC-Y1D/X1D |
| 2B06 | 2A06 | 2B06    | IN/OUT | PLC-Y0E/X0E | 2A06    | IN/OUT | PLC-Y1E/X1E |
| 2B05 | 2A05 | 2B05    | IN/OUT | PLC-Y0F/X0F | 2A05    | IN/OUT | PLC-Y1F/X1F |
| 2B04 | 2A04 | 2B04    |        | ---         | 2A04    |        | ---         |
| 2B03 | 2A03 | 2B03    |        | ---         | 2A03    |        | ---         |
| 2B02 | 2A02 | 2B02    |        | 24VDC(COM1) | 2A02    |        | 0V(COM2)    |
| 2B01 | 2A01 | 2B01    |        | 24VDC(COM1) | 2A01    |        | 0V(COM2)    |



(Note 1) Output pins with (\*) allow 0.2A output. Other pins have 0.1A output.

(Note 2) The device Nos. written above are for the assignment on hardware. These Nos. are different from the device Nos. to be actually used.

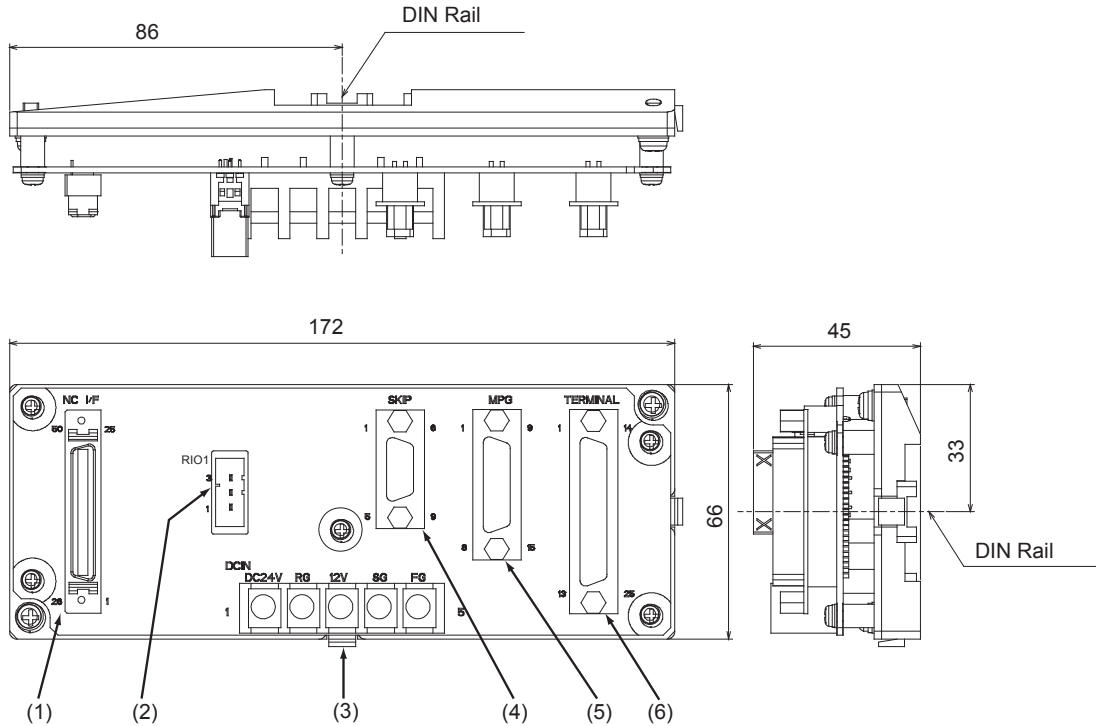
Cable side connector type

| Connector type | Pressure displacement type | Crimp-contact type  | Soldering type  |
|----------------|----------------------------|---|---|
| Connector      | FCN-367J040-AU/F           | FCN-363J040   | FCN-361J040-AU  |
| Contact        | -                          | AWG#24 to #28: FCN-363J-AU<br>AWG#22 to #26: FCN-363J-AU/S                            | -   |
| Case           | -                          | FCN-360C040-B<br>FCN-360C040-D (Wide-mouthed type)<br>FCN-360C040-E (Long screw type) | FCN-360C040-H/E<br>(Side-mouthed type)<br>FCN-360C040-J1<br>(Sloped-mouth cover)<br>FCN-360C040-J2<br>(Thin sloped-mouth cover) |
|                |                            | -   | -   |
| Manufacturer   | FUJITSU Component          |   |   |

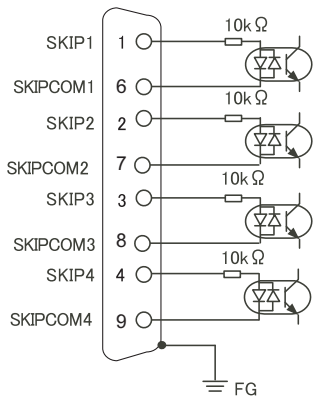
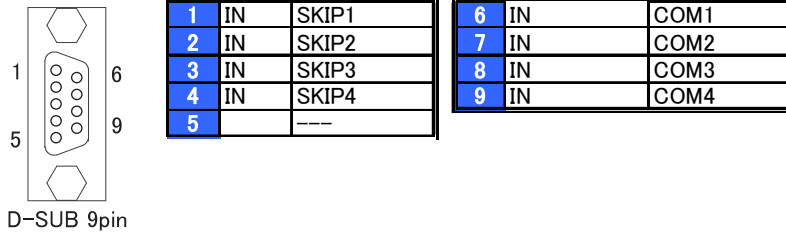
2.8 Signal Splitter

(Note) Signal splitter allows DIN rail installation only.

Dimension and Names of parts



- (1) NC I/F : Connector for CNC CPU
- (2) RIO1 : (Not used)
- (3) DCIN : Terminal block for power supply (Used for the 12V power supply type manual pulse generator)
- (4) SKIP : Connector for skip signal



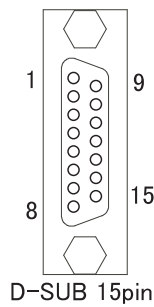
---SKIP I/F specification---

Input ON voltage : 18V or more to 25.2V or less  
 Input ON current : 6mA or more  
 Input OFF voltage : 4V or less  
 Input OFF current : 2mA or less  
 Input signal holding time (Ton) : 2ms or more  
 Internal response time : 0.08ms or less

(Note) NC recognizes input signals of 2ms or more as the valid skip signals. If machine contacts (relay, etc.) are used, malfunctions will occur due to chattering. Use semiconductor contacts (transistor, etc.).



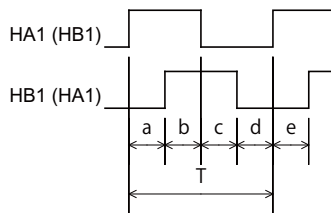
(5) MPG : 5V/12V Connector for manual pulse generator



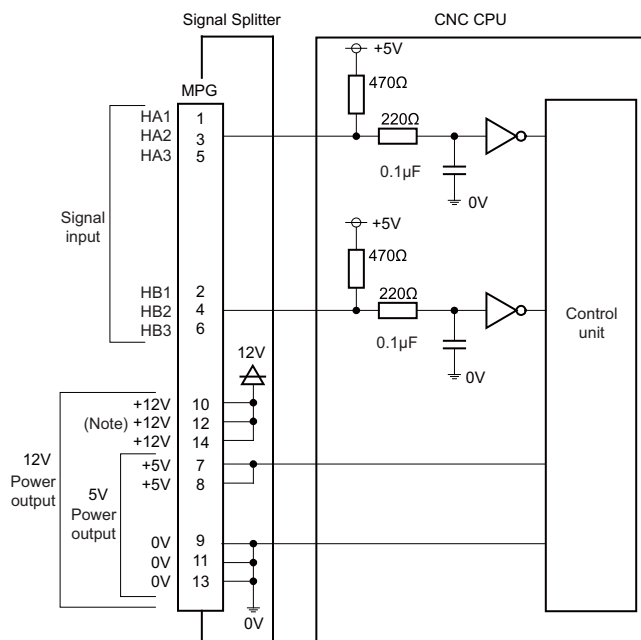
|   |     |       |
|---|-----|-------|
| 1 | IN  | HA1   |
| 2 | IN  | HB1   |
| 3 | IN  | HA2   |
| 4 | IN  | HB2   |
| 5 | IN  | HA3   |
| 6 | IN  | HB3   |
| 7 | OUT | +5VDC |
| 8 | OUT | +5VDC |

|    |     |        |
|----|-----|--------|
| 9  | OUT | SG(0V) |
| 10 | OUT | +12VDC |
| 11 | OUT | SG(0V) |
| 12 | OUT | +12VDC |
| 13 | OUT | SG(0V) |
| 14 | OUT | +12VDC |
| 15 |     | ---    |

|                                       | 5V manual pulse generator (UFO-01-2Z9) input conditions                        | 12V manual pulse generator (HD60C) input conditions |
|---------------------------------------|--|---|
| Input pulse signal type               | HA1 and HB1 phases (with phase difference 90° ) (Refer to the waveform below.) |   |
| Input signal voltage                  | H level 3.5V to 5.25V<br>L level 0V to 0.5V                                    |   |
| Max. input pulse frequency            | 5kHz   |   |
| Pulse generators power supply voltage | 5VDC ± 10%   | 5VDC ± 10%  |
| Current consumption                   | 100mA or less  |   |
| Number of pulses per rotation         | 100 pulse/rev  | 25 pulse/rev  |



a.b.c.d.e: HA1 or HB1 rising edge (falling edge) phase difference =  $T/4 \pm T/10$   
 T: HA1 or HB1 cycle (Min. 10μs)



(Note) 12V power is separately required to connect 12V manual pulse generator. (Refer to 4.9 Connecting the Manual Pulse Generator)

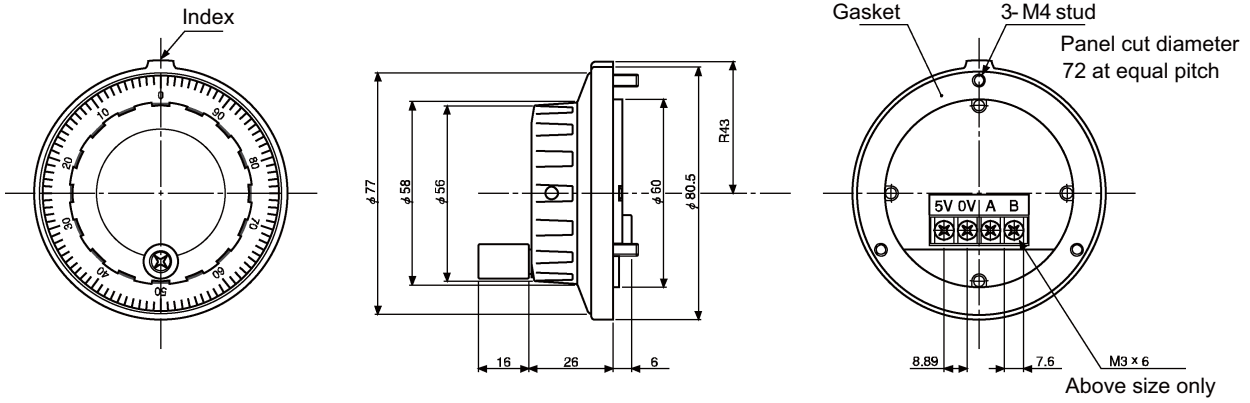
(6) TERMINAL : (Not used)

2.9 Manual Pulse Generator

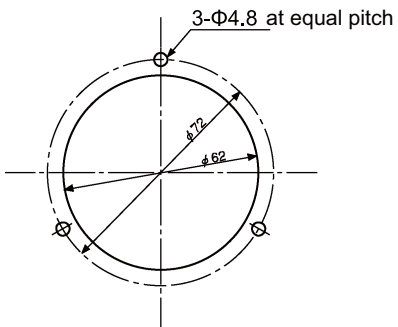
[UFO-01-2Z9]

5V manual pulse generator (100 pulse/rev)

<Outline dimension>



<Panel cut drawing>

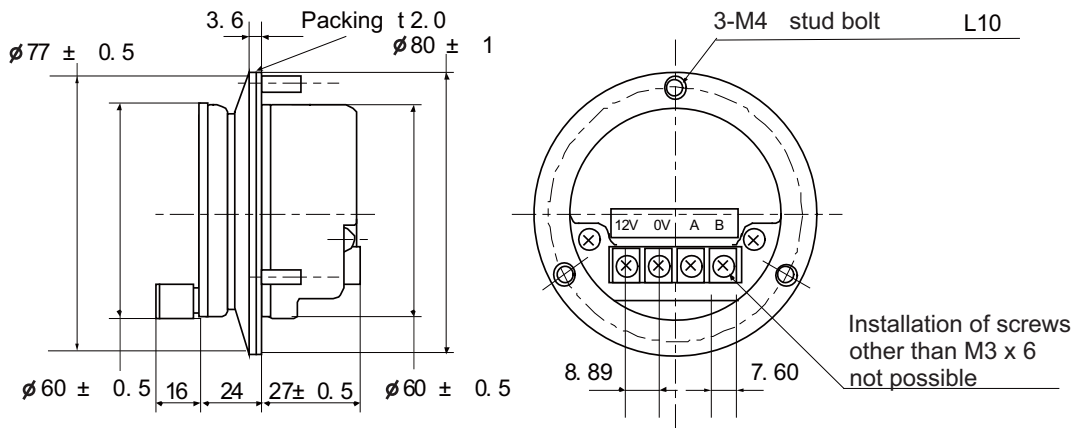


Produced by NIDEC NEMICON CORPORATION

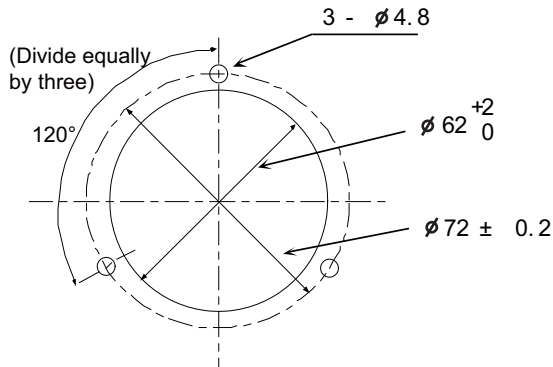
[HD60C]

12V manual pulse generator (25 pulse/rev)

<Outline dimension>



<Panel cut dimension drawing>



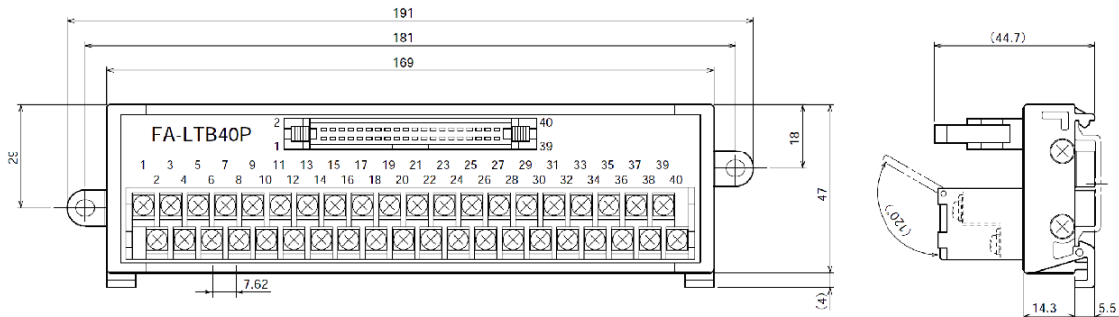
## 2. General Specifications

### 2.10 Terminal block for Dual Signal Module (Recommended)

#### 2.10 Terminal block for Dual Signal Module (Recommended)

Terminal block converter module FA-LTB40P, produced by MITSUBISHI ELECTRIC ENGINEERING, is recommended to connect the dual signals to the dual signal module. Use the connection cable FA-CBL □□ FMV-M produced by MITSUBISHI ELECTRIC ENGINEERING.

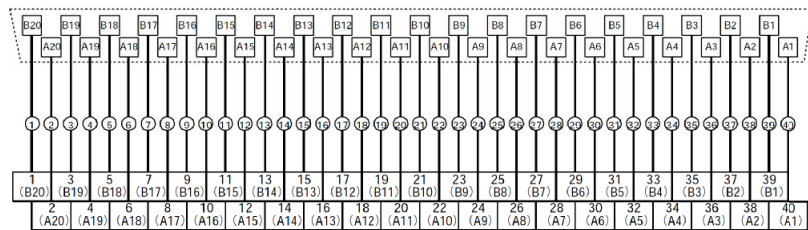
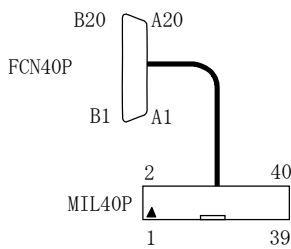
A dual signal module requires two units of terminal converter modules and two cables.



FA-CBL □□ FMV-M cable (length: 05 as 0.5m, 10 as 1m, 20 as 2m, 30 as 3m and 50 as 5m)

Connector and the terminal block

Connection diagram



(Note 1) Connect 24VDC to the terminals No.37 and 39, OV to the terminals No.38 and 40.

(Note 2) Input/output cables must be protected against damage and mechanical stress/movement.

The installation must be that short circuits between cores (of multicore cables) cannot be possible or do not lead to hazardous situation.

(Note 3) EMG-Switches must employ 2 NC contacts and be of direct opening type. (IEC60947-5-1 Annex K, IEC60947-5-5)

## 2.11 I/O Extension Connector Unit

General specifications of I/O Extension connector unit is same as that of GOT. Refer to the instruction manual of GOT you are using.

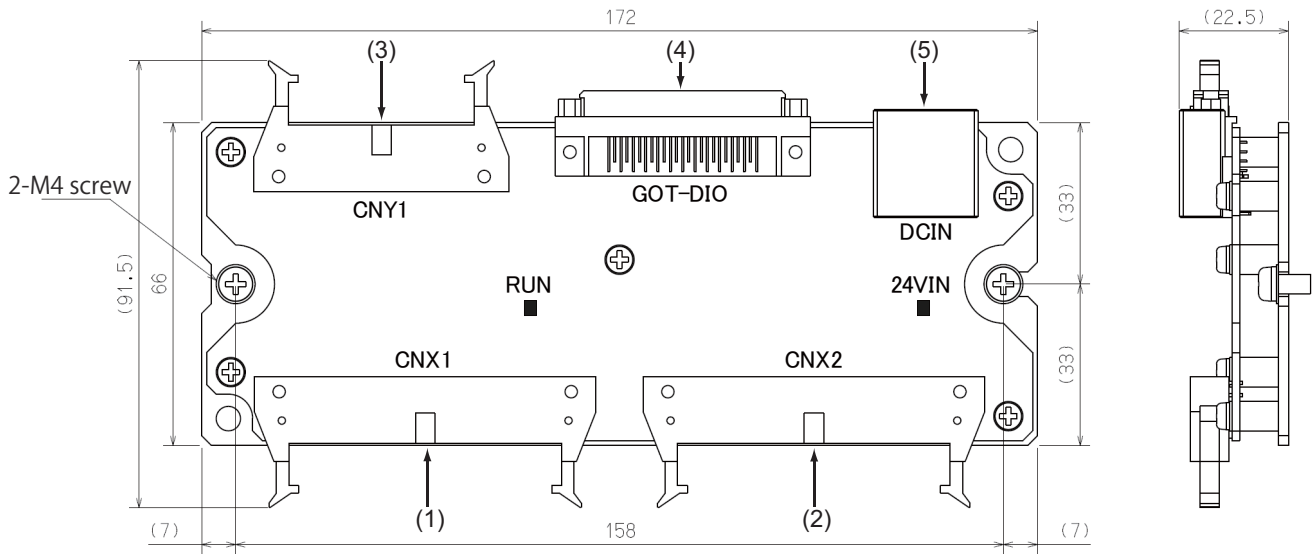
As for input/output specifications, they are basically same as GT15-DIOR unit apart from the number of input points is extended to 64points. Refer to the instruction manual for GT15-DIOR unit.

(Note) This unit is dedicated to GT15-DIOR (sink input/source output). It cannot be used for GT15-DIO (source input/sink output)

## Specifications list

| Item                                   | Specification  |
|--|--|
| External connection method             | Input connector: MIL-40 pin connector x 2 (CNX1, CNX2)<br>Output connector: MIL-26 pin connector x 1 (CNY1)  |
| Applicable size of wire                | Batch solderless type: AWG28 1.27 pitch flat cable<br>Multicore cable solderless type: AQQ24-28 twisted cable  |
| External power supply                  | [Voltage]<br>24VDC (20.4 - 28.8V, Ripple ratio: Less than 5%)  |
|  | [Current]<br>1.85A   |
|  | [Connector]<br>DCIN connector (Supply from CNX1 or CNX3 connector is available)<br>(Applicable size of electric wire: AWG16 - 20)  |
| Connection cable between GT15 and DIOR | H810 cable<br>(Install FCU7-HN831 unit in the same panel as GOT.)  |
| Input method                           | Dynamic scan method/sink input   |
| The number of input points             | 64 points (16 points x 4, 4 points of output for scan are used)  |
| Cycle of dynamic scan                  | 13.3ms   |
| Output method                          | Direct output/source output  |
| The number of output points            | 16 points + 1point(RUN)  |
| Protection function                    | Generic output signal: Overload protection function, Overheat protection function (inside GT15-DIOR)<br>RUN output signal: Overload protection function (inside FCU7-HN831)<br>(Recovers automatically when overload or overheat is resolved.) |
| LED display                            | 24VINDC, RUN output(RUN)   |
| Outline dimension                      | 172 × 66[91.5] × 22.5<br>(The figure inside brackets indicates the dimension to the tip of the connector.)   |

Outline dimension and names of each parts



(1) CNX1

Connector: 3432-6002-LCPL \* 3M  
 (Cable side: 7940-□□00SC/3448-7940)

| Pin number | Name of the signal |      |
|------------|--------------------|------|
|            | B                  | A    |
| 20         | X00                | X10  |
| 19         | X01                | X11  |
| 18         | X02                | X12  |
| 17         | X03                | X13  |
| 16         | X04                | X14  |
| 15         | X05                | X15  |
| 14         | X06                | X16  |
| 13         | X07                | X17  |
| 12         | X08                | X18  |
| 11         | X09                | X19  |
| 10         | X0A                | X1A  |
| 9          | X0B                | X1B  |
| 8          | X0C                | X1C  |
| 7          | X0D                | X1D  |
| 6          | X0E                | X1E  |
| 5          | X0F                | X1F  |
| 4          | COM0               | COM1 |
| 3          | COM0               | COM1 |
| 2          | ( 24VDC)           | (0V) |
| 1          | (24VDC)            | (0V) |

**(2) CNX2**

Connector: 3432-6002-LCPL \* 3M  
 (Cable side: 7940-□□00SC/3448-7940)

| Pin number | Name of the signal |      |
|------------|--------------------|------|
|            | B                  | A    |
| 20         | X20                | X30  |
| 19         | X21                | X31  |
| 18         | X22                | X32  |
| 17         | X23                | X33  |
| 16         | X24                | X34  |
| 15         | X25                | X35  |
| 14         | X26                | X36  |
| 13         | X27                | X37  |
| 12         | X28                | X38  |
| 11         | X29                | X39  |
| 10         | X2A                | X3A  |
| 9          | X2B                | X3B  |
| 8          | X2C                | X3C  |
| 7          | X2D                | X3D  |
| 6          | X2E                | X3E  |
| 5          | X2F                | X3F  |
| 4          | COM2               | COM3 |
| 3          | COM2               | COM3 |
| 2          | (24VDC)            | (0V) |
| 1          | (24VDC)            | (0V) |

**(3) CNY1**

Connector: 3429-5002-LCPL \* 3M  
 (Cable side: 7926-□□00SC/3448-7926)

| Pin number | Name of the signal |     |
|------------|--------------------|-----|
|            | B                  | A   |
| 13         | Y00                | Y08 |
| 12         | Y01                | Y09 |
| 11         | Y02                | Y0A |
| 10         | Y03                | Y0B |
| 9          | Y04                | Y0C |
| 8          | Y05                | Y0D |
| 7          | Y06                | Y0E |
| 6          | Y07                | Y0F |
| 5          | 0V                 | 0V  |
| 4          | 0V                 | 0V  |
| 3          | N.C                | N.C |
| 2          | RUN                | N.C |
| 1          | 0V                 | N.C |

**(4) GOT-DIO**

Connector: PCS-E50LMD+ \* HONDA TSUSHIN KOGYO  
(Cable side: PCS-E50FA)

| Pin number | Name of the signal | Pin number | Name of the signal |
|------------|--------------------|------------|--------------------|
| 25         | XD0E               | 50         | XD0F               |
| 24         | XD0C               | 49         | XD0D               |
| 23         | XD0A               | 48         | XD0B               |
| 22         | XD08               | 47         | XD09               |
| 21         | XD06               | 46         | XD07               |
| 20         | XD04               | 45         | XD05               |
| 19         | XD02               | 44         | XD03               |
| 18         | XD00               | 43         | XD01               |
| 17         | XSCN06             | 42         | XSCN07             |
| 16         | XSCN04             | 41         | XSCN05             |
| 15         | XSCN02             | 40         | XSCN03             |
| 14         | XSCN00             | 39         | XSCN01             |
| 13         | YD0E               | 38         | YD0F               |
| 12         | YD0C               | 37         | YD0D               |
| 11         | YD0A               | 36         | YD0B               |
| 10         | YD08               | 35         | YD09               |
| 9          | YD06               | 34         | YD07               |
| 8          | YD04               | 33         | YD05               |
| 7          | YD02               | 32         | YD03               |
| 6          | YD00               | 31         | YD01               |
| 5          | N.C                | 30         | RUN                |
| 4          | 24VDC              | 29         | 0V                 |
| 3          | 24VDC              | 28         | 0V                 |
| 2          | 24VDC              | 27         | 0V                 |
| 1          | 24VDC              | 26         | 0V                 |

**(5) DCIN**

Connector: 2-178313-5 \* Tyco Electronics  
(Cable side: 2-178288-3)

| Pin number | Name of the signal |
|------------|--------------------|
| 3          | FG                 |
| 2          | 0V                 |
| 1          | 24VDC              |

(Note 1) Xxx or Yxx. in this chapter does not indicate the internal device No.

(Note 2) Connect to common signal which is determined for each input signal since dynamic scan method is applied for the input method. (If the common is connected to 24VDC, it does not operate normally.)

X00 to X0F: COM0 is used as the common

X10 to X1F: COM1 is used as the common

X20 to X2F: COM2 is used as the common

X30 to X3F: COM is used as the common

(Note 3) It is recommended to use DCIN as a connector for 24VDC input, but it is available to supply from CNX1 or CNX2. In this case, make sure to wire more than 2 pins.

(Note 4) Pressure welding connector for multicore cable is also required for a cable side connector which connects to CNX1, CNX2 or CNY1 connector.

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### 3. Servo/Spindle Drive System

### 3. Servo/Spindle Drive System

(1) Power supply regenerative type

| <b>MDS-D-V1/V2 Series</b>   | <b>MDS-DH-V1/V2 Series</b>  |
|---|---|
| 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%  | 380 to 440VAC (50Hz)/380 to 480VAC (60Hz)<br>±10%   |
| MDS-D-V1 1-axis servo drive unit<br>MDS-D-V2 2-axis servo drive unit<br>MDS-D-SP 1-Spindle drive unit<br>MDS-D-SP2 2-Spindle drive unit<br>MDS-D-CV Power supply unit   | MDS-DH-V1 1-axis servo drive unit<br>MDS-DH-V2 2-axis servo drive unit<br>MDS-DH-SP Spindle drive unit<br>MDS-DH-CV Power supply unit     |
| <b>MDS-D2-V1/V2/V3 Series</b>   | <b>MDS-DH2-V1/V2 Series</b>   |
| 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%  | 380 to 440VAC (50Hz)/380 to 480VAC (60Hz)<br>±10%   |
| MDS-D2-V1 1-axis servo drive unit<br>MDS-D2-V2 2-axis servo drive unit<br>MDS-D2-V3 3-axis servo drive unit<br>MDS-D2-SP 1-spindle drive unit<br>MDS-D2-SP2 2-spindle drive unit<br>MDS-D2-CV Power supply unit | MDS-DH2-V1 1-axis servo drive unit<br>MDS-DH2-V2 2-axis servo drive unit<br>MDS-DH2-SP Spindle drive unit<br>MDS-DH2-CV Power supply unit |

(2) Resistance regenerative type

| <b>MDS-D-SVJ3/SPJ3 Series</b>                                       | <b>MDS-DJ Series</b>  |
|---|---|
| 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%                    | 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%  |
| MDS-D-SVJ3 1-axis servo drive unit<br>MDS-D-SPJ3 Spindle drive unit | MDS-DJ-V1 1-axis servo drive unit<br>MDS-DJ-V2 2-axis servo drive unit<br>MDS-DJ-SP 1-spindle drive unit<br>MDS-DJ-SP2 2-spindle drive unit |

(3) Multi-axis integrated regenerative type

| <b>MDS-DM Series</b>  | <b>MDS-DM2 Series</b>                                    |
|---|--|
| 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%  | 200VAC (50Hz)/200 to 230VAC (60Hz)<br>+10%, -15%         |
| MDS-DM-V3 3-axis integrated servo drive unit<br>MDS-DM-SPV2/SPV3 Multi-axis integrated drive unit | MDS-DM2-SPV2/SPV3/SPHV3 Multi-axis integrated drive unit |

## 4. CNC Signals (PLC Interface Signals)

### 4. CNC Signals (PLC Interface Signals)

The CNC signal includes the following signals.  
Refer to "PLC Interface Manual" for detail.

| Bit Type Input Signals<br>(CNC->PLC)   | PLC axis position switch 16<br>APLC input signal 1-32   |   |
|--|---|---|
|  |   | All axes in-position<br>All axes smoothing zero<br>Manual arbitrary feed completion<br>External search finished<br>In rapid traverse<br>In cutting feed<br>In tapping<br>In thread cutting<br>In synchronous feed<br>In constant surface speed<br>In skip<br>In reference position return<br>F 1-digit commanded<br>In tool life management<br>Tool life over<br>NC alarm 3 (Program error)<br>NC alarm 4 (Operation error)<br>Search & start (error)<br>Search & start (search)<br>Illegal axis selected<br>F 1-digit No. code 1<br>F 1-digit No. code 2<br>F 1-digit No. code 4<br>Waiting between part systems<br>In hypothetical axis command mode<br>M code independent output M00<br>M code independent output M01<br>M code independent output M02<br>M code independent output M30<br>M function strobe 1<br>M function strobe 2<br>M function strobe 3<br>M function strobe 4<br>Manual numerical command<br>Tool change position return completion<br>New tool change<br>T function strobe 1<br>2nd M function strobe 1<br>S function strobe 1<br>S function strobe 2<br>S function strobe 3<br>S function strobe 4<br>S function strobe 5<br>S function strobe 6<br>S function strobe 7<br>Position switch 1<br>Position switch 2<br>Position switch 3<br>Position switch 4<br>Position switch 5 |
| <b>System State</b>  | <b>Axis State</b>   |   |
| 24 hours continuous operation<br>Dual signal unconfirmed after compare error<br>Output OFF check not complete<br>Power shutoff notification<br>SKIP0 Input signal state<br>SKIP1 Input signal state<br>SKIP2 Input signal state<br>SKIP3 Input signal state<br>Controller ready completion<br>Servo ready completion<br>Door open enable<br>In spindle synchronization<br>Spindle rotation speed synchronization completion<br>Spindle phase synchronization completion<br>Chuck close confirmation<br>Battery warning<br>Battery alarm<br>NC alarm 1<br>NC alarm 2 (Servo alarm)<br>In door interlock<br>Macro single valid<br>Power OFF required after parameter change<br>Edited data in processing<br>Edited data error<br>NC data sampling completed<br>ATS valid<br>Download in progress<br>Download completed<br>Download error<br>PLC axis position switch 1<br>PLC axis position switch 2<br>PLC axis position switch 3<br>PLC axis position switch 4<br>PLC axis position switch 5<br>PLC axis position switch 6<br>PLC axis position switch 7<br>PLC axis position switch 8<br>PLC axis position switch 9<br>PLC axis position switch 10<br>PLC axis position switch 11<br>PLC axis position switch 12<br>PLC axis position switch 13<br>PLC axis position switch 14<br>PLC axis position switch 15 | PLC axis position switch 16<br>APLC input signal 1-32<br><br>Servo ready<br>Axis selection<br>In axis plus motion<br>In axis minus motion<br>1st reference position reached<br>2nd reference position reached<br>3rd reference position reached<br>4th reference position reached<br>Near reference position<br>NC axis up-to-speed<br>Zero point initialization set completed<br>Zero point initialization set error completed<br>In zero point initialization<br>Zero point initialization incomplete<br>In current limit<br>Current limit reached<br>Unclamp command<br>In-position<br>In multi-step speed monitor<br>Multi-step speed monitor mode output 1<br>Multi-step speed monitor mode output 2<br>Axis switching invalid status<br>In PLC axis control<br>In stop monitor<br>Brake test uncompleted<br>In brake test on the NC side<br>In brake test on the PLC side |   |
|  | <b>Part System State</b>  |   |
|  | In jog mode<br>In handle mode<br>In incremental mode<br>In manual arbitrary feed mode<br>In reference position return mode<br>In automatic initial set mode<br>In memory mode<br>In MDI mode<br>In automatic operation "run"<br>In automatic operation "start"<br>In automatic operation "pause"<br>In "reset"<br>In manual arbitrary feed<br>In rewind<br>Motion command completion  |   |

## 4. CNC Signals (PLC Interface Signals)

Position switch 6  
 Position switch 7  
 Position switch 8  
 Waiting for data to be downloaded  
 Tap retract possible  
 No. of work machining over  
 Power shutoff movement over  
 Position switch 9  
 Position switch 10  
 Position switch 11  
 Position switch 12  
 Position switch 13  
 Position switch 14  
 Position switch 15  
 Position switch 16

### Spindle State

S command gear No. illegal  
 S command max./min. command value over  
 S command no gear selected  
 Spindle speed upper limit over  
 Spindle speed lower limit over  
 Spindle gear shift command 1  
 Spindle gear shift command 2  
 Current detection  
 Speed detection  
 In spindle alarm  
 Zero speed  
 Spindle up-to-speed  
 Spindle in-position  
 In L coil selection  
 Spindle ready-ON  
 Spindle servo-ON  
 In spindle forward run  
 In spindle reverse run  
 Z-phase passed  
 Position loop in-position  
 In spindle torque limit  
 In spindle multi-step speed monitor  
 In spindle multi-step speed monitor output 1  
 In spindle multi-step speed monitor output 2  
 In spindle stop monitor

### Data Type Input Signals (CNC->PLC)

### System State

KEY IN  
 Speed monitor door open possible  
 1st handle pulse counter  
 2nd handle pulse counter  
 3rd handle pulse counter

CRT display information  
 Emergency stop cause  
 User macro output #1132 (Controller -> PLC)  
 User macro output #1133 (Controller -> PLC)  
 User macro output #1134 (Controller -> PLC)  
 User macro output #1135 (Controller -> PLC)  
 CNC software version code  
 Battery drop cause  
 Temperature warning cause  
 Spindle synchronization phase error 1  
 Spindle synchronization phase error 2  
 Spindle synchronization phase error output  
 Spindle synchronization Phase error monitor  
 Spindle synchronization Phase error monitor (lower limit)  
 Spindle synchronization Phase error monitor (upper limit)  
 Spindle synchronization Phase offset data  
 APLC input signal 1-10  
 NC exclusive instruction (DDWR/DDRD) error ZR device No.  
 GOT window data changeover completion  
 Encoder communication alarm  
 Insulation degradation monitor: Alarm output  
 Insulation degradation monitor: Limit value alarm output

### Part System State

External search status  
 M code data 1  
 M code data 2  
 M code data 3  
 M code data 4  
 S code data 1  
 S code data 2  
 S code data 3  
 S code data 4  
 T code data 1  
 2nd M function data 1  
 Tool No.  
 Group in tool life management  
 No. of work machining(current value)  
 Near reference position (per reference position)  
 Tool life usage data

No. of work machining(maximum value)  
 Error code output  
 Error code output extension  
 S code data 5  
 S code data 6  
 S code data 7  
 User Macro output #1132 (Controller -> PLC)  
 User Macro output #1133 (Controller -> PLC)  
 User Macro output #1134 (Controller -> PLC)  
 User Macro output #1135 (Controller -> PLC)  
 Chopping status  
 Chopping error No.  
 Chopping axis

### Axis State

Thermal expansion compensation amount  
 Servo motor temperature

### Spindle State

Spindle command rotation speed input  
 Spindle command final data (Rotation speed)  
 Spindle command final data (12-bit binary)  
 Spindle actual speed  
 Spindle motor temperature

### Bit Type Output Signals (PLC->CNC)

### System Command

Contactor shutoff test signal  
 Dual signals check start  
 Output OFF check  
 Integration time input 1  
 Integration time input 2  
 Data protect key 1  
 Data protect key 2  
 Data protect key 3  
 CRT changeover completion  
 Display changeover \$1  
 Display changeover \$2  
 NC data sampling trigger  
 Saving operation history data  
 Edited data recovery confirmation  
 PLC emergency stop  
 Door open I  
 Door open II  
 PLC axis control buffering mode valid  
 PLC axis 1st handle valid  
 PLC axis 2st handle valid



## 4. CNC Signals (PLC Interface Signals)

Magnification valid for each handle  
 Handle/incremental feed multiplication code 4  
 Handle/incremental feed magnification method selection  
 Tool alarm 1 /Tool skip 1  
 Tool alarm 2  
 Usage data count valid  
 Tool life management input  
 Tool change reset  
 Manual arbitrary feed 1st axis selection code 1  
 Manual arbitrary feed 1st axis selection code 2  
 Manual arbitrary feed 1st axis selection code 4  
 Manual arbitrary feed 1st axis selection code 8  
 Manual arbitrary feed 1st axis selection code 16  
 Manual arbitrary feed 1st axis valid  
 Manual arbitrary feed 2nd axis selection code 1  
 Manual arbitrary feed 2nd axis selection code 2  
 Manual arbitrary feed 2nd axis selection code 4  
 Manual arbitrary feed 2nd axis selection code 8  
 Manual arbitrary feed 2nd axis selection code 16  
 Manual arbitrary feed 2nd axis valid  
 Manual arbitrary feed 3rd axis selection code 1  
 Manual arbitrary feed 3rd axis selection code 2  
 Manual arbitrary feed 3rd axis selection code 4  
 Manual arbitrary feed 3rd axis selection code 8  
 Manual arbitrary feed 3rd axis selection code 16  
 Manual arbitrary feed 3rd axis valid  
 Manual arbitrary feed smoothing off  
 Manual arbitrary feed axis independent  
 Manual arbitrary feed EX.F/MODAL.F  
 Manual arbitrary feed G0/G1  
 Manual arbitrary feed MC/WK  
 Manual arbitrary feed ABS/INC  
 Manual arbitrary feed stop  
 Manual arbitrary feed strobe

2nd reference position return interlock  
 Search & start  
 Inclined axis control: no z axis compensation  
 Hypothetical axis command mode  
 Chopping  
 Chopping parameter valid  
 Compensation method selection  
 Operation mode selection  
 Rapid traverse override valid  
 1st spindle multiple-spindle synchronous tapping valid  
 2nd spindle multiple-spindle synchronous tapping valid  
 3rd spindle multiple-spindle synchronous tapping valid  
 4th spindle multiple-spindle synchronous tapping valid  
 5th spindle multiple-spindle synchronous tapping valid  
 6th spindle multiple-spindle synchronous tapping valid  
 7th spindle multiple-spindle synchronous tapping valid  
 Multiple-spindle synchronous tapping valid

### Spindle Command

Gear shift completion  
 Spindle override code 1  
 Spindle override code 2  
 Spindle override code 4  
 Spindle override method selection  
 Spindle gear selection code 1  
 Spindle gear selection code 2  
 Spindle stop  
 Spindle gear shift  
 Spindle orientation  
 Spindle forward run start  
 Spindle reverse run start  
 Spindle forward run index  
 Spindle reverse run index  
 Spindle orientation command  
 L coil selection  
 Spindle torque limit 1  
 Spindle torque limit 2  
 Spindle torque limit 3  
 Spindle multi-step monitor request  
 Spindle multi-step speed monitor mode input 1  
 Spindle multi-step speed monitor mode input 2  
 External axis speed clamp  
 Spindle stop monitor request

### Data Type Output Signals (PLC->CNC)

#### System Command

Speed monitor mode  
 PLC axis droop release invalid axis  
 KEY OUT  
 Speed monitor mode  
 User macro input #1032 (PLC -> Controller)  
 User macro input #1033 (PLC -> Controller)  
 User macro input #1034 (PLC -> Controller)  
 User macro input #1035 (PLC -> Controller)  
 PLC version code  
 1st axis index  
 2nd axis index  
 3rd axis index  
 4th axis index  
 5th axis index  
 6th axis index  
 7th axis index  
 8th axis index  
 9th axis index  
 10th axis index  
 11th axis index  
 12th axis index  
 13th axis index  
 14th axis index  
 15th axis index  
 16th axis index  
 Spindle synchronization Basic spindle selection  
 Spindle synchronization  
 Synchronous spindle selection  
 Spindle synchronization Phase shift amount  
 PLC version code (method 2)  
 APLC output data 1-10  
 GOT window Data changeover request

#### Part System Command

1st cutting feedrate override  
 2nd cutting feedrate override  
 Rapid traverse override  
 Manual feedrate  
 1st handle/incremental feed magnification  
 2nd handle feed magnification  
 3rd handle feed magnification  
 Manual arbitrary feed 1st axis travel amount  
 Manual arbitrary feed 2nd axis travel amount

## 4. CNC Signals (PLC Interface Signals)

|  |  |
|--|--|
| Manual arbitrary feed 3rd axis travel amount             | Window command                           |
| OT ignored   | Data registered to magazine for M system |
| Near-point dog ignored                                   | Tool life management (M system)          |
| Tool group No. designation                               | Safety observing                         |
| Synchronization control operation method                 | PLC constants                            |
| Droop release invalid axis                               | PLC bit selection                        |
| Search & start program No.                               | PLC axis indexing interface              |
| Each axis reference position selection                   | Special relay/register signals           |
| Workpiece coordinate offset measurement compensation No. |  |
| Selected tool No.  |  |
| External search device No.                               |  |
| External search program No.                              |  |
| External search sequence No.                             |  |
| External search block No.                                |  |
| User Macro input #1032 (PLC -> Controller)               |  |
| User Macro input #1033 (PLC -> Controller)               |  |
| User Macro input #1034 (PLC -> Controller)               |  |
| User Macro input #1035 (PLC -> Controller)               |  |
| Chopping override  |  |
| Chopping axis selection                                  |  |
| Upper dead point designation (L)                         |  |
| Upper dead point designation (H)                         |  |
| Lower dead point designation (L)                         |  |
| Lower dead point designation (H)                         |  |
| Number of cycles designation                             |  |
| Data No.   |  |

### Axis Command

External machine coordinate system compensation data  
Thermal expansion offset compensation amount  
Thermal expansion max. compensation amount  
External deceleration speed selection

### Spindle Command

Spindle command rotation speed output  
S command override  
Multi-point orientation position data

### Classified Under Purpose (CNC->PLC) (PLC->CNC)

PLC axis state  
PLC axis control  
Window result information



## **II FUNCTIONAL SPECIFICATIONS**





## 1. Control Axes

The NC axis, spindle, PLC axis are generically called the control axis.

The NC axis can be manually or automatically operated using the machining program.

The PLC axis can be controlled using the sequence program.

### 1.1 Control Axes

#### 1.1.1 Number of Basic Control Axes (NC axes)

**M system : 3 axes**

**L system : 2 axes**

#### 1.1.2 Max. Number of Axes (NC axes + Spindles + PLC axes)

**M system : 16 axes**

**L system : 16 axes**

A number of axes that are within the maximum number of control axes, and that does not exceed the maximum number given for the NC axis, spindle and PLC axis can be used.

For example, if 16 NC axes are used, this alone is the maximum number of control axes, so a spindle and PLC axis cannot be connected.

##### 1.1.2.1 Max. Number of NC axes (In Total for All the Part Systems)

**M system : 16 axes**

**L system : 16 axes**

##### 1.1.2.2 Max. Number of Spindles

**M system : 7 axes**

**L system : 4 axes**

##### 1.1.2.3 Max. Number of PLC axes

**M system : 8 axes**

**L system : 8 axes**

#### 1.1.4 Max. Number of PLC Indexing Axes

**M system : 8 axes**

**L system : 8 axes**

#### 1.1.5 Number of Simultaneous Contouring Control Axes

Simultaneous control of up to four axes or less is possible in the same part system.

However, for actual use, the machine tool builder specification will apply.

**M system : 4 axes**

**L system : 4 axes**

#### 1.1.6 Max. Number of NC Axes in a Part System

**M system : 8 axes**

**L system : 8 axes**

Listed are the maximum number of axes which can be controlled in a part system. For actual use, the machine tool builder specification will apply.

## 1.2 Control Part System

### 1.2.1 Standard Number of Part Systems

**M system : 1 part system    L system : 1 part system**

The standard number of part systems is one.

### 1.2.2 Max. Number of Part Systems

**M system :  $\Delta 7$  part systems    L system :  $\Delta 3$  part systems**

The maximum number of part systems for lathe system is three, and for machining center is seven. For actual use, the machine tool builder specification will apply.

## 1.3 Control Axes and Operation Modes

### 1.3.2 Memory Mode

**M system : ○                      L system : ○**

The machining programs stored in the memory of the CNC unit are run.

### 1.3.3 MDI Mode

**M system : ○                      L system : ○**

The MDI data stored in the memory of the CNC unit is executed. Once executed, the MDI data is set to the "setting incomplete" status, and the data will not be executed unless the "setting completed" status is established by performing screen operations.

### 1.3.102 High-speed program server mode

**M system :  $\Delta$                       L system :  $\Delta$**

This function allows a high-speed transfer and operation of machining programs to the large capacity buffer memory in a CNC CPU, using the Ethernet FTP function. And the operation requires an FTP server, such as PC, or an Ethernet connection with GTO (with FTP server function) connected with a memory card or a USB memory.

## 2. Input Command

### 2.1 Data Increment

#### 2.1.1 Least command increment

##### 2.1.1.1 Least command increment: 1 $\mu\text{m}$

**M system :** ○                      **L system :** ○

It is possible to command 0.001mm for the linear axis and 0.001° for the rotation axis.

##### 2.1.1.2 Least command increment: 0.1 $\mu\text{m}$

**M system :** Δ                      **L system :** Δ

It is possible to command 0.0001mm for the linear axis and 0.0001° for the rotation axis.

The data increment handled in the controller include the least input increment, least command increment and least detection increment. Each type is set with parameters.

- (1) The least input increment indicates the increment handled in the internal processing of the controller. The counter and tool offset data, etc., input from the screen is handled with this increment. This increment is applied per part system (all part systems, PLC axis).

| Increment type        | Input increment (parameter) | Metric unit system      |                        | Inch unit system          |                        |
|-----------------------|-----------------------------|-------------------------|------------------------|---------------------------|------------------------|
|                       |                             | Linear axis (Unit = mm) | Rotary axis (Unit = °) | Linear axis (Unit = inch) | Rotary axis (Unit = °) |
| Least input increment | B                           | 0.001                   | 0.001                  | 0.0001                    | 0.001                  |
|                       | C                           | 0.0001                  | 0.0001                 | 0.00001                   | 0.0001                 |

**(Note 1)** The inch and metric systems cannot be used together.

- (2) The command increment indicates the command increment of the movement command in the machining program. This can be set per axis.

| Increment type    | Command increment (parameter) | Metric unit system      |                        | Inch unit system          |                        |
|-------------------|-------------------------------|-------------------------|------------------------|---------------------------|------------------------|
|                   |                               | Linear axis (Unit = mm) | Rotary axis (Unit = °) | Linear axis (Unit = inch) | Rotary axis (Unit = °) |
| Command increment | 10                            | 0.001                   | 0.001                  | 0.0001                    | 0.001                  |
|                   | 100                           | 0.01                    | 0.01                   | 0.001                     | 0.01                   |
|                   | 1000                          | 0.1                     | 0.1                    | 0.01                      | 0.1                    |
|                   | 10000                         | 1.0                     | 1.0                    | 0.1                       | 1.0                    |

**(Note 1)** The inch and metric systems cannot be used together.

- (3) The least detection increment indicates the detection increment of the NC axis and PLC axis detectors. The increment is determined by the detector being used.

## 2.2 Unit System

### 2.2.1 Inch/Metric Changeover

**M system** : Δ

**L system** : Δ

The unit systems of the data handled in the controller include the metric system and inch system. The type can be designated with the parameters and machining program. The unit system can be set independently for the (1) Program command, (2) Setting data such as offset amount and (3) Parameters.

| Unit system        | Length data | Meaning  |
|--------------------|-------------|----------|
| Metric unit system | 1.0         | 1.0 mm   |
| Inch unit system   | 1.0         | 1.0 inch |

**(Note 1)** For the angle data, 1.0 means 1 degree (°) regardless of the unit system.

| Parameter \ Data |   | Machining program |                    | Screen data<br>(Offset amount, etc.) | Parameter          |
|------------------|---|-------------------|--------------------|--------------------------------------|--------------------|
| I_inch           | 0 | G20               | Inch unit system   | Metric unit system                   | Not affected       |
|                  |   | G21               | Metric unit system |                                      |                    |
|                  | 1 | G20               | Inch unit system   | Inch unit system                     |                    |
|                  |   | G21               | Metric unit system |                                      |                    |
| M_inch           | 0 | Not affected      |                    | Not affected                         | Metric unit system |
|                  | 1 |                   |                    | Inch unit system                     |                    |

**(Note 1)** The parameter changeover is valid after the power is turned ON again.

**(Note 2)** Even if parameter "I\_inch" is changed, the screen data (offset amount, etc.) will not be automatically converted.

**(Note 3)** When the power is turned ON or resetting is performed, the status of the G20/G21 modal depends on the "I\_G20" parameter setting.

**2.3 Program Format****2.3.1 Program Format**

This is G code (program) format.

The G-code of lathe system is selected by parameter.

This specification manual explains the G function with G-code series 3 as standard.

**2.3.1.1 Format 1 for Lathe**

**M system : -**

**L system : O**

**2.3.1.2 Format 2 for Lathe**

**M system : -**

**L system : O**

**2.3.1.4 Format 1 for Machining Center**

**M system : O**

**L system : -**

## 2.4 Command Value

## 2.4.1 Decimal Point Input I, II

M system : ○

L system : ○

There are two types of the decimal point input commands and they can be selected by parameter.

(1) Decimal point input type I (When parameter #1078 Decpt2 is 0.)

When axis coordinates and other data are supplied in machining program commands, the assignment of the program data can be simplified by using the decimal point input. The minimum digit of a command not using a decimal point is the same as the least command increment.

Usable addresses can be applied not only to axis coordinate values but also to speed commands and dwell commands.

The decimal point position serves as the millimeter unit in the metric mode, as the inch unit in the inch mode and as the second unit in a time designation of dwell command.

(2) Decimal point input type II (When parameter #1078 Decpt2 is 1.)

As opposed to type I, when there is no decimal point, the final digit serves as the millimeter unit in the metric mode, as the inch unit in the inch mode and as the second unit in the time designation.

The "." (point) must be added when commands below the decimal point are required.

|     |                    | Unit interpretation (for metric system) |                    |
|-----|--------------------|---|--------------------|
|     |                    | Type I                                  | Type II            |
| G00 | X100. Y-200.5      | X100mm, Y-200.5mm                       | ←                  |
| G1  | X100 F20.          | X100μm, F20mm/min                       | X100mm, F20mm/min  |
| G1  | Y200 F100 (Note 1) | Y200μm, F100mm/min                      | Y200mm, F100mm/min |
| G4  | X1.5               | Dwell 1.5 s                             | ←                  |
| G4  | X2                 | 2ms                                     | 2s                 |

(Note 1) The F unit is mm/min for either type (inch system : inch/min).

2.4.2 Absolute/Incremental Command

M system : ○

L system : ○

(1) M system

When axis coordinate data is issued in a machining program command, either the incremental command method (G91) that commands a relative distance from the current position or the absolute command method (G90) that moves to a designated position in a predetermined coordinate system can be selected.

The absolute and incremental commands can be both used in one block, and are switched with G90 or G91. However, the arc radius designation (R) and arc center designation (I, J, K) always use incremental designations.

G90 ... Absolute command (absolute value command)

G91 ... Incremental command (incremental value command)

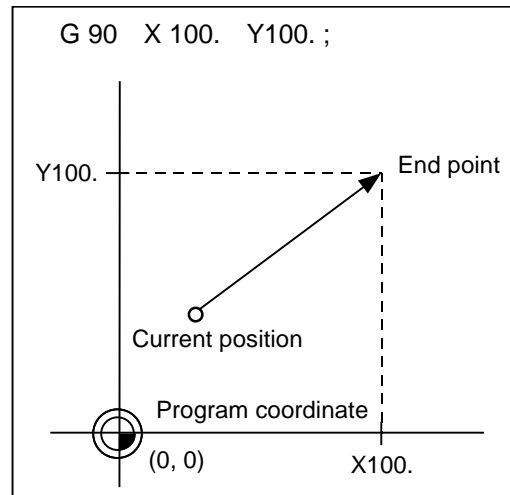
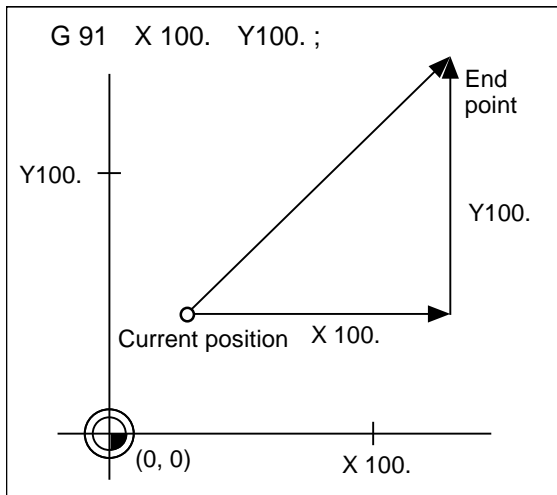
These G codes can be commanded multiple times in one block.

Example

|                |                   |                |
|----------------|-------------------|----------------|
| G90 X100.      | G91 Y200.         | G90 Z300.      |
| Absolute value | Incremental value | Absolute value |

(Note 1) As with the memory command, if there is no G90/G91 designation in the MDI command, the previously executed modal will be followed.

(Incremental value command)    (Absolute value command)





(2) L system

When axis coordinate data is issued in a machining program command, either the incremental command method that commands a relative distance from the current position or the absolute command method that moves to a designated position in a predetermined coordinate system can be selected.

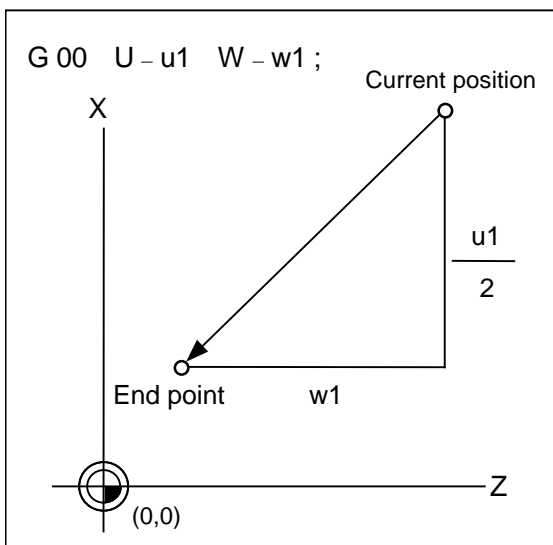
When issuing an incremental value command, the axis address to be commanded as the incremental axis name is registered in the parameter. However, the arc radius designation (R) and arc center designation (I, J, K) always use incremental designations.

Absolute command (absolute value command) ... X, Z

Incremental command (incremental value command) ... U, W

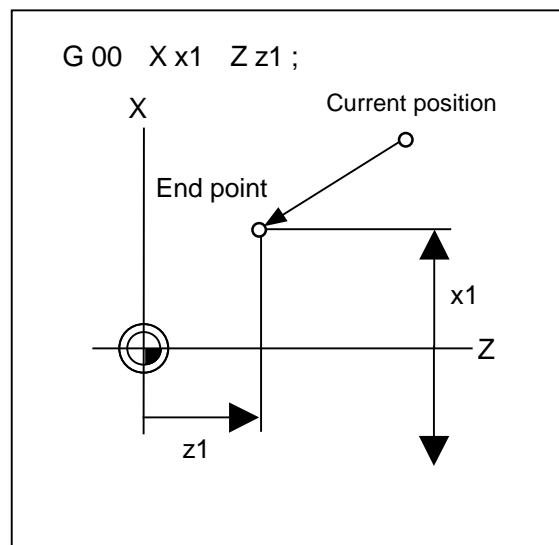
|   |
|---|
| Example <code>G00</code> $\frac{X100.}{\text{Absolute value}}$ $\frac{W200.}{\text{Incremental value}}$ ; |
|---|

(Incremental value command)



The above drawing shows the case for the diameter command.

(Absolute value command)



The above drawing shows the case for the diameter command.

**(Note 1)** In addition to the above command method using the above axis addresses, the absolute value command and incremental value command can be switched by commanding the G code (G90/G91). (Select with the parameters.)

2.4.3 Diameter/Radius Designation

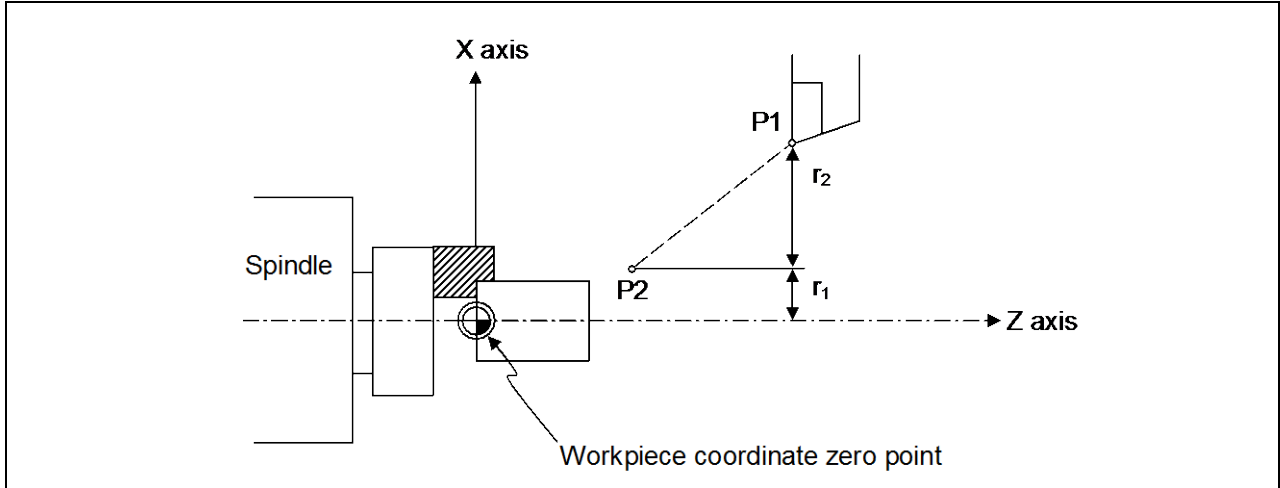
M system : -

L system : O

For the axis command value, the radius designation or diameter designation can be changed with parameters.

When the diameter designation is selected, the scale of the length of the selected axis is doubled. (Only half (1/2) of the commanded amount moves.)

This function is used when programming the workpiece dimensions on a lathe as diameters. Changing over from the diameter designation to the radius designation or vice versa can be set separately for each axis.



When the tool is to be moved from point P1 to point P2

| X command |            | U command |            | Remarks   |
|-----------|------------|-----------|------------|---|
| Radius    | Diameter   | Radius    | Diameter   |   |
| $X = r_1$ | $X = 2r_1$ | $U = r_2$ | $U = 2r_2$ | Even when a diameter command has been selected, only the U command can be made a radius command by parameter. |

Radius and diameter commands

## 3. Positioning/Interpolation

### 3.1 Positioning

#### 3.1.1 Positioning

**M system :** ○

**L system :** ○

This function carries out positioning at high speed using a rapid traverse rate with the movement command value given in the program.

**G00 Xx1 Yy1 Zz1 ; (Also possible for additional axes A, B, C, U, V, W simultaneously)**  
 x1, y1, z1: numerical values denoting the position data

The above command positions the tool by rapid traverse. The tool path takes the shortest distance to the end point in the form of a straight line.

For details on the rapid traverse feed rate of the NC, refer to the section entitled "Rapid Traverse Rate".

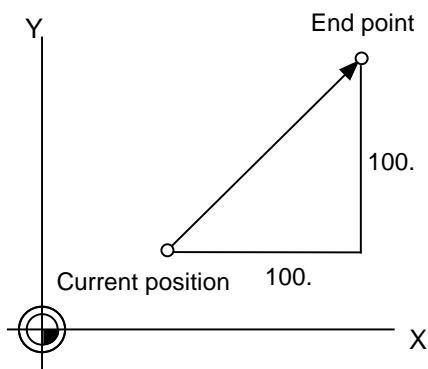
Since the actual rapid traverse feed rate depends on the machine, refer to the specifications of the machine concerned.

- (1) The rapid traverse feed rate for each axis can be set independently with parameters.
- (2) The number of axes which can be driven simultaneously depends on the specifications (number of simultaneously controlled axes). The axes can be used in any combination within this range.
- (3) The feed rate is controlled within the range that it does not exceed the rapid traverse rate of each axis and so that the shortest time is taken. (Linear type)

Parameter setting enables movement at the rapid traverse rates of the respective axes independently for each axis. In this case, the tool path does not take the form of a straight line to the end point. (Non-Linear type)

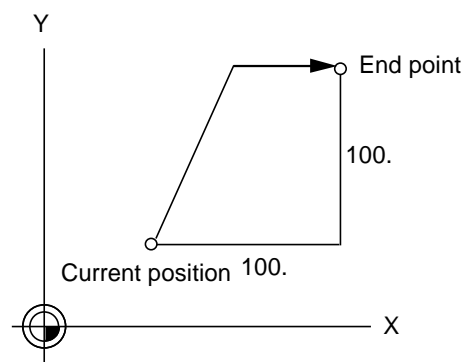
**(Example) Linear type** (Moves linearly to the end point.)

G 00 G 91 X 100. Y 100. ;



**(Example) Non-linear type** (Each axis moves at each parameter speed.)

G 00 G 91 X 100. Y 100. ;



**(Note 1)** If the acceleration/deceleration conditions differ between the axes, the path will not be linear to the end point even when using the linear type.

- (4) The tool is always accelerated at the start of the program command block and decelerated at the end of the block.

## 3.1.2 Unidirectional Positioning

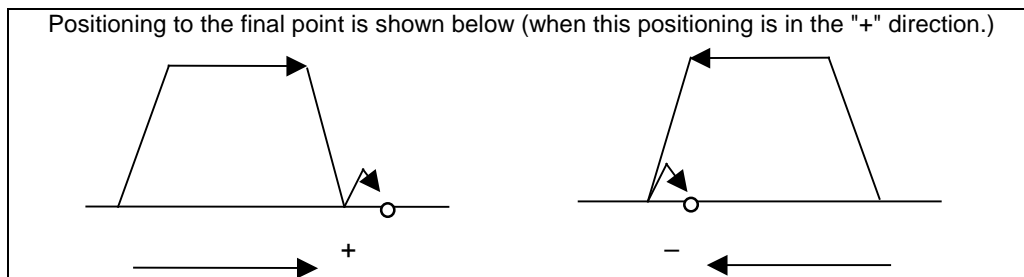
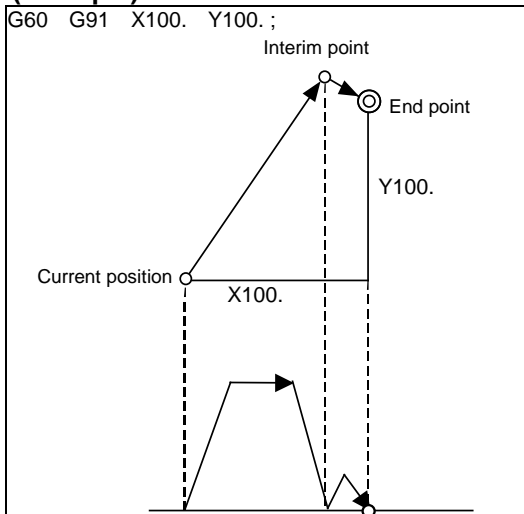
M system :  $\Delta$ 

L system : -

The G60 command always moves the tool to the final position in the direction determined by parameters. The tool can be positioned without backlash.

**G60 Xx1 Yy1 Zz1 ; (Also possible for additional axes A, B, C, U, V, W simultaneously)**  
 x1, y1, z1: numerical values denoting the position data

With the above command, the tool is first moved to a position distanced from the end point position by an amount equivalent to the creep distance (parameter setting) and then moved to its final position. For details on the rapid traverse feed rate of the NC, refer to the section entitled "Rapid Traverse Rate". Since the actual rapid traverse feed rate depends on the machine, refer to the specifications of the machine concerned.

**(Example)**

- (1) The rapid traverse rate for each axis is the value set with parameters as the G00 speed.
- (2) The vector speed to the interim point is the value produced by combining the distance and respective speeds.
- (3) The creep distance of the distance between the interim and end points can be set independently for each axis by "parameters".

**(Note 1)** The processing of the above pattern will be followed even for the machine lock and Z-axis command cancel.

**(Note 2)** On the creep distance, the tool is moved with rapid traverse.

**(Note 3)** G60 is valid even for positioning in drilling in the fixed cycle.

**(Note 4)** When the mirror image function is on, the tool will be moved in the reverse direction by mirror image as far as the interim position, but operation over the creep distance with the final advance will not be affected by the mirror image.

## 3.2 Linear/Circular Interpolation

### 3.2.1 Linear Interpolation

M system : ○

L system : ○

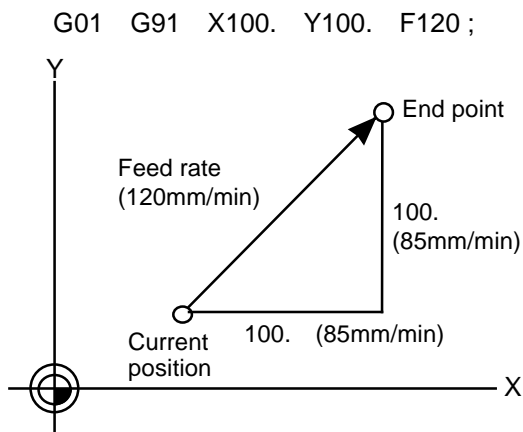
Linear interpolation is a function that moves a tool linearly by the movement command value supplied in the program at the cutting feed rate designated by the F code.

**G01 Xx1 Yy1 Zz1 Ff1 ; (Also possible for additional axes A, B, C, U, V, W simultaneously)**  
 x1, y1, z1 : numerical values denoting the position data  
 f1 : numerical value denoting the feed rate data

Linear interpolation is executed by the above command at the f1 feed rate. The tool path takes the shortest distance to the end point in the form of a straight line.

For details on the f1 command values for NC, refer to the section entitled "Cutting Feed Rate". Since the actual cutting feed rate depends on the machine, refer to the specifications of the machine concerned.

#### (Example)



- (1) The cutting feed rate command moves the tool in the vector direction.
- (2) The component speeds of each axis are determined by the proportion of respective command values to the actual movement distance with linear interpolation.

- (1) The number of axes which can be driven simultaneously depends on the specifications (number of simultaneously controlled axes). The axes can be used in any combination within this range.
- (2) The feed rate is controlled so that it does not exceed the cutting feed rate clamp of each axis.
- (3) When a rotary axis has been commanded in the same block, it is treated as a linear axis in degree(°) units (1° = 1mm), and linear interpolation is performed.

3.2.2 Circular Interpolation (Center/Radius Designation)

M system : O

L system : O

(1) Circular interpolation with I, J, K commands

This function moves a tool along a circular arc on the plane with movement command value supplied in the program.

```
G02(G03) Xx1 Yy1 Ii1 Jj1 Ff1 ; (Also possible for additional axes A, B, C, U, V, W)

G02, G03 : Arc rotation direction
Xx1, Yy1 : End point coordinate values
Ii1, Jj1 : Arc center coordinate values
Ff1 : Feed rate
```

The above commands move the tool along the circular arc at the f1 feed rate. The tool moves along a circular path, whose center is the position from the start point designated by distance "i1" in the X-axis direction and distance "j1" in the Y-axis direction, toward the end point.

The direction of the arc rotation is specified by G02 or G03.

G02: Clockwise (CW)

G03: Counterclockwise (CCW)

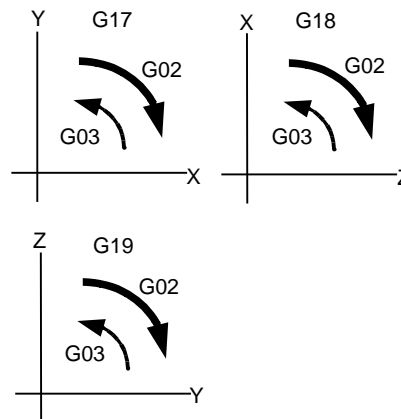
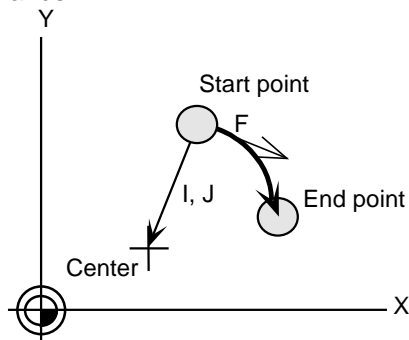
The plane is selected by G17, G18 or G19.

G17: XY plane

G18: ZX plane

G19: YZ plane

(Example) See below for examples of circular commands.



- (a) The axes that can be commanded simultaneously are the two axes for the selected plane.
- (b) The feed rate is controlled so that the tool always moves at a speed along the circumference of the circle.
- (c) Circular interpolation can be commanded within a range extending from 0° to 360°.
- (d) The max. value of the radius can be set up to six digits above the decimal point.

**(Note 1)** The arc plane is always based on the G17, G18 or G19 command. If a command is issued with two addresses which do not match the plane, an alarm will occur.

**(Note 2)** The axes configuring a plane can be designated by parameters. Refer to the section entitled "Plane Selection".

## (2) R-specified circular interpolation

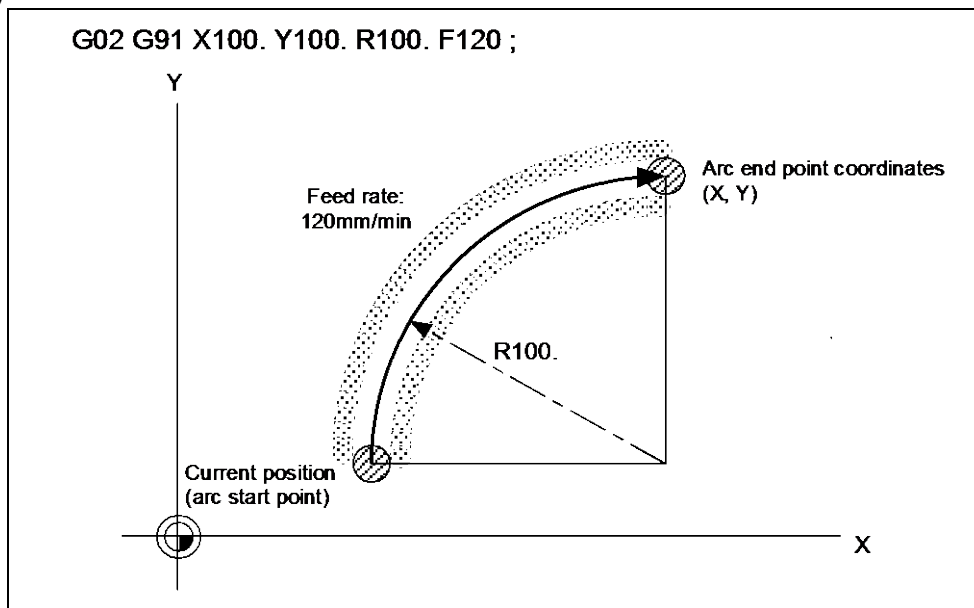
Besides the designation of the arc center coordinates using the above-mentioned I, J and K commands, arc commands can also be issued by designating the arc radius directly.

**G02(G03) Xx1 Yy1 Rr1 Ff1 ; (Also possible for additional axes A, B, C, U, V, W)**

G02, G03 : Arc rotation direction  
 Xx1, Yy1 : End point coordinate values  
 Rr1 : Arc radius  
 Ff1 : Feed rate

G02 or G03 is used to designate the direction of the arc rotation.  
 The arc plane is designated by G17, G18 or G19.

The arc center is on the bisector which orthogonally intersects the segment connecting the start and end points, and the point of intersection with the circle, whose radius has been designated with the start point serving as the center, is the center coordinate of the arc command.  
 When the sign of the value of R in the command program is positive, the command will be for an arc of 180° or less; when it is negative, it will be for an arc exceeding 180°.

**(Example)**

- (a) The axes that can be commanded simultaneously are the two axes for the selected plane.
- (b) The feed rate is controlled so that the tool always moves at a speed along the circumference of the circle.

**(Note 1)** The arc plane is always based on the G17, G18 or G19 command. If a command is issued with two addresses which do not match the plane, an alarm will occur.

## 3.2.3 Helical Interpolation

M system : Δ

L system : Δ

With this function, any two of three axes intersecting orthogonally are made to perform circular interpolation while the third axis performs linear interpolation in synchronization with the arc rotation. This simultaneous 3-axis control can be exercised to machine large-diameter screws or 3-dimensional cams.

|  |
|--|
| <b>G17 G02(G03) Xx1 Yy1 Zz1 Ii1 Jj1 Pp1 Ff1 ; (Specify arc center)</b> |
| <b>G17 G02(G03) Xx1 Yy1 Zz1 Rr1 Ff1 ; (Specify arc radius "R")</b>     |
| G17 : Arc plane  |
| G02, G03 : Arc rotation direction                                      |
| Xx1, Yy1 : End point coordinate values for arc                         |
| Zz1 : End point coordinate value of linear axis                        |
| Ii1, Jj1 : Arc center coordinate values                                |
| Pp1 : Pitch No.  |
| Ff1 : Feed rate  |
| Rr1 : Arc radius   |

- (1) The arc plane is designated by G17, G18 or G19.
- (2) G02 or G03 is used to designate the direction of the arc rotation.
- (3) Absolute or incremental values can be assigned for the arc end point coordinates and the end point coordinate of the linear axis, but incremental values must be assigned for the arc center coordinates.
- (4) The linear interpolation axis is the other axis which is not included in the plane selection.
- (5) Command the speed in the component direction that represents all the axes combined for the feed rate. Pitch I1 is obtained by the formula below.

$$I1 = z1 / ((2\pi \cdot p1 + \theta) / 2\pi)$$

$$\theta = \theta_e - \theta_s = \arctan(y_e/x_e) - \arctan(y_s/x_s)$$

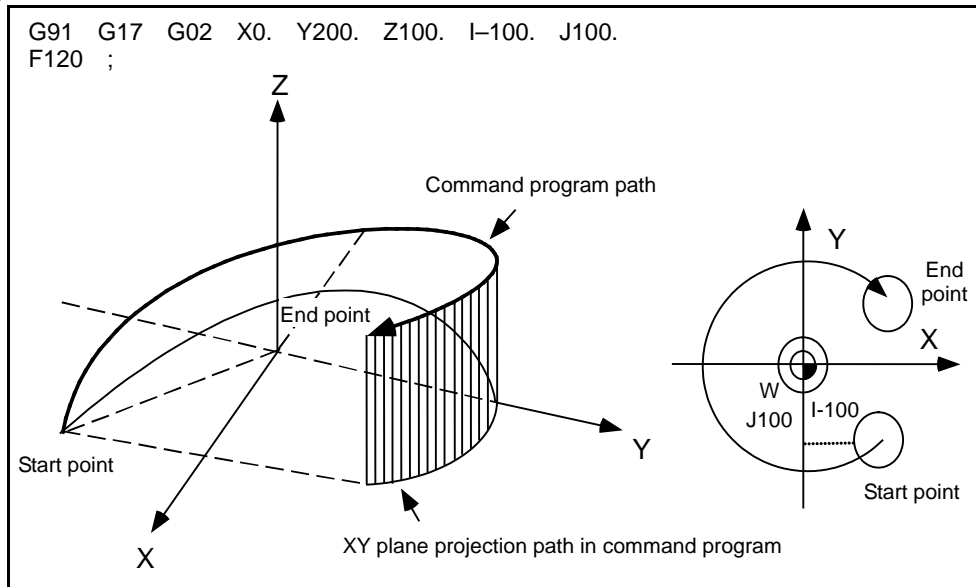
Where  $x_s, y_s$  are the start point coordinates ( $0 \leq \theta < 2\pi$ )

$x_e, y_e$  are the end point coordinates

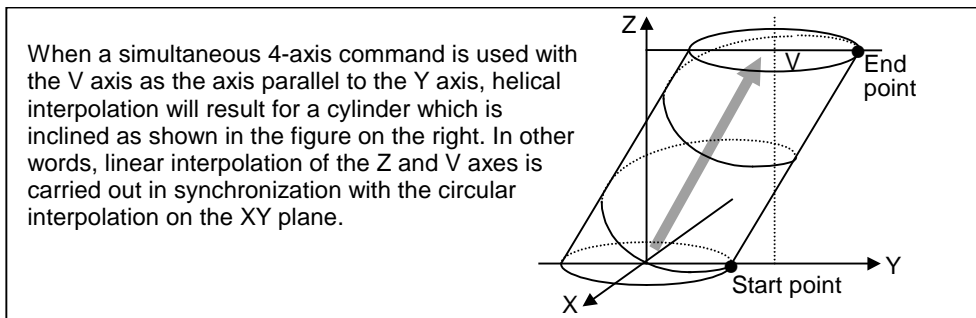
The combination of the axes which can be commanded simultaneously depends on the specifications. The axes can be used in any combination under the specifications. The feed rate is controlled so that the tool always moves at a speed along the circumference of the circle.



(Example)



**(Note 1)** Helical shapes are machined by assigning linear commands for one axis which is not a circular interpolation axis using an orthogonal coordinate system. It is also possible to assign these commands to two or more axes which are not circular interpolation axes.



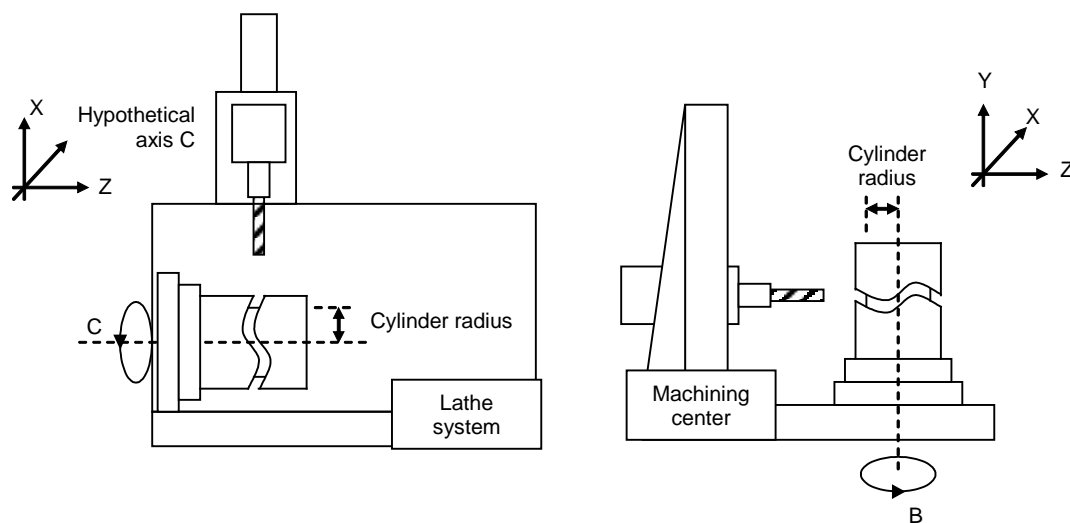
## 3.2.5 Cylindrical Interpolation

M system :  $\Delta$ L system :  $\Delta$ 

This function transfers a shape on the cylinder's side (the shape yielded by the cylindrical coordinate system) onto the plane surface. When the transferred shape is designated in the form of plane coordinates in the program, the shape is converted into a movement along the linear and rotary axes of the original cylinder coordinates, and the contours are controlled by the means of the CNC unit during machining.

Since the programming can be performed for the shapes produced by transferring the side surfaces of the cylinders, this function is useful for the machining of cylindrical cam and other such parts.

The following figures show that different axes should be commanded between the lathe system and the machining center system. The program is commanded to the rotary axis and the orthogonal axis for machining a groove etc. on the cylinder's side surface.



- (1) Cylindrical interpolation mode start  
Format : G07.1 Name of rotary axis Cylinder radius value;

Cylindrical interpolation is performed between the rotary axis designated in the G07.1 block or the G107 block and any other linear axis.  
G07.1 and G107 have the same movement.

- (2) Cylindrical interpolation mode cancel  
Format : G07.1 Name of rotary axis 0;

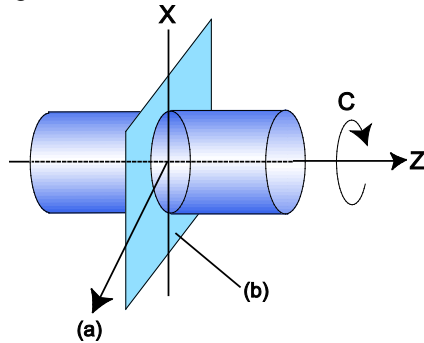
If the name of the rotary axis is "C", the cylindrical interpolation cancel mode is established with the command below.  
G07.1 C0;

3.2.6 Polar Coordinate Interpolation

M system : Δ

L system : Δ

This function converts the commands programmed by the orthogonal coordinate axes into linear axis movements (tool movements) and rotary axis movements (workpiece rotation) to control the contours. It is useful for cutting linear cutouts on the outside diameter of the workpiece, grinding cam shafts, etc.



(a) Hypothetical axis  
(b) Polar coordinate interpolation plane (G17 plane)

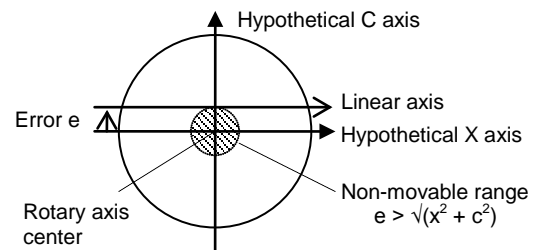
(1) Polar coordinate interpolation mode (G12.1)

The polar coordinate interpolation mode is established by designating the G12.1 command.

Polar coordinate interpolation plane consists of a linear axis and a hypothetical axis, which are at right angles to each other.

Polar coordinate interpolation is performed on this plane.

- (a) Linear interpolation and circular interpolation can be designated in the polar coordinate interpolation mode.
- (b) Either absolute command or incremental command can be issued.
- (c) Tool radius compensation can be applied to the program commands. Polar coordinate interpolation is performed for the path after tool radius compensation.
- (d) For the feed rate, designate a tangential rate on the polar coordinate interpolation plane (orthogonal coordinate system) using the F command. The F rate is in either mm/min or inch/min units.
- (e) Even when there is an error between the linear axis and rotary axis center, the control can implement polar coordinate interpolation while correcting the error.



(2) Polar coordinate interpolation cancel mode (G13.1)

The polar coordinate interpolation cancel mode is established by designating the G13.1 command.

(3) Shifting coordinate system during polar coordinate interpolation (G12.1 X\_ C\_)

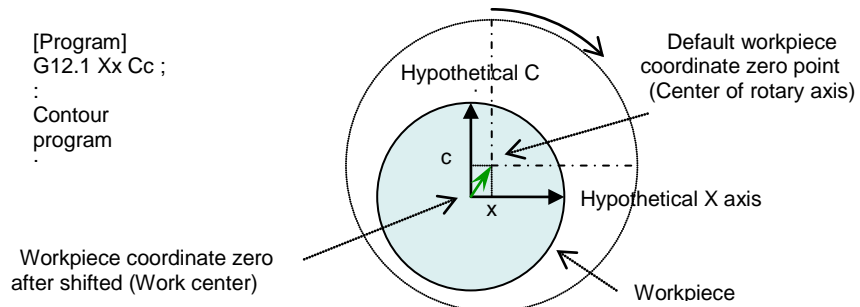
Workpiece coordinate system can be shifted under polar coordinate interpolation.

Use the following program format at the start of polar coordinate interpolation to specify the shift amount. Specify the rotary center coordinates with respect to the shifted workpiece coordinate system.

G12.1 X\_ C\_ ;

X : The 1st axis component of the rotation center coordinates on the shifted work coordinate

C : The 2nd axis component of the rotation center coordinates on the shifted work coordinate



3.2.101 Hypothetical Linear Axis Control

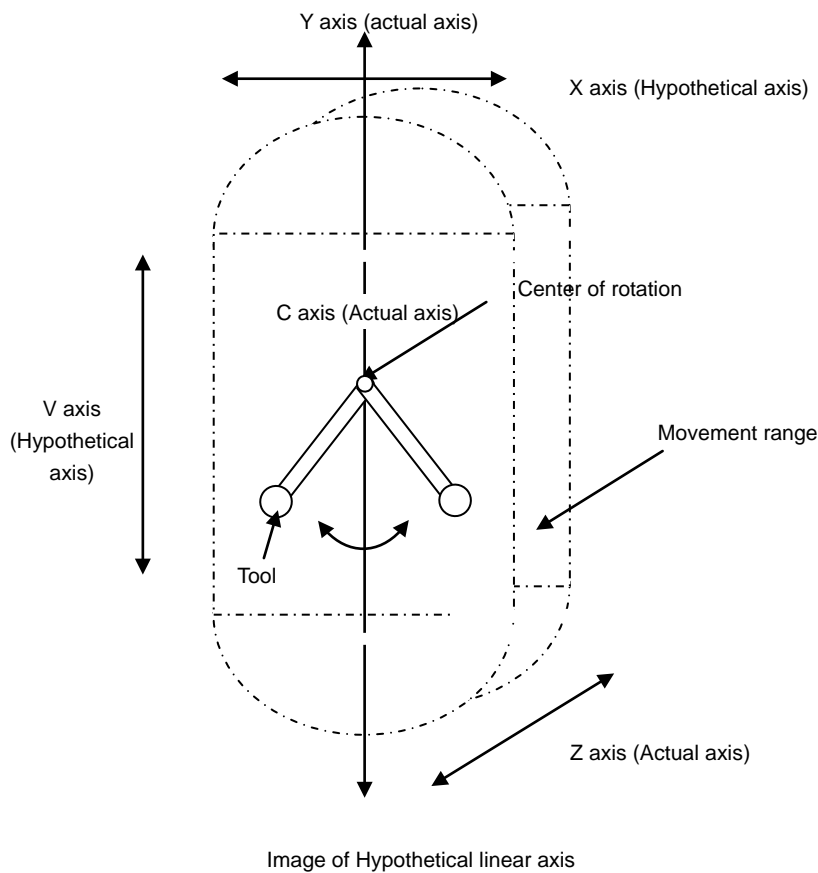
M system : Δ

L system : -

Using 1 linear axis and 1 rotary axis, this function composes a hypothetical linear axis which orthogonally intersects the real linear axis. Thus, 3-dimensional positioning and compensation operation can be executed by configuring two linear axes and one rotation axis.

This function reduces actual linear axes, so movement mechanism will be eliminated and the machine configuration can be simplified. In the figure below, the movement mechanism of X axis direction which intersects with Y axis is not required. Although a hypothetical axis has no actual linear axis, it needs setting as CNC control axis. There are three actual axes and two hypothetical axes, so total of five CNC control axes are required for the figure below. A mode to control a hypothetical axis is called hypothetical axis command mode and a mode to control actual axis is called actual axis command mode. Each mode can be switched with a control signal from PLC I/F.

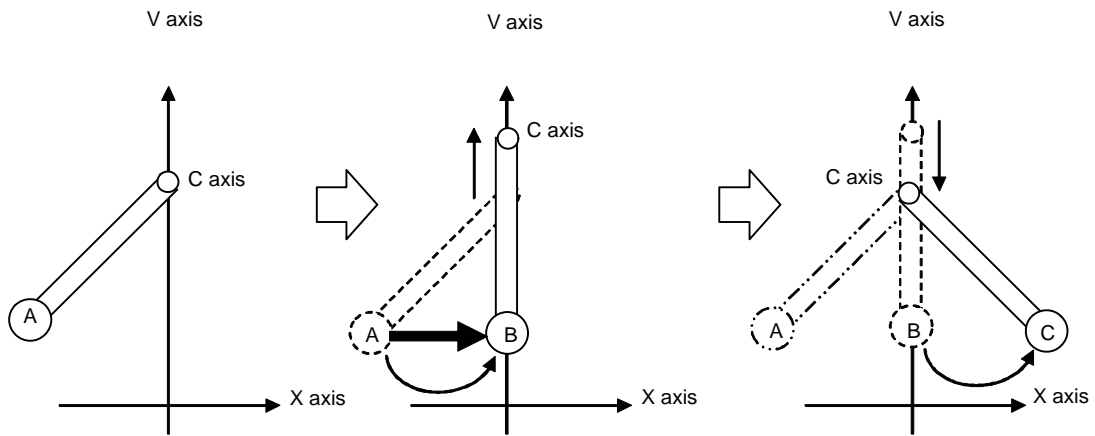
This function is valid both automatic operation and manual feed.



Movement of hypothetical X axis is realized by controlling the rotation axis (C axis) and the linear axis (V axis).

- (1) V axis moves up with rotating C axis in counterclockwise. (Move from A to B)
- (2) After that, V axis moves down with rotating C axis in counterclockwise. (Move from B to C)

This enables the X axis to operate as if it has moved to right.



Operation example of hypothetical X axis which is controlled by the rotation axis C and the linear axis V

- Current position
- Previous position
- ..... Last but one position

## 4. Feed

### 4.1 Feed Rate

#### 4.1.1 Rapid Traverse Rate (m/min)

**M system : 1000**

**L system : 1000**

[M system]

The rapid traverse rate can be set independently for each axis using the parameter.  
The rapid traverse rate is effective for G00, G27, G28, G29, G30 and G60 commands.  
Override can be applied to the rapid traverse rate using the external signal supplied.

- Rapid Traverse Rate setting range

| Least input increment | B                         | C                        |
|-----------------------|---------------------------|--------------------------|
| Metric input          | 1~1000000 (mm/min, °/min) | 1~100000 (mm/min, °/min) |
| Inch input            | 1~39370 (inch/min)        | 1~3937 (inch/min)        |

Least input increment B : 0.001 mm (0.0001 inch)

Least input increment C : 0.0001 mm (0.00001 inch)

[L system]

The rapid traverse rate can be set independently for each axis by the parameter.  
The rapid traverse rate is effective for G00, G27, G28, G29, G30 and G53 commands.  
Override can be applied to the rapid traverse rate using the external signal supplied.

- Rapid Traverse Rate setting range

| Least input increment | B                         | C                        |
|-----------------------|---------------------------|--------------------------|
| Metric input          | 1~1000000 (mm/min, °/min) | 1~100000 (mm/min, °/min) |
| Inch input            | 1~39370 (inch/min)        | 1~3937 (inch/min)        |

Least input increment B : 0.001 mm (0.0001 inch)

Least input increment C : 0.0001 mm (0.00001 inch)

## 4.1.2 Cutting Feed Rate (m/min)

M system : 1000

L system : 1000

[M system]

This function specifies the feedrate of the cutting commands, and gives a command for a feed amount per spindle rotation or feed amount per minute.

Once commanded, it is stored in the memory as a modal value. The feed rate modal value is cleared to zero only when the power is turned ON.

The maximum cutting feed rate is clamped by the cutting feed rate clamp parameter (whose setting range is the same as that for the cutting feed rate).

- Cutting feed rate setting range

| Least input increment | B                         | C                        |
|-----------------------|---------------------------|--------------------------|
| Metric input          | 1~1000000 (mm/min, °/min) | 1~100000 (mm/min, °/min) |
| Inch input            | 1~39370 (inch/min)        | 1~3937 (inch/min)        |

Least input increment B : 0.001 mm (0.0001 inch)

Least input increment C : 0.0001 mm (0.00001 inch)

- The cutting feed rate is effective for G01, G02, G03, G33 commands, etc. As to others, refer to the interpolation specifications.

[L system]

This function specifies the feed rate of the cutting commands, and a feed amount per spindle rotation or feed amount per minute is commanded.

Once commanded, it is stored in the memory as a modal value. The feed rate modal is cleared to zero only when the power is turned ON.

The maximum cutting feed rate is clamped by the cutting feed rate clamp parameter (whose setting range is the same as that for the cutting feed rate).

- Cutting Feed Rate setting range

| Least input increment | B                         | C                        |
|-----------------------|---------------------------|--------------------------|
| Metric input          | 1~1000000 (mm/min, °/min) | 1~100000 (mm/min, °/min) |
| Inch input            | 1~39370 (inch/min)        | 1~3937 (inch/min)        |

Least input increment B : 0.001 mm (0.0001 inch)

Least input increment C : 0.0001 mm (0.00001 inch)

- The cutting feed rate is effective for G01, G02, G03, G33 commands, etc. As to others, refer to interpolation specifications.

### 4.1.3 Manual Feed Rate (m/min)

**M system : 1000**

**L system : 1000**

The manual feed rates are designated as the feed rate in jog mode or incremental feed mode for manual operation and the feed rate during dry run ON for automatic operation. The manual feed rates are set using external signals.

The manual feed rate signals from the PLC includes two methods, the code method and numerical value method.

Which method to be applied is determined with a signal common to the entire system.

The signals used by these methods are common to all axes.

- Setting range under the code method
 

|              |                                      |
|--------------|--------------------------------------|
| Metric input | 0.00 to 14000.00 mm/min (31 steps)   |
| Inch input   | 0.000 to 551.000 inch/min (31 steps) |
- Setting range under the value setting method
 

|              |  |
|--------------|--|
| Metric input | 0 to 1000000.00 mm/min in 0.01 mm/min increments |
| Inch input   | 0 to 39370 inch/min in 0.001 inch/min increments |

Multiplication factor PCF1 and PCF2 are available with the value setting method.

### 4.1.4 Rotary Axis Command Speed Tenfold

**M system : ○**

**L system : ○**

This function multiplies the rotary axis' command speed by 10 during initial inching.

The commanded speeds are as follow.

|                     |   |
|---------------------|---|
| Automatic operation |   |
| Cutting feed rate   | For the inch system, the rotary axis command speed is multiplied by 10. For example, if the B axis is the rotary axis in the inch system and the following type of machining program is executed, the rotary axis command speed will be multiplied by 10, and the rotary axis will move at 1000 deg./min.<br>N1 G1 B100. F100.; |
| Rapid traverse rate | The rapid traverse rate is not multiplied by 10, and is the speed set in the parameters.  |
| Manual operation    | The command speeds related to manual operation, such as JOG feed, are not multiplied by 10. The display speed unit also remains as "deg./min".  |



## 4.2 Feed Rate Input Methods

## 4.2.1 Feed per Minute

M system : ○

L system : ○

[M system]

By issuing the G94 command, the commands from that block are issued directly by the numerical value following F as the feed rate per minute (mm/min, inch/min).

Metric input (mm)

| Least input increment               |                              | (B) 0.001 mm     | (C) 0.0001 mm    |
|-------------------------------------|------------------------------|------------------|------------------|
| <b>F command increment (mm/min)</b> | <b>without decimal point</b> | F1 = 1 mm/min    | F1 = 1 mm/min    |
|                                     | <b>with decimal point</b>    | F1. = 1 mm/min   | F1. = 1 mm/min   |
| <b>Command range (mm/min)</b>       |                              | 0.01~1000000.000 | 0.001~100000.000 |

Inch input (inch)

| Least input increment                 |                              | (B) 0.0001 inch   | (C) 0.00001 inch |
|---------------------------------------|------------------------------|-------------------|------------------|
| <b>F command increment (inch/min)</b> | <b>without decimal point</b> | F1 = 1 inch/min   | F1 = 1 inch/min  |
|                                       | <b>with decimal point</b>    | F1. = 1 inch/min  | F1. = 1 inch/min |
| <b>Command range (inch/min)</b>       |                              | 0.001~100000.0000 | 0.001~10000.0000 |

- When commands without a decimal point have been assigned, it is not possible to assign commands under 1 mm/min (or 1 inch/min). To assign commands under 1 mm/min (or 1 inch/min), ensure that commands are assigned with a decimal point.
- The initial status after power-ON can be set to asynchronous feed (per-minute-feed) by setting the "Initial synchronous feed" parameter to OFF.
- The F command increments are common to all part systems.

[L system]

By issuing the G94 command, the commands from that block are issued directly by the numerical value following F as the feed rate per minute (mm/min, inch/min).

Metric input (mm)

| Least input increment               |                              | (B) 0.001 mm      | (C) 0.0001 mm          |
|-------------------------------------|------------------------------|-------------------|------------------------|
| <b>F command increment (mm/min)</b> | <b>without decimal point</b> | F1 = 1 mm/min     | F1 = 1 mm/min          |
|                                     | <b>with decimal point</b>    | F1. = 1 mm/min    | F1. = 1 mm/min         |
| <b>Command range (mm/min)</b>       |                              | 0.001~1000000.000 | 0.0001<br>~100000.0000 |

Inch input (inch)

| Least input increment                 |                              | (B) 0.0001 inch   | (C) 0.00001 inch   |
|---------------------------------------|------------------------------|-------------------|--------------------|
| <b>F command increment (inch/min)</b> | <b>without decimal point</b> | F1 = 1 inch/min   | F1 = 1 inch/min    |
|                                       | <b>with decimal point</b>    | F1. = 1 inch/min  | F1. = 1 inch/min   |
| <b>Command range (inch/min)</b>       |                              | 0.0001~39370.0787 | 0.00001~3937.00787 |

- When commands without a decimal point have been assigned, it is not possible to assign commands under 1 mm/min (or 1 inch/min). To assign commands under 1 mm/min (or 1 inch/min), ensure that commands are assigned with a decimal point.
- The initial status after power-ON can be set to asynchronous feed (per-minute-feed) by setting the "Initial synchronous feed" parameter to OFF.

## 4.2.2 Feed per Revolution

M system : Δ

L system : ○

By issuing the G95 command, the commands from that block are issued directly by the numerical value following F as the feed rate per spindle revolution (mm/revolution or inch/revolution).

The F command increment and command range are as follows.

[M system]

Metric input (mm)

| Least input increment        |                       | (B) 0.001 mm  | (C) 0.0001 mm  |
|------------------------------|-----------------------|---------------|----------------|
| F command increment (mm/rev) | without decimal point | F1 = 0.01     | F1 = 0.01      |
|                              | with decimal point    | F1. = 1       | F1. = 1        |
| Command range (mm/rev)       |                       | 0.001~999.999 | 0.0001~99.9999 |

Inch input (inch)

| Least input increment          |                       | (B) 0.0001 inch | (C) 0.00001 inch |
|--------------------------------|-----------------------|-----------------|------------------|
| F command increment (inch/rev) | without decimal point | F1 = 0.001      | F1 = 0.001       |
|                                | with decimal point    | F1. = 1         | F1. = 1          |
| Command range (inch/rev)       |                       | 0.0001~999.9999 | 0.00001~99.99999 |

- When commands without a decimal point have been assigned, it is not possible to assign commands under 1 mm/min (or 1 inch/min).
- The initial status after power-ON can be set to asynchronous feed (per-minute-feed) by setting the "Initial synchronous feed" parameter to OFF.
- The F command increments are common to all part systems.

[L system]

Metric input (mm)

| Least input increment        |                       | (B) 0.001 mm   | (C) 0.0001 mm    |
|------------------------------|-----------------------|----------------|------------------|
| F command increment (mm/rev) | without decimal point | F1 = 0.0001    | F1 = 0.0001      |
|                              | with decimal point    | F1. = 1        | F1. = 1          |
| Command range (mm/rev)       |                       | 0.0001~999.999 | 0.00001~99.99999 |

Inch input (inch)

| Least input increment          |                       | (B) 0.0001 inch    | (C) 0.00001 inch    |
|--------------------------------|-----------------------|--------------------|---------------------|
| F command increment (inch/rev) | without decimal point | F1 = 0.000001      | F1 = 0.000001       |
|                                | with decimal point    | F1. = 1            | F1. = 1             |
| Command range (inch/rev)       |                       | 0.000001~99.999999 | 0.0000001~9.9999999 |

- When commands without a decimal point have been assigned, it is not possible to assign commands under 1 mm/min (or 1 inch/min).
- The initial status after power-ON can be set to asynchronous feed (per-minute-feed) by setting the "Initial synchronous feed" parameter to OFF.

#### 4.2.4 F1-digit Feed

**M system :** ○

**L system :** ○

When the "F1digit" parameter is ON, the feed rate registered by parameter in advance can be assigned by designating a single digit following address F.

There are six F codes: F0 and F1 to F5. The rapid traverse rate is applied when F0 is issued which is the same as the G00 command. When one of the codes F1 to F5 is issued, the cutting feed rate set to support the code serves as the valid rate command. When a command higher than F5 is issued, it serves as a regular direct command with feed rate value of 5 digits following address F.

When an F1-digit command has been issued, the "In F1-digit" external output signal is output.

## 4.3 Override

### 4.3.1 Rapid Traverse Override

**M system** : ○

**L system** : ○

(1) Code method

Four levels of override (1%, 25%, 50% and 100%) can be applied to manual or automatic rapid traverse using the external input signal supplied.

Code method commands are assigned as combinations of bit signals from the PLC.

(2) Value setting method

Override can be applied in 1% steps from 0% to 100% to manual or automatic rapid traverse using the external input signal supplied.

**(Note 1)** Code method and value setting method can be selected by PLC processing.

### 4.3.2 Cutting Feed Override

**M system** : ○

**L system** : ○

(1) Code method

Override can be applied in 10% steps from 0% to 300% to the feed rate command designated in the machining program using the external input signal supplied.

Code method commands are assigned as combinations of bit signals from the PLC.

(2) Value setting method

Override can be applied in 1% steps from 0% to 327% to the feed rate command designated in the machining program using the external input signal supplied.

### 4.3.3 2nd Cutting Feed Override

**M system** : ○

**L system** : ○

Override can be further applied in 0.01% steps from 0% to 327.67% as a second-stage override to the feed rate after the cutting feed override has been applied.

### 4.3.4 Override Cancel

**M system** : ○

**L system** : ○

By turning on the override cancel external signal, the override is automatically set to 100% for the cutting feed during automatic operation mode (memory and MDI).

**(Note 1)** The override cancel signal is not valid for manual operation.

**(Note 2)** When the cutting feed override or second cutting feed override is 0%, the 0% override takes precedence and the override is not canceled.

**(Note 3)** The override cancel signal is not valid for rapid traverse.

## 4.4 Acceleration/Deceleration

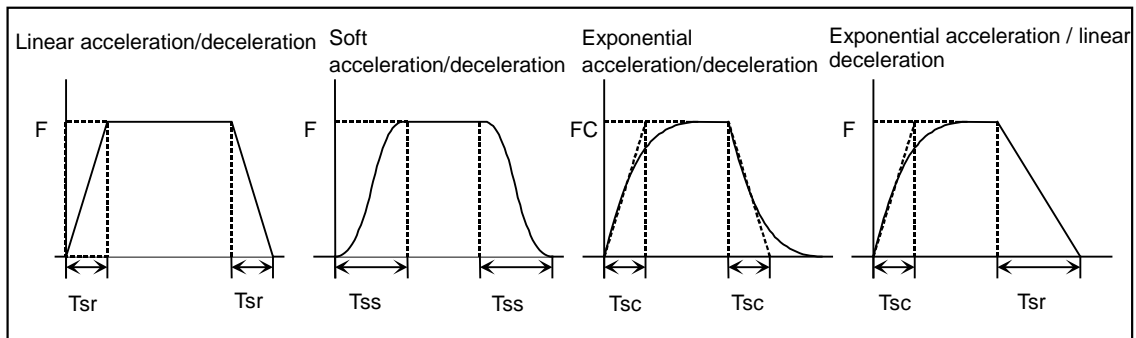
### 4.4.1 Automatic Acceleration/Deceleration after Interpolation

M system : ○

L system : ○

Acceleration/deceleration is applied to all commands automatically. The acceleration/deceleration patterns are linear acceleration/deceleration, soft acceleration/deceleration, exponent function acceleration/deceleration, exponent function acceleration/linear deceleration and any other that can be selected using a parameter.

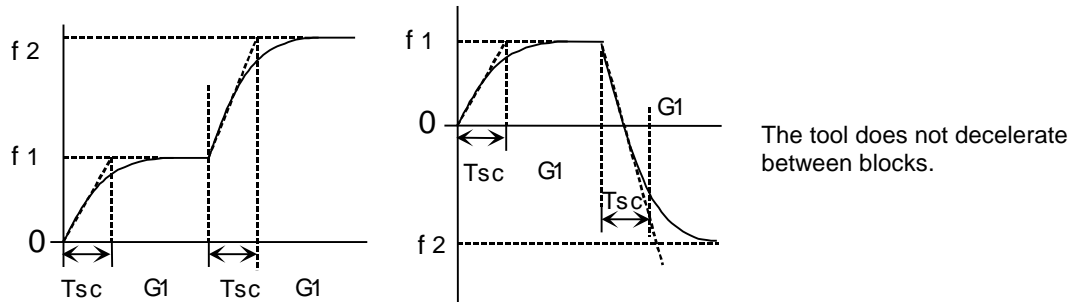
For rapid traverse feed or manual feed, acceleration/deceleration is always made for each block, and the time constant can be set for each axis separately.



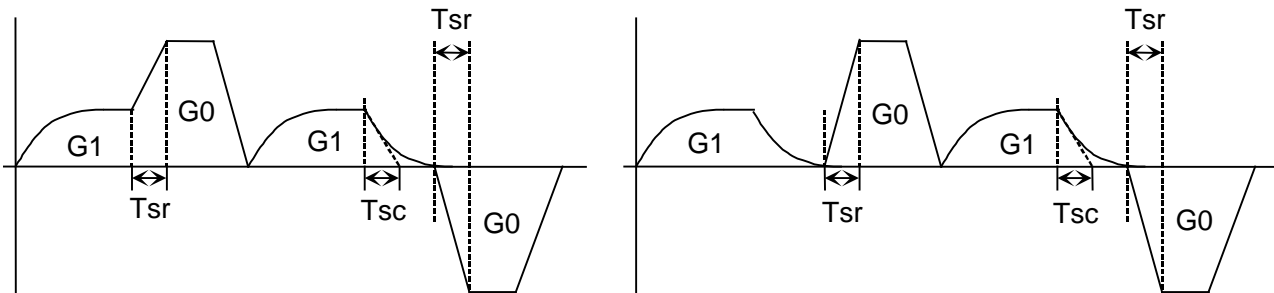
- (Note 1)** The rapid traverse feed acceleration/deceleration patterns are effective for the following: G00, G27, G28, G29, G30, rapid traverse feed in manual run, JOG, incremental feed, return to reference position.
- (Note 2)** Acceleration/deceleration in handle feed mode is usually performed according to the acceleration/deceleration pattern for cutting feed. However, a parameter can be specified to select a pattern with no acceleration/deceleration (step).

## Acceleration/Deceleration during Continuing Blocks

## (1) Continuous G1 blocks



## (2) Continuous G1-G0 blocks



If the G0 command direction is the same as that for G1, whether G1 is to be decelerated is selected using a parameter.

If no deceleration is set, superposition is performed even when G0 is in the constant inclination acceleration/deceleration state.

If the G0 command direction is the opposite of that for G1, G0 will be executed after G1 has decelerated.

(In the case of two or more simultaneous axes, G0 will also be executed after G1 has decelerated when the G0 command direction is the opposite of that for G1 for even one axis.)

4.4.2 Rapid Traverse Constant Inclination Acceleration/Deceleration

M system : ○

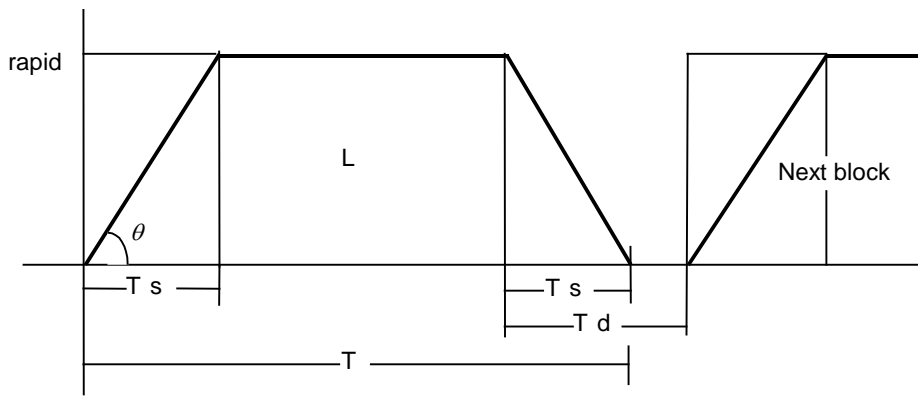
L system : ○

This function performs acceleration and deceleration at a constant inclination during linear acceleration/deceleration in the rapid traverse mode. Compared to the method of acceleration/ deceleration after interpolation, the constant inclination acceleration/deceleration method makes for improved cycle time.

Rapid traverse constant inclination acceleration/deceleration are valid only for a rapid traverse command. Also, this function is effective only when the rapid traverse command acceleration/ deceleration mode is linear acceleration and linear deceleration.

The acceleration/deceleration patterns in the case where rapid traverse constant inclination acceleration/deceleration are performed are as follows.

(1) When the interpolation distance is longer than the acceleration and deceleration distance



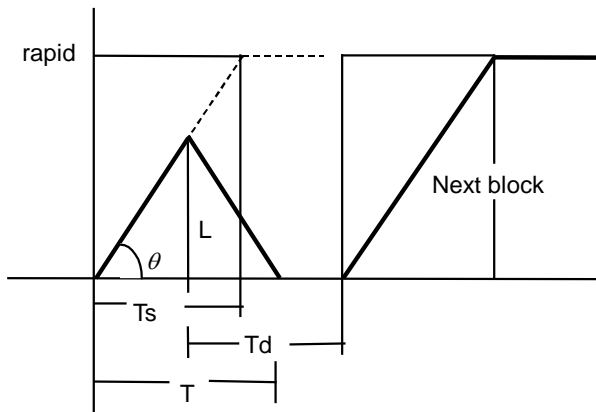
rapid : Rapid traverse rate  
 Ts : Acceleration/deceleration time constant  
 Td : Command deceleration check time  
 $\theta$  : Acceleration/deceleration inclination  
 T : Interpolation time  
 L : Interpolation distance

$$T = \frac{L}{\text{rapid}} + T_s$$

$$T_d = T_s + (0 \sim 1.7 \text{ ms})$$

$$\theta = \tan^{-1} \left( \frac{\text{rapid}}{T_s} \right)$$

(2) When the interpolation distance is shorter than the acceleration and deceleration distance



rapid: Rapid traverse rate  
 Ts: Acceleration/deceleration time constant  
 Td: Command deceleration check time  
 $\theta$ : Acceleration/deceleration inclination  
 T: Interpolation time  
 L: Interpolation distance

$$T = 2 \times \sqrt{T_s \times L / \text{rapid}}$$

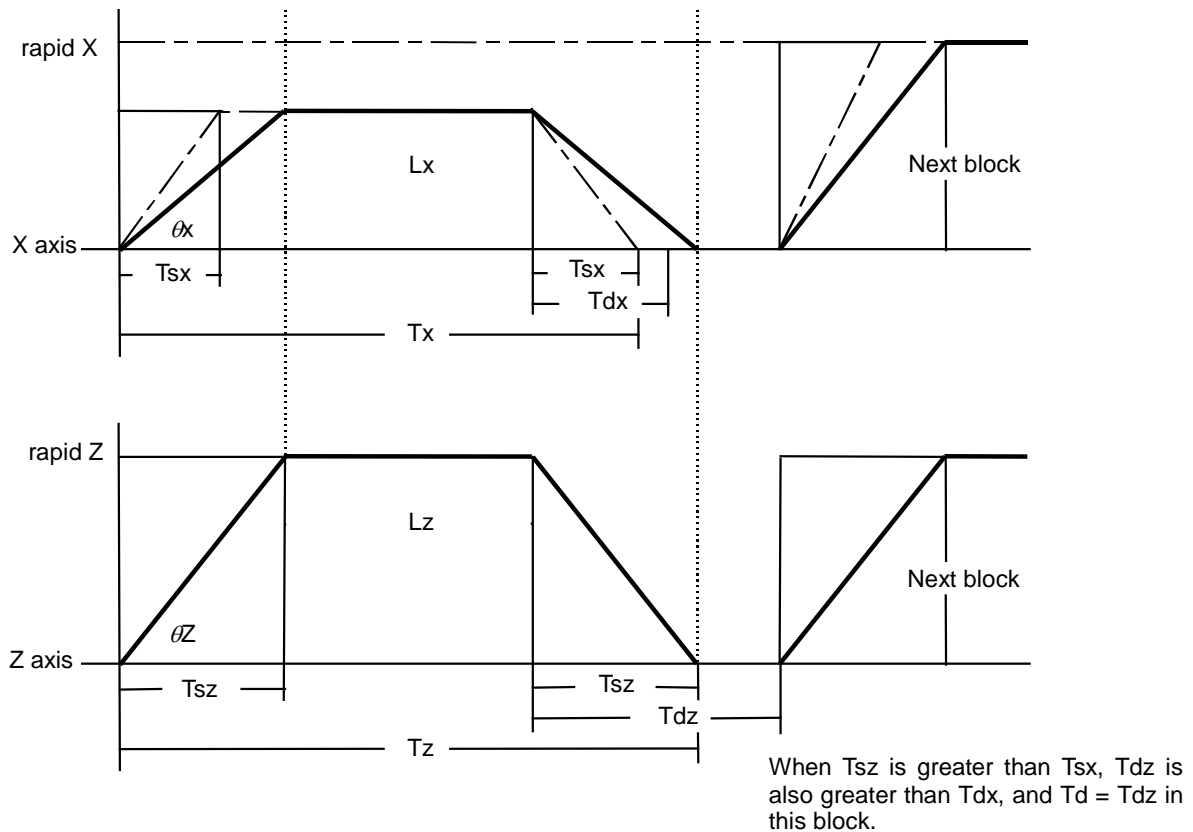
$$T_d = \frac{T}{2} + (0 \sim 1.7 \text{ ms})$$

$$\theta = \tan^{-1} \left( \frac{\text{rapid}}{T_s} \right)$$

The time required to perform a command deceleration check during rapid traverse constant inclination acceleration/deceleration is the longest value among the rapid traverse deceleration check times determined for each axis by the rapid traverse rate of commands executed simultaneously, the rapid traverse acceleration/deceleration time constant, and the interpolation distance, respectively.

- (3) 2-axis simultaneous interpolation (When linear interpolation is used,  $T_{sx} < T_{sz}$ , and  $L_x \neq L_z$ )

When 2-axis simultaneous interpolation (linear interpolations) is performed during rapid traverse constant inclination acceleration and deceleration, the acceleration (deceleration) time is the longest value of the acceleration (deceleration) times determined for each axis by the rapid traverse rate of commands executed simultaneously, the rapid traverse acceleration and deceleration time constant, and the interpolation distance, respectively. Consequently, linear interpolation is performed even when the axes have different acceleration and deceleration time constants.



The program format of G0 (rapid traverse command) when rapid traverse constant inclination acceleration/deceleration are executed is the same as when this function is invalid (time constant acceleration/deceleration).

This function is valid only for G0 (rapid traverse).



## 4.5 Thread Cutting

### 4.5.1 Thread Cutting (Lead/Thread Number Designation)

**M system : Δ**

**L system : ○**

The thread cutting with a designated lead can be performed. Inch threads are cut by designating the number of threads per inch with the E address.

(1) Lead designation

The thread cutting with designated lead are performed based on the synchronization signals from the spindle encoder.

|                  |  |                |            |                |   |
|------------------|--|----------------|------------|----------------|---|
| <b>G33</b>       | <b>Zz1/Ww1</b>   | <b>Xx1/Uu1</b> | <b>Qq1</b> | <b>Ff1/Ee1</b> | ; |
| G33              | : Thread command   |                |            |                |   |
| Zz1/Ww1, Xx1/Uu1 | : Thread end point coordinates                               |                |            |                |   |
| Qq1              | : Shift angle at start of thread cutting (0.000 to 360.000°) |                |            |                |   |
| Ff1              | : Thread lead (normal lead threads)                          |                |            |                |   |
| Ee1              | : Thread lead (precise lead threads)                         |                |            |                |   |

The tables below indicate the thread lead ranges.

[M system]

| Metric command             |                      |                          | Inch command                 |                       |                          |
|----------------------------|----------------------|--------------------------|------------------------------|-----------------------|--------------------------|
| Least input increment (mm) | F (mm/rev)           | E (mm/rev)               | Least input increment (inch) | F (inch/rev)          | E (inch/rev)             |
| 0.001                      | 0.001<br>to 999.999  | 0.00001<br>to 999.99999  | 0.0001                       | 0.0001<br>to 39.3700  | 0.000001<br>to 39.370078 |
| 0.0001                     | 0.0001<br>to 99.9999 | 0.000001<br>to 99.999999 | 0.00001                      | 0.00001<br>to 3.93700 | 0.000001<br>to 3.937007  |

[L system]

| Metric command             |                        |                          | Inch command                 |                           |                             |
|----------------------------|------------------------|--------------------------|------------------------------|---------------------------|-----------------------------|
| Least input increment (mm) | F (mm/rev)             | E (mm/rev)               | Least input increment (inch) | F (inch/rev)              | E (inch/rev)                |
| 0.001                      | 0.0001<br>to 999.9999  | 0.00001<br>to 999.99999  | 0.0001                       | 0.000001<br>to 99.999999  | 0.000010<br>to 9.9999999    |
| 0.0001                     | 0.00001<br>to 99.99999 | 0.000001<br>to 99.999999 | 0.00001                      | 0.0000001<br>to 9.9999999 | 0.00000001<br>to 0.99999999 |

The direction of the axis with a large movement serves as the reference for the lead.

## (2) Thread number designation

Inch threads are cut by designating the number of threads per inch with the E address.

Whether the E command is a thread number designation or lead designation is selected with the parameters.

|                  |  |
|------------------|--|
| <b>G33</b>       | <b>Zz1/Ww1 Xx1/Uu1 Qq1 Ee1 ;</b>                             |
| G33              | : Thread cutting command                                     |
| Zz1/Ww1, Xx1/Uu1 | : Thread end point coordinates                               |
| Qq1              | : Shift angle at start of thread cutting (0.000 to 360.000°) |
| Ee1              | : Thread number per inch                                     |

The tables below indicate the thread number.

[M system]

| Metric command             |   | Inch command                 |   |
|----------------------------|---|------------------------------|---|
| Least input increment (mm) | Thread number command range (thread/inch) | Least input increment (inch) | Thread number command range (thread/inch) |
| 0.001                      | 0.03 to 999.99                            | 0.0001                       | 0.0255 to 9999.9999                       |
| 0.0001                     | 0.255 to 9999.999                         | 0.00001                      | 0.25401 to 999.9999                       |

[L system]

| Metric command             |   | Inch command                 |   |
|----------------------------|---|------------------------------|---|
| Least input increment (mm) | Thread number command range (thread/inch) | Least input increment (inch) | Thread number command range (thread/inch) |
| 0.001                      | 0.03 to 999.99                            | 0.0001                       | 0.0101 to 9999.9999                       |
| 0.0001                     | 0.255 to 9999.999                         | 0.00001                      | 0.10001 to 999.99999                      |

The number of thread per inch is commanded for both metric and inch systems, and the direction of the axis with a large movement serves as the reference.

## 4.5.2 Variable Lead Thread Cutting

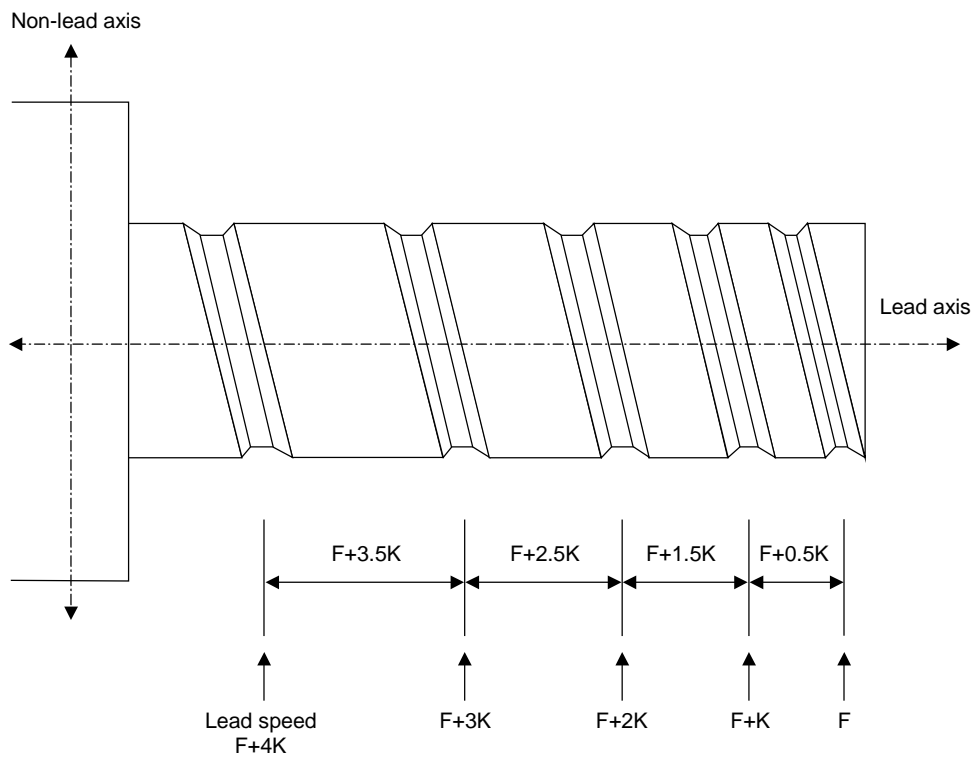
M system : -

L system : O

By commanding the lead increment/decrement amount per thread rotation, variable lead thread cutting can be performed.

The machining program is commanded in the following manner.

|            |   |            |            |          |   |
|------------|---|------------|------------|----------|---|
| <b>G34</b> | <b>X/U</b>  | <b>Z/W</b> | <b>F/E</b> | <b>K</b> | ; |
| G34        | : Variable lead thread cutting command                |            |            |          |   |
| X/U        | : Thread end point X coordinate                       |            |            |          |   |
| Z/W        | : Thread end point Z coordinate                       |            |            |          |   |
| F/E        | : Thread's basic lead                                 |            |            |          |   |
| K          | : Lead increment/decrement amount per thread rotation |            |            |          |   |



### 4.5.3 Synchronous Tapping (with digital I/F spindle)

#### 4.5.3.1 Synchronous Tapping Cycle

**M system : Δ**

**L system : Δ**

This function performs tapping through synchronized control of the spindle and servo axis. This eliminates the need for floating taps and enables tapping to be conducted at a highly precise tap depth.

(1) Tapping pitch assignment

|                 |   |
|-----------------|---|
| <b>G84(G74)</b> | <b>Xx1 Yy1 Zz1 Rr1 Pp1 Ff1 Ss1 , R1 ;</b>                 |
| G84             | : Synchronous tapping mode ON, forward tapping            |
| G74             | : Synchronous tapping mode ON, reverse tapping            |
| Xx1, Yy1        | : Hole position data, hole drilling coordinate position   |
| Zz1             | : Hole machining data, hole bottom position               |
| Rr1             | : Hole machining data, hole R position                    |
| Pp1             | : Hole machining data, dwell time at hole bottom          |
| Ff1             | : Z-axis feed amount (tapping pitch) per spindle rotation |
| Ss1             | : Spindle speed   |
| ,R1             | : Synchronous system selection                            |

(2) Tapping thread number assignment

|                 |   |
|-----------------|---|
| <b>G84(G74)</b> | <b>Xx1 Yy1 Zz1 Rr1 Pp1 Ee1 Ss1 , R1 ;</b>               |
| G84             | : Synchronous tapping mode ON, forward tapping          |
| G74             | : Synchronous tapping mode ON, reverse tapping          |
| Xx1, Yy1        | : Hole position data, hole drilling coordinate position |
| Zz1             | : Hole machining data, hole bottom position             |
| Rr1             | : Hole machining data, hole R position                  |
| Pp1             | : Hole machining data, dwell time at hole bottom        |
| Ee1             | : Tap thread number per 1-inch feed of Z axis           |
| Ss1             | : Spindle speed   |
| ,R1             | : Synchronous system selection                          |

The control state will be as described below when a tapping mode command (G74, G84) is commanded.

- |  |               |
|--|---------------|
| 1. Cutting override                            | Fixed to 100% |
| 2. Feed hold invalid                           |               |
| 3. "In tapping mode" signal is output          |               |
| 4. Deceleration command between blocks invalid |               |
| 5. Single block invalid                        |               |

The tapping mode will be canceled with the following G commands.

- G61 ..... Exact stop check mode
- G61.1 ..... High-accuracy control mode
- G62 ..... Automatic corner override
- G64 ..... Cutting mode

4.5.3.2 Pecking Tapping Cycle

M system : Δ

L system : -

This function performs cutting the workpiece to the hole bottom for a multiple number of passes by designating the depth of cut per pass. The load applied to the tool can be reduced.

The amount retracted from the hole bottom is set to the parameters.

When the pecking tapping cycle is executed in the synchronous tapping mode, the synchronous tapping cycle option and pecking tapping cycle option are required.

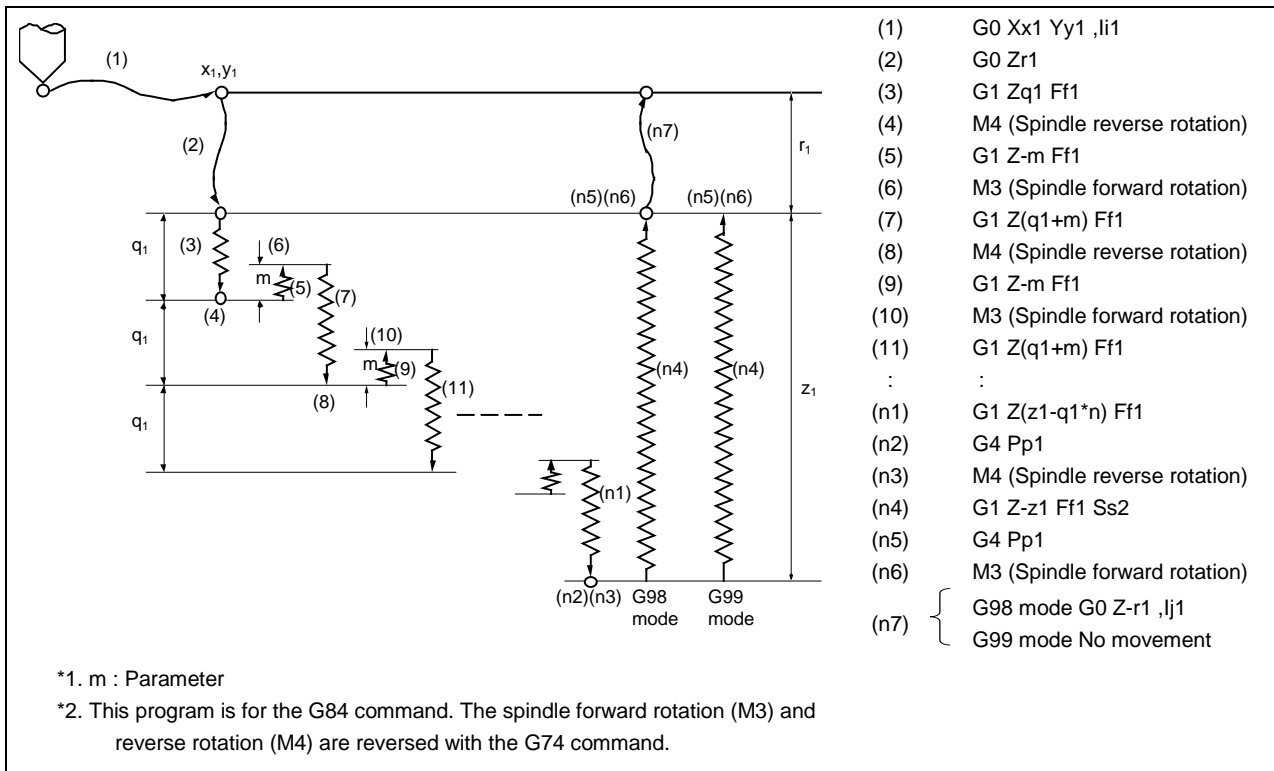
When "depth of cut per pass Q" is designated in the block containing the G84 or G74 command in the state where the pecking tapping cycle is selected by parameter, the pecking tapping cycle is executed.

In the following cases, the normal tapping cycle is established.

- When Q is not designated
- When the command value of Q is zero

|  |
|--|
| <b>G84(G74) Xx1 Yy1 Zz1 Rr1 Qq1 Ff1 Ee1 Pp1 Ss1 ,Ss2 ,li1 ,Jj1 ,Rr2 ;</b>      |
| G84 : G84 forward tapping cycle  |
| G74 : G74 reverse tapping cycle  |
| Xx1, Yy1 : Hole drilling position  |
| Zz1 : Hole bottom position   |
| Rr1 : Point R position   |
| Qq1 : Depth of cut per pass (designated as an incremental position)            |
| Ff1 : Z-axis feed amount (tapping pitch) per spindle rotation                  |
| Ee1 : Tap thread number per 1-inch feed of Z axis                              |
| Pp1 : Dwell time at hole bottom position                                       |
| Ss1 : Rotation speed of spindle  |
| , Ss2 : Rotation speed of spindle during retract                               |
| , li1 : In-position width of positioning axis                                  |
| , Jj1 : In-position width of hole drilling axis                                |
| , Rr2 : Synchronization method selection (r2=1 synchronous, r2=0 asynchronous) |

(Note 1) When ",R0" is commanded, F address is regarded as cutting feedrate.



**4.5.3.102 Multi-Spindle Synchronous Tapping****M system : Δ****L system : Δ**

This function enables the synchronous tapping on several spindles and is efficient for the tapping machining. All consisting spindles can be designated.

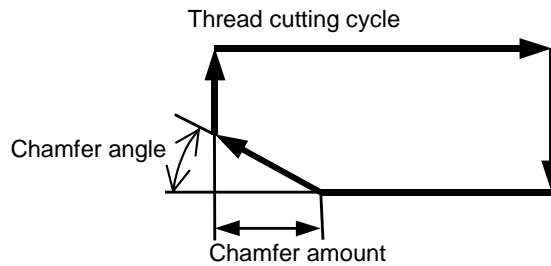
The command format is same as that of the normal synchronous tapping.

4.5.4 Chamfering

M system : -

L system : O

Chamfering can be validated during the thread cutting cycle by using external signals. The chamfer amount and angle are designated with parameters.

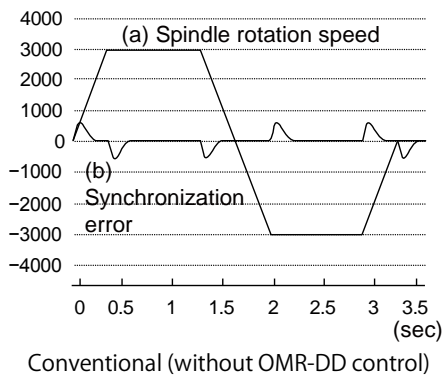


4.5.8 High-speed Synchronous Tapping(OMR-DD)

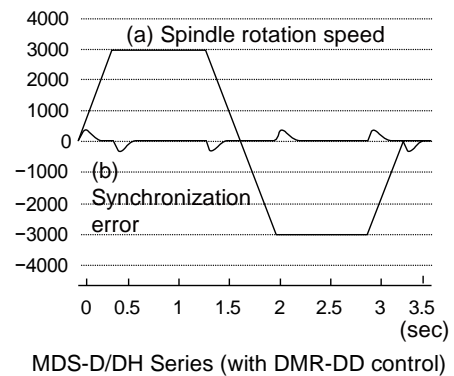
M system : Δ

L system : Δ

The servo axis directly detects and compensates the spindle's delay in tracking by using drive unit communication over the high-speed optical servo network. By minimizing the synchronization error in this way, the accuracy of the synchronous tapping is increased.



Implement to increase the accuracy of the synchronous tapping



### 4.6 Manual Feed

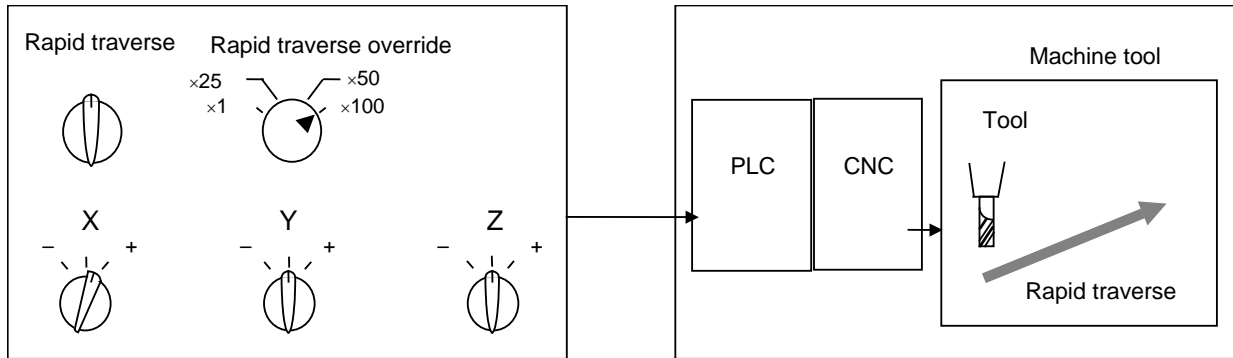
#### 4.6.1 Manual Rapid Traverse

M system : ○

L system : ○

When the manual rapid traverse mode is selected, the tool can be moved at the rapid traverse rate for each axis separately. Override can also be applied to the rapid traverse rate by means of the rapid traverse override function.

Rapid traverse override is common to all part systems.

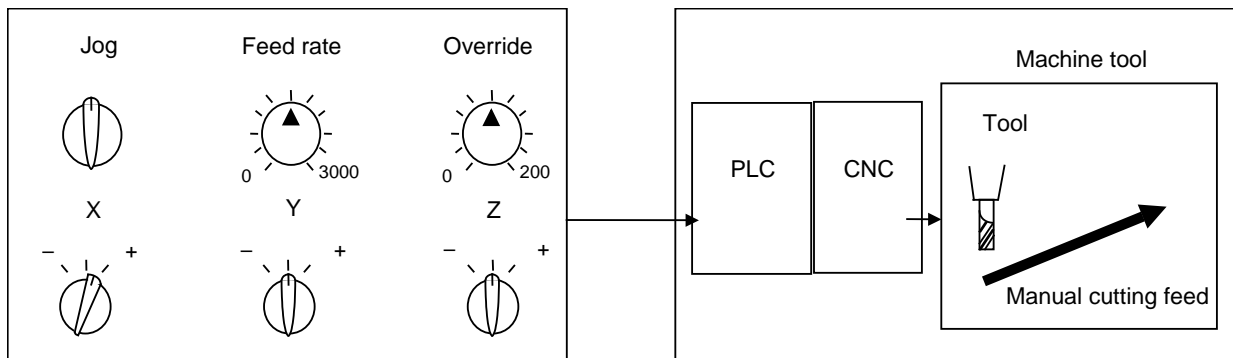


#### 4.6.2 Jog Feed

M system : ○

L system : ○

When the jog feed mode is selected, the tool can be moved in the axis direction (+ or -) in which the machine is to be moved at the per-minute feedrate. The jog feed rate is common to all part systems.



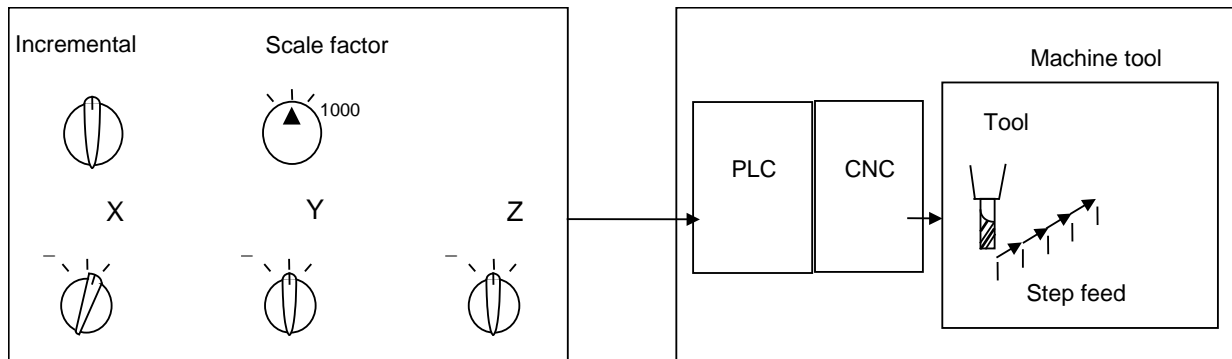


## 4.6.3 Incremental Feed

M system : ○

L system : ○

When the incremental feed mode is selected, the tool can be operated by an amount equivalent to the designated amount (incremental value) in the axis direction each time the jog switch is pressed. The incremental feed amount is the amount obtained by multiplying the least input increment that was set with the parameter by the incremental feed magnification rate. The incremental feed amount parameter and its magnification rate are common to all part systems.



## 4.6.4 Handle Feed

M system : Δ

L system : Δ

(1-axis)

In the handle feed mode, the machine can be moved in very small amounts by rotating the manual pulse generator. The scale can be selected from X1, X10, X100, X1000 or arbitrary value.

**(Note 1)** The actual movement amount and scale may not match if the manual pulse generator is rotated quickly.

(3-axes)

In the handle feed mode, individual axes can be moved in very small amounts either separately or simultaneously by rotating the manual pulse generators installed on each of the axes.

**(Note 1)** The actual movement amount and scale may not match if the manual pulse generator is rotated quickly.

## 4.7 Dwell

### 4.7.1 Dwell (Time-based Designation)

**M system** : ○

**L system** : ○

The G04 command temporarily stops machine movement and sets the machine stand-by status for the time designated in the program.

(1) M system

|                               |
|-------------------------------|
| <b>G04 Xx1 ; or G04 Pp1 ;</b> |
| G04 : Dwell                   |
| Xx1, Pp1 : Dwell time         |

The time-based dwell can be designated in the range from 0.001 to 99999.999 seconds.  
(The input command increment for the dwell time depends on the parameter.)

(2) L system

|   |
|---|
| <b>(G94) G04 Xx1/Uu1 ; or G04 Pp1 ;</b> |
| G94 : Asynchronous                      |
| G04 : Dwell                             |
| Xx1, Uu1, Pp1 : Dwell time              |

The time-based dwell can be designated in the range from 0.001 to 99999.999 seconds.  
(The input command increment for the dwell time depends on the parameter.)

## 5. Program Memory/Editing

### 5.1 Memory Capacity

Machining programs are stored in the CNC memory.

#### 5.1.1 Memory Capacity (Number of Programs Stored)

(Note 1) The tape length will be the total of two part systems when using the 2-part system specifications.

##### 5.1.1.1 15KB [40m] (64 programs)

M system : ○                      L system : ○

##### 5.1.1.2 30KB [80m] (128 programs)

M system : Δ                      L system : Δ

##### 5.1.1.3 60KB [160m] (200 programs)

M system : Δ                      L system : Δ

##### 5.1.1.4 125KB [320m] (200 programs)

M system : Δ                      L system : Δ

##### 5.1.1.5 230KB [600m] (400 programs)

M system : Δ                      L system : Δ

##### 5.1.1.6 500KB [1280m] (1000 programs)

M system : Δ                      L system : Δ

##### 5.1.1.7 1000kB[2560m] (1000 programs)

M system : Δ                      L system : Δ

##### 5.1.1.8 2000kB[5120m] (1000 programs)

M system : Δ                      L system : Δ

## 5.2 Editing

### 5.2.1 Program Editing

**M system :** ○

**L system :** ○

The following editing functions are possible.

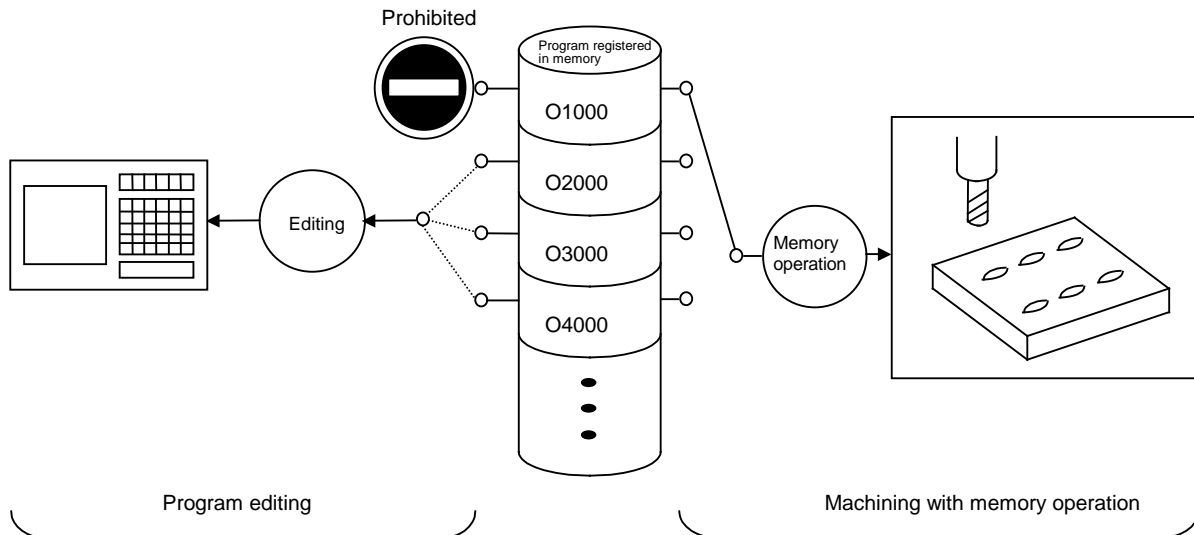
- (1) Program erasing
  - (a) Machining programs can be erased individually or totally.
  - (b) When all machining programs are to be erased, the programs are classified with their No. into B: 8000 to 8999, C: 9000 to 9999, and A: all others.
- (2) Program filing
  - (a) This function displays a list of the machining programs stored (registered) in the controller memory.
  - (b) The programs are displayed in ascending order.
  - (c) Comments can be added to corresponding program numbers.
- (3) Program copying
  - (a) Machining programs stored in the controller memory can be copied, condensed or merged.
  - (b) The program No. of the machining programs in the memory can be changed.
- (4) Program editing
  - (a) Overwriting, inserting and erasing can be done per character.

## 5.2.2 Background Editing

M system : ○

L system : ○

This function enables one machining program to be created or editing while another program is run.



- (1) The data of the machining programs being used in memory operation can be displayed and scrolled on the setting and display unit, but data cannot be added, revised or deleted.
- (2) The editing functions mentioned in the preceding section can be used at any time for machining programs which are not being used for memory operation. This makes it possible to prepare and edit the next program for machining, and so the machining preparations can be made more efficiently.
- (3) The machining program will not be searched as the operation target even when searched in the edit screen.

## 5.2.4 Word Editing

M system : ○

L system : ○

This function enables to edit programs in word unit by insertion, deletion, and replacement.

## 6. Operation and Display

### 6.1 Structure of Operation/Display Panel

#### 6.1.2 Color Display (GOT)

M system :

L system :

Refer to the "I 1.3.2 GOT"

## 6.2 Operation Methods and Functions

### 6.2.2 Absolute Value/Incremental Value Setting

**M system :** ○                      **L system :** ○

When setting the data, the absolute/incremental setting can be selected from the menu.

The absolute/incremental settings can be selected on the following screens.

- Tool compensation amount screen
- Coordinate system offset screen

### 6.2.3 Single-NC and Multi-display Unit Switch

**M system :** ○                      **L system :** ○

By adding an Ethernet hub, up to eight displays can be changed over for one CNC. (Note that the max. number of displays that can be connected is limited by the machine operation panel specifications.)

### 6.2.4 Multi-NC and Common-display Unit

**M system :** ○                      **L system :** ○

By adding an Ethernet hub, up to 64 CNC modules can be changed over and displayed on one display. (Note that the max. number of modules that can be connected is limited by the machine operation panel specifications.)

### 6.2.5 Displayed Part System Switch

**M system :** ○                      **L system :** ○

The part system displayed on the screen can be changed with the **SHIFT**, **\$** keys.

The number of displayed part systems is counted by one each time the **SHIFT**, **\$** keys are pressed. The screen corresponding to that part system opens.

If the number of displayed part systems exceeds the valid number of part systems, the number of displayed part systems will return to 1.

### 6.2.10 Screen Saver, Backlight OFF

**M system :** ○                      **L system :** ○

The GOT's screensaver function protects the display by turning the backlight OFF after the preset time has elapsed.

### 6.2.15 Screen Capture

**M system :** ○                      **L system :** ○

The GOT's hard copy function captures the screen image in JPEG or bitmap format.

**6.2.101 CNC Machining Programing Editing**

**M system : ○**

**L system : ○**

This function is to produce/edit CNC machining programs on GOT monitor. Machining program, Fixed cycle program and MDI program are applicable.



## 6.3 Display Methods and Contents (CNC Monitor Function)

### 6.3.1 Status Display

**M system** : ○

**L system** : ○

The status of the program currently being executed is indicated.

- (1) Display of G, S, T, M commands and 2nd miscellaneous command modal values
- (2) Feed rate display
- (3) Tool offset number and offset amount display
- (4) Real speed display (Note 1)

**(Note 1)** The feed rate of each axis is converted from the final speed output to the drive unit, and is displayed. However, during follow up, the speed is converted and displayed with the signals from the detector installed on the servomotor.

### 6.3.2 Clock Display

**M system** : ○

**L system** : ○

The clock is built-in, and the date (year, month, date) and time (hour, minutes, seconds) are displayed. Once the time is set, it can be seen as a clock on the screen.

### 6.3.3 Position Display

**M system** : ○

**L system** : ○

Various information related to operation, such as the axis counter, speed display and MSTB command are displayed on the Position Display screen. The following operations regarding operation can be executed.

- (1) Operation search
- (2) Setting of common variables
- (3) Setting of local variables
- (4) Counter zero
- (5) Origin zero
- (6) Manual numeric command, etc.

### 6.3.4 Tool Compensation/Parameter

**M system** : ○

**L system** : ○

Tool/workpiece related settings, user parameter settings, manual numeric command issuing and tool length measurements can be carried out on the Tool Compensation/Parameter screen.

**6.3.5 Program****M system : ○****L system : ○**

Machining program searching, creating and editing (addition, deletion, change), program list display and MDI editing can be carried out on the Program screen.

**6.3.6 Alarm Diagnosis****M system : ○****L system : ○**

The following operations related to CNC diagnosis can be carried out on the Diagnosis screen.

- (1) Display of hardware, software and drive unit configuration
- (2) Operation monitor of servo and spindle drive unit
- (3) Diagnosis of NC input/output signal (interface diagnosis)
- (4) Display of operation history
- (5) Display of alarm / stop code history list
- (6) Data sampling for maintenance
- (7) Deleting, copying and list displaying of machining program

**6.3.8 Additional Languages****6.3.8.1 Japanese****M system : ○****L system : ○****6.3.8.2 English****M system : ○****L system : ○****6.3.8.3 German****M system : Δ****L system : Δ****6.3.8.4 Italian****M system : Δ****L system : Δ****6.3.8.5 French****M system : Δ****L system : Δ****6.3.8.6 Spanish****M system : Δ****L system : Δ**

**6.3.8.7 Chinese**

**6.3.8.7.2 Simplified Chinese Characters**

**M system : Δ**

**L system : Δ**

**6.3.8.14 Polish**

**M system : Δ**

**L system : Δ**

## 7. Input/Output Functions and Devices

### 7.1 Input/Output Data

CNC data input/output function of GOT (Mitsubishi Graphic Operation Terminal) is used.

Various data of CNC can be input/output for a memory card or a USB memory which is attached to GOT.

#### 7.1.1 Machining Program Input / Output

M system :                       L system :

#### 7.1.2 Tool Offset Data Input / Output

M system :                       L system :

#### 7.1.3 Common Variable Input / Output

M system :                       L system :

#### 7.1.4 Parameter Input / Output

M system :                       L system :

#### 7.1.5 History Data Output

M system :                       L system :

## 8. Spindle, Tool and Miscellaneous Functions

### 8.1 Spindle Functions (S)

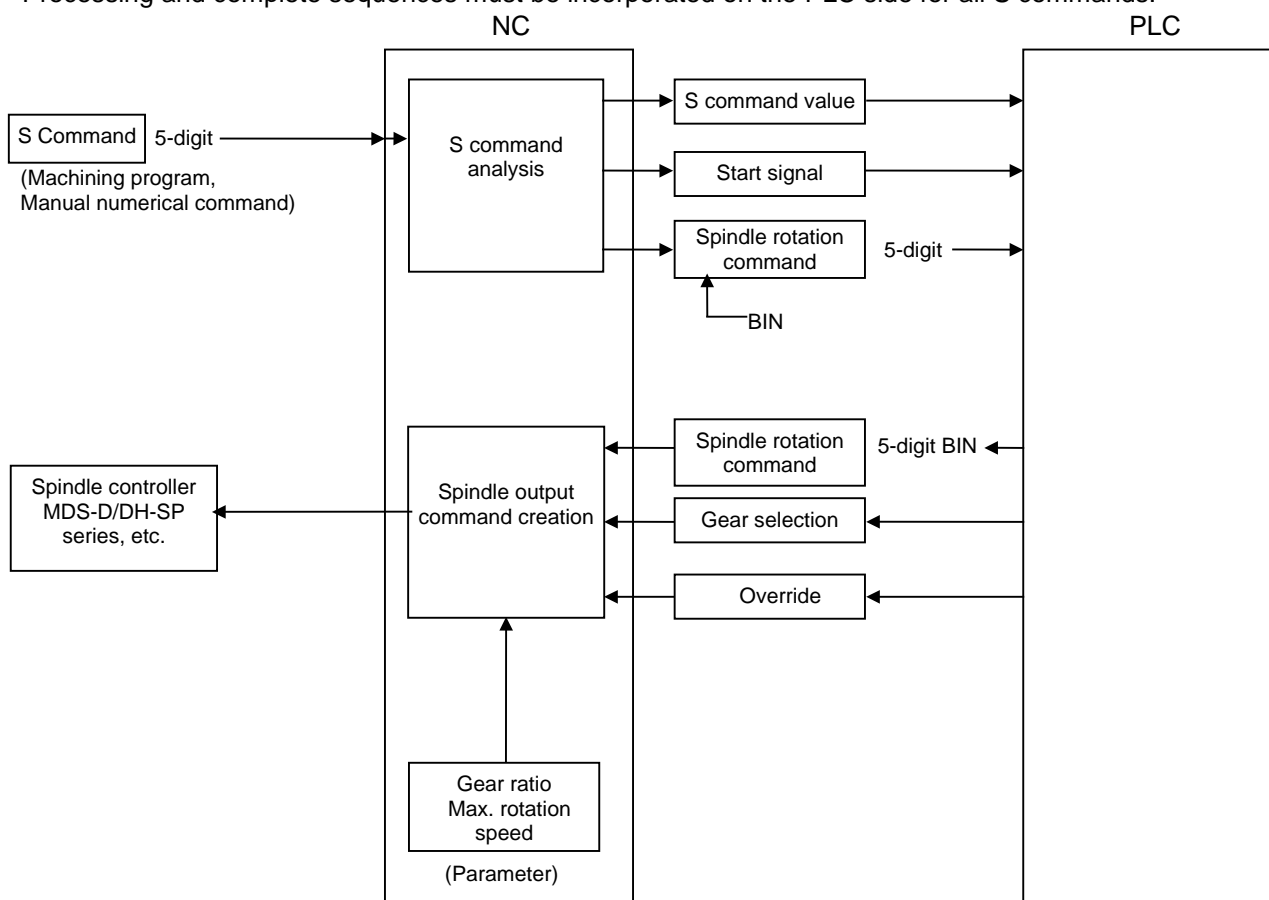
#### 8.1.1 Spindle Control Functions

The spindle rotation speed is determined in consideration of the override and gear ratio for the S command given in automatic operation or with manual numerical commands, and the spindle is rotated. The following diagram shows an outline of the spindle control.

When an 8-digit number following address S (S-99999999 to S99999999) is commanded, a signed 32-bit binary data and start signal will be output to the PLC.

When multiple spindle control "Sn = \*\*\*\*" method, up to seven sets of S commands can be commanded in one block.

Processing and complete sequences must be incorporated on the PLC side for all S commands.



- (1) The override can be designated as 50% to 120% in 10% increments or 0 to 200% in 1% increments. The override is not changed while the spindle stop input is ON, during the tapping mode, or during the thread cutting mode.
- (2) The number of gear steps can be commanded up to four steps.
- (3) The max. spindle rotation speed can be set for each gear.

**(Note 1)** S command can be commanded by eight digits. However, setting range of the parameter highest rotation speed and rotation speed limit, etc. are five digits or less. So, S command which can be substantially controlled are five digits or less.

**(Note 2)** The display of S command is five digits or less display on some screens.

**8.1.1.1 Spindle Digital I/F**

**M system : ○                      L system : ○**

This interface is used to connect the digital spindle (AC spindle motor and spindle drive unit).

**8.1.1.2 Spindle analog I/F**

**M system : Δ (using MELSEC I/O)              L system : Δ (using MELSEC I/O)**

Spindle control can be performed with analog voltage input type spindle instead of digital spindle.

**8.1.1.3 Coil Switch**

**M system : ○                      L system : ○**

Constant output characteristics can be achieved across a broad spectrums down to the low-speed ranges by switching the spindle motor connections.

This is a system under which commands are assigned from the PLC.

**8.1.1.4 Automatic Coil Switch**

**M system : ○                      L system : ○**

Constant output characteristics can be achieved across a broad spectrums down to the low-speed ranges by switching the spindle motor connections.

This is a system under which the CNC unit switches the coils automatically in accordance with the motor speed.

**8.1.2 S Code Output**

**M system : ○                      L system : ○**

When an 8-digit number following address S (S-99999999 to S99999999) is commanded, a signed 32-bit binary data and start signal will be output to the PLC.

One set of S commands can be issued in one block.

Processing and complete sequences must be incorporated on the PLC side for all S commands.

S function can be designated with any other kind of commands. In the case where a movement command is in the same block, two different command sequences are available. Depending on user PLC process (presence of DEN signal process), either one of the following two will be applied.

- (1) S function is executed after the movement is completed.
- (2) S function is executed at the same time as when the movement command is issued.

**(Note)** The display of S command is five digits or less display on some screens.



### 8.1.4 Spindle Override

**M system :** ○

**L system :** ○

This function applies override to the rotation speed of a spindle assigned by the machining program command during automatic operation or by manual operation. There are two types of override.

(1) Code method

Using an external signal, override can be applied to the commanded rotation speed of a spindle or mill spindle in 10% increments from 50% to 120%.

(2) Value setting method

Using an external signal, override can be applied to the commanded rotation speed of a spindle or mill spindle in 1% increments from 0% to 200%.

**(Note 1)** Selection between code method and value setting method can be designated by user PLC processing.

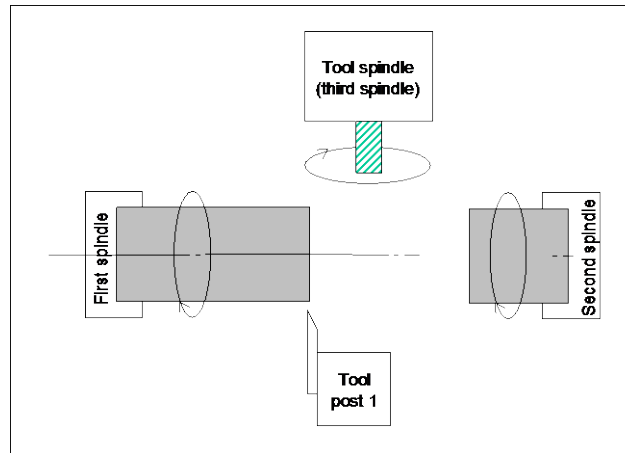


### 8.1.5 Multiple-spindle Control

When using a machine tool equipped with several spindles (up to seven spindles), this function controls those spindles.

Multiple-spindle control I: Control based on a spindle selection command, such as G43.1, and spindle control command [S\*\*\*\*\*;] or [SO=\*\*\*\*\*;], etc.

The figure below shows an example of the configuration for a machine which is equipped with second and third spindles.



#### 8.1.5.1 Multiple-spindle Control I

**M system : O**

**L system : O**

##### (1) Spindle selection commands

Using the spindle selection command (such as G43.1 [G group 20]), this function makes it possible to switch the spindle among the first through seventh spindles to which the subsequent S command (S\*\*\*\*\*) is to apply.

Command format

|               |   |
|---------------|---|
| <b>G43.1;</b> | Selected spindle control mode ON; the selected spindle number is set using a parameter. |
| <b>G44.1;</b> | Second spindle control mode ON  |

##### (2) Spindle control commands (using an extended word address (SO=\*\*\*\*\*))

In addition to using the "S\*\*\*\*\*" S commands, it is also possible to assign commands which differentiate the applicable spindle among the first through seventh spindles by using the SO=\*\*\*\*\*. The S command can be issued from a machining program for any part system. The number of spindle axes differs according to the model, so check the specifications. The C6 T and L System and C64 T System cannot control multiple spindles in one part system.

Command format

|                  |   |
|------------------|---|
| <b>SO=*****;</b> |   |
| <b>O</b>         | : Number assigned as the spindle number (1: first spindle; 2: second spindle; ... 7: seventh spindle); variables can be designated. |
| <b>*****</b>     | : Rotational speed or surface speed value assigned by 6-digit analog command; variables can be designated.                          |

## 8.1.6 Spindle Orientation

M system : ○

L system : ○

This function stops the spindle rotation at a certain position.

## (1) Orientation

This function stops the spindle rotation at a certain position when using the digital spindle.

When the orientation command is used, the spindle will rotate several times and then stop at the orientation point. The orientation point is the Z-phase position when using encoder orientation (PLG and external encoder) or the proximity switch neighborhood when using the proximity switch method.

## (2) Multi-point orientation

This function performs orientation to a position other than the Z-phase position by inputting a shift amount with the parameter or PLC. The shift amount is 0 to 35999. (Unit:  $360^\circ/36000 = 0.01^\circ$ )

**(Note 1)** Orientation is possible only when the gear ratio is 1:1 for the PLG orient.

(The orientation is completed at the PLG encoder's Z-phase, so when using reduction gears, the orientation points will be generated at several points during one spindle rotation.)

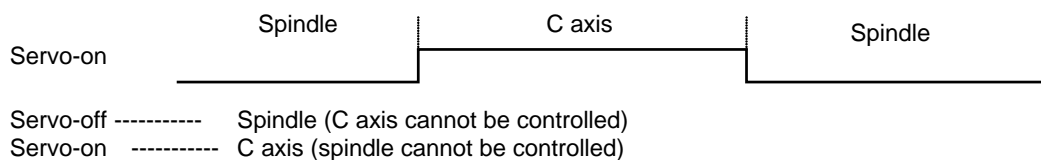
## 8.1.7 Spindle position control (Spindle/C axis control)

M system : Δ

L system : Δ

This function enables one spindle drive unit to be used also as the C axis (rotary axis) using an external signal.

The C axis servo ON signal is used to switch between the spindle and C axis.



## - Reference position return state

Reference position return is incomplete when the Z phase has not been passed.

Reference position return is complete when the Z phase has been passed.

## - C axis position data

The NC's internal C axis position data is updated even for the spindle rotation during spindle control.

The C axis coordinate position counter is held during spindle control, and is updated according to the amount moved during spindle control when the C axis servo READY is turned ON. (The C axis position at servo ON may differ from the position just before the previous servo OFF.)

### 8.1.8 Spindle Synchronization

In a machine with two or more spindles, this function controls the rotation speed and phase of one selected spindle (synchronized spindle) in synchronization with the rotation of the other selected spindle (basic spindle). There are two methods for giving commands: G code and PLC.

It is used in cases where, for instance, workpiece clamped to the basic spindle is to be clamped to the synchronized spindle instead or where the spindle rotation speed is to be changed while one workpiece remains clamped to both spindles.

#### 8.1.8.1 Spindle Synchronization I

**M system :** Δ

**L system :** Δ

The synchronous spindle is designated and the start/end of the synchronization are commanded with the G command in the machining program.

Command format

Spindle synchronization control cancel (G113)

This command releases the state of synchronization between two spindles whose rotation has been synchronized by the spindle synchronization command.

|              |
|--------------|
| <b>G113;</b> |
|--------------|

Spindle synchronization control ON (G114.1)

This command is used to designate the basic spindle and the spindle to be synchronized with the basic spindle, and it places the two designated spindles in the synchronized state.

By designating the synchronized spindle phase shift amount, the phases of the basic spindle and synchronized spindle can be aligned.

|                                 |
|---------------------------------|
| <b>G114.1 H__ D__ R__ A__ ;</b> |
|---------------------------------|

H\_\_ : Selects the basic spindle.

D\_\_ : Selects the spindle to be synchronized with the basic spindle.

E\_\_ : Designates the synchronized spindle phase shift amount.

A\_\_ : Designates the spindle synchronization acceleration/deceleration time constant.

#### 8.1.8.2 Spindle Synchronization II

**M system :** Δ

**L system :** Δ

Whereas the spindle synchronization I executes the selection of the spindles to be synchronized, the start of the synchronization and other settings with G code in the machining program, this function designates all these from the PLC.

The spindle synchronization control mode is established by inputting the spindle synchronization control signal. While this mode is established, the synchronized spindle is controlled in synchronization with the rotation speed assigned for the basic spindle.

#### 8.1.11 Spindle Speed Clamp

**M system :** ○

**L system :** ○

The spindle rotation speed is clamped between maximum rotation speed and minimum rotation speed.

**8.1.12 External Spindle Speed Clamp****M system : ○****L system : ○**

This function clamps the spindle rotation speed at the speed set by parameter when the external spindle clamp signal which is externally input from the sequence program turns ON. This is used for limiting the speed when the usual speed is too fast, in a situation such as carrying out machining with the door open.

## 8.2 Tool Functions (T)

### 8.2.1 Tool Functions (T Command)

**M system :** ○

**L system :** ○

This function commands the tool No. by an 8-digit number that follows address T (T0 to T99999999). Tool compensation No.(tool length compensation and/or tool nose wear compensation) will be displayed for L system.

#### (1) M system

When an 8-digit number following address T (T00000000 - T99999999) is assigned, 8-digit code data and start signal will be output to PLC.

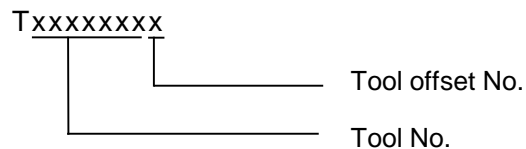
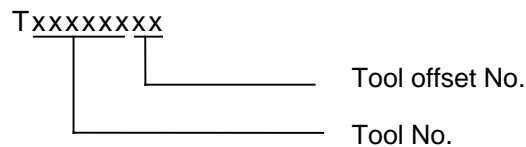
Only one set of T commands can be commanded in a block.

Processing and complete sequences must be incorporated on the PLC side for all T commands.

**(Note 1)** There are some screens in the setting and display unit that cannot display all eight digits.

#### (2) L system

The command is issued with an 8-digit number following address T (T0 - T99999999). The high-order 6 digits or 7 digits are designated as the tool No., and the low-order 2 digits or 1 digit are designated as the offset No. Which method is to be used is designated with parameters.



The 6-digit (or 7-digit) tool No. code data and start signal will be output to the PLC.

Processing and complete sequences must be incorporated on the PLC side for all T commands.

**(Note 1)** There are some screens in the setting and display unit that cannot display all eight digits.

### 8.3 Miscellaneous Functions (M)

#### 8.3.1 Miscellaneous Functions

**M system :** ○

**L system :** ○

When an 8-digit number (M00000000~M99999999) is assigned following address M, the 8-digit code data and start signal are output to the PLC.

Apart from the above signals, various special independent signals are also output for the following signals.

M00 : Program stop

M01 : Optional stop

M02 : Program end

M30 : Program end

Respective processing and complete sequences must be incorporated on the PLC side for all M commands from M00000000 to M99999999.

M98 and M99 have specific purposes and can not be used.

**(Note 1)** There are some screens in the setting and display unit that cannot display all eight digits.

#### 8.3.2 Multiple M Codes in 1 Block

**M system :** ○

**L system :** ○

Four sets of M commands can be issued simultaneously in a block.

Respective processing and completion sequences are required for all M commands included in a block (except M98 and M99).

**(Note 1)** The code data and start signals of all the M commands in the same block are transferred simultaneously from the controller to the PLC, and so high-speed machine control can be done by the PLC processing sequence.

#### 8.3.3 M Code Independent Output

**M system :** ○

**L system :** ○

When the M00, M01, M02 or M30 command is assigned during an automatic operation (memory, MDI) or by a manual numerical command, the signal of this function is output. It is turned OFF after the miscellaneous function finishes or by the "Reset & Rewind" signal.

| Machining program | M code independent output | Response to controller |
|-------------------|---------------------------|------------------------|
| M00               | M00                       | Fin1 or Fin2           |
| M01               | M01                       | Fin1 or Fin2           |
| M02               | M02                       | Reset & rewind         |
| M30               | M30                       | Reset & rewind         |

If movement or dwell command exists in the same block as these M commands, this signal is output upon completion of the movement or dwell command.

8.3.4 Miscellaneous Function Finish

M system : ○

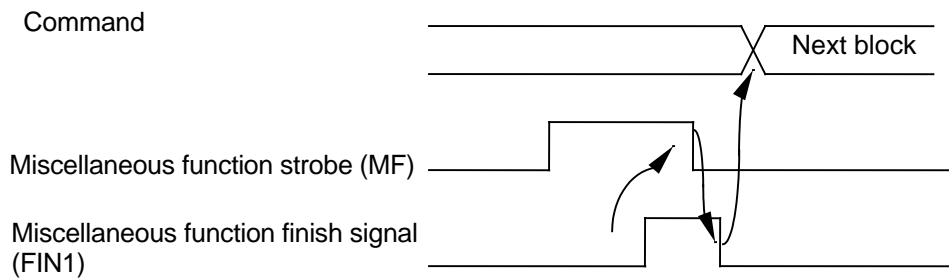
L system : ○

These signals inform the CNC system that a miscellaneous function (M), spindle function (S), tool function (T) or 2nd miscellaneous function (A, B, C) has been assigned, and that the PLC which has received it has completed the required operation. They include miscellaneous function finish signal 1 (FIN1) and miscellaneous function finish signal 2 (FIN2).

Miscellaneous function finish signal 1 (FIN1)

When the controller checks that FIN1 is ON, it sets the function strobes OFF. Furthermore, when the PLC checks that the function strobes are OFF, it sets FIN1 OFF. The controller checks that FIN1 is OFF and advances to the next block.

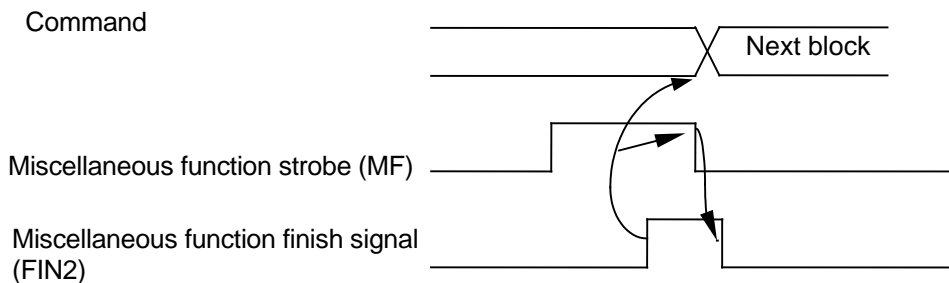
Below is an example of a time chart applying when a miscellaneous function has been assigned.



Miscellaneous function finish signal 2 (FIN2)

When the controller checks that FIN2 is ON, it sets the function strobes OFF and simultaneously advances to the next block. The PLC checks that the strobe signals are OFF and sets FIN2 OFF.

Below is an example of a time chart applying when a miscellaneous function has been assigned.



#### 8.4 2nd Miscellaneous Functions (B)

##### 8.4.1 2nd Miscellaneous Functions

**M system :** ○

**L system :** ○

The code data and start signals are output when an 8-digit number is assigned following the address code A, B or C — whichever does not duplicate the axis name being used.

Processing and complete sequences must be incorporated on the PLC side for all 2nd miscellaneous commands.

**(Note 1)** There are some screens in the setting and display unit that cannot display all eight digits.



## 9. Tool Compensation

### 9.1 Tool Length/Tool Position

#### 9.1.1 Tool Length Compensation

M system : O

L system : O

These commands make it possible to control the axis movement by offsetting the position of the end point of the movement command by the amount set on the TOOL OFFSET screen.

Using this function, it is possible to offset the difference in distance between the actual position of the machine's tool nose and the program coordinate position made by the tool length and to enhance both the programming and operational efficiency.

(1) M system

|                  |             |            |   |   |
|------------------|-------------|------------|---|---|
| G43              | Zz1         | Hh1        | ; | Tool length offset can be provided not only for the Z axis but for all other axes which can be controlled in the system (X, Y, etc.). |
| G44              | Zz1         | Hh1        |   |   |
| Offset direction | Offset axis | Offset No. |   |   |
| G49              |             |            | ; | Tool length offset cancel   |

The offset direction is determined by the G command.

G43: Forward direction ( $z1 + h1$ )

G44: Reverse direction ( $z1 - h1$ )

Offset can be canceled by the following G commands.

G49;

G43 H0;

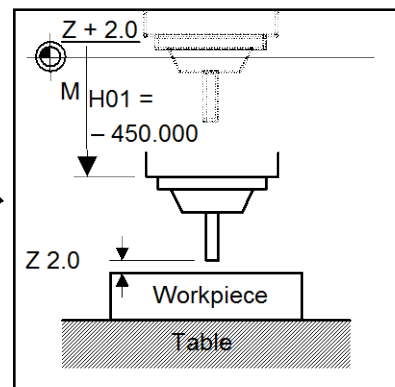
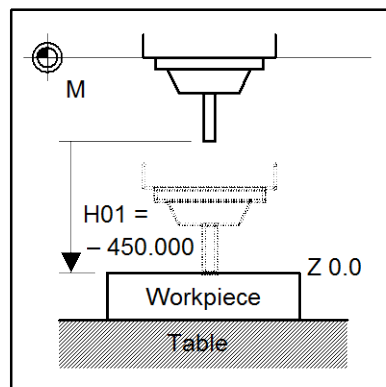
G44 H0;

**(Note 1)** When the tool length offset axis is returned to the reference point, the offset of that axis is canceled.

**(Example)** Example of tool length offset using a combination with tool length measurement type I

```
G28 X0 Y0 Z0 ;
T01 ;
T02 M06 ;
G91 G00 G43
Z2.0 H01 ;
```

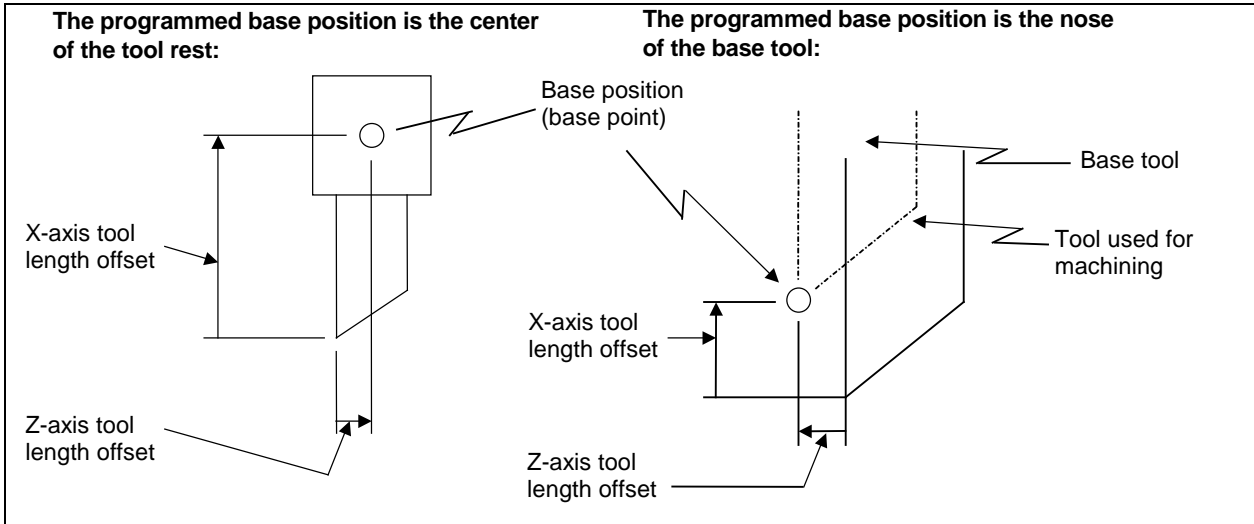
**(Note)** The tool length offset amount is set as a negative value such as  $H01 = -450.000$ .



(2) L system

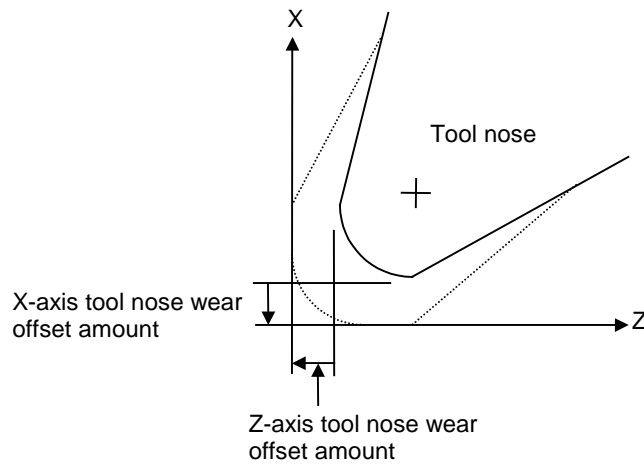
(a) Shape offset

Tool length is offset in reference to the programmed base position. The programmed base position is usually the center of the tool rest or the nose position of the base tool.



(b) Wear offset

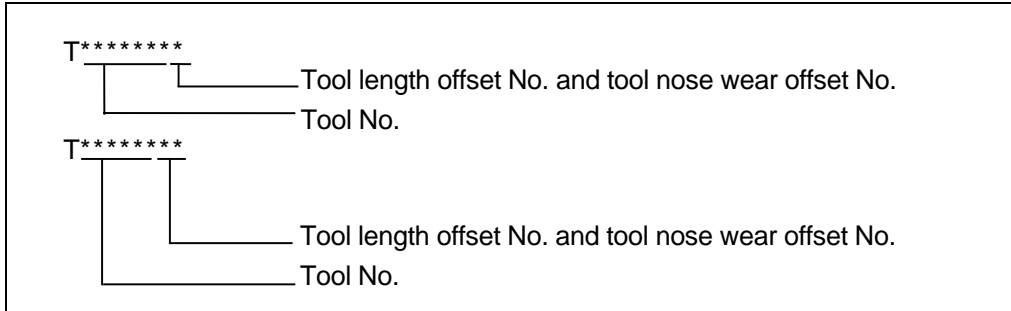
The wear of a tool nose can be offset.



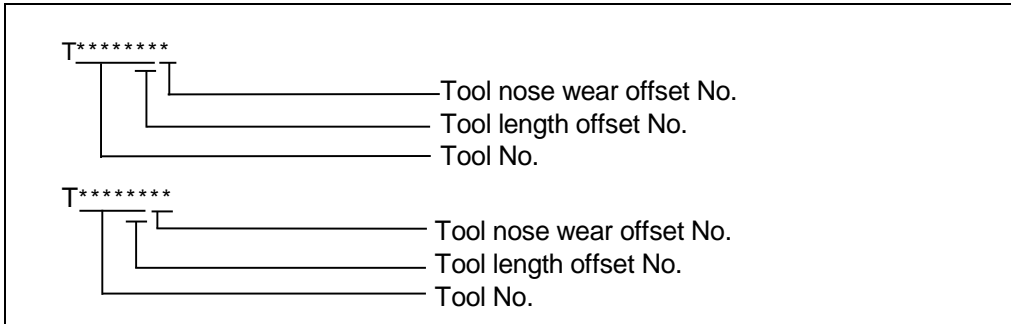
(c) Command format

Tool offset is performed by a T command. It is specified in eight digits following address T. Tool offset is divided into two types: tool length offset and tool nose wear offset. The Nos. of such two types of offsets are specified by a parameter. Also a parameter is used to specify whether the offset Nos. is specified by one or two low-order digits of a T command.

1. Specifying tool length and wear offset Nos. together using one or two low-order digits of the T command



2. Specifying tool length and wear offset Nos. separately



The tool offset for the L system is valid only for the X and Z axes.

## 9.2 Tool Radius

### 9.2.1 Tool Radius Compensation

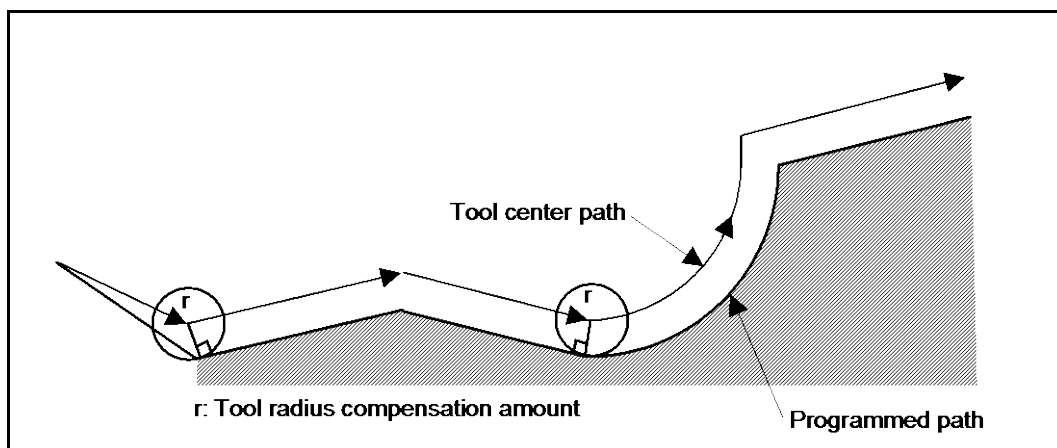
**M system :** O

**L system :** -

These commands function to provide tool radius compensation. Through a combination with the G command and D address assignment, they compensate for the actual tool center path either inside or outside the programmed path by an amount equivalent to the tool radius.

The tool path is calculated by the intersection point arithmetic system and, as a result, excessive cut amounts on the inside of corners are avoided.

| G code | Function                                      |
|--------|---|
| G38    | Vector change during tool radius compensation |
| G39    | Corner arc during tool radius compensation    |
| G40    | Tool radius compensation cancel               |
| G41    | Tool radius compensation left command         |
| G42    | Tool radius compensation right command        |



The tool radius compensation command controls the compensation from that block in which G41 or G42 is commanded. In the tool radius compensation mode, the program is read up to five blocks ahead including blocks with no movement, and interference check using tool radius is conducted up to three blocks ahead in any of those blocks with movement.

**G17 G01 G41 Xx1 Yy1 Dd1 ;**

G17 : Compensation plane  
 G01 : Cutting command  
 G41 : Left compensation  
 Xx1,Yy1 : Movement axis  
 Dd1 : Compensation No.

The compensation plane, movement axes and next advance direction vector are based on the plane selection command designated by G17 to G19.

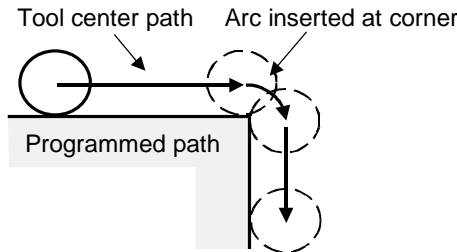
G17: XY plane, X, Y, I, J

G18: ZX plane, Z, X, K, I

G19: YZ plane, Y, Z, J, K

An arc is inserted at the corner by the following command during tool radius compensation.

```
G39 Xx1 Yy1 ;
Xx1, Yy1 : Movement amount
```



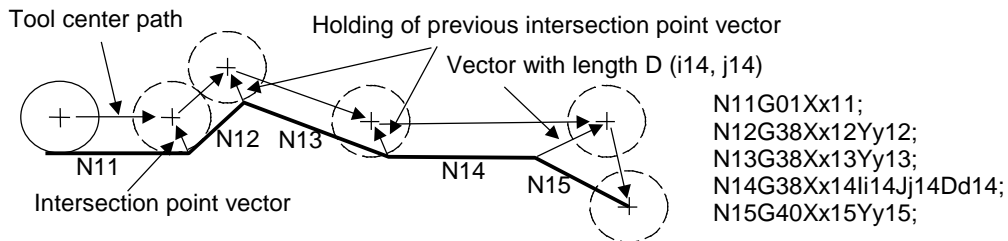
The compensation vector can be changed in following two ways.

```
G38 Xx1 Yy1 ;
Xx1, Yy1 : Movement amount
```

The tool radius compensation vector amount and direction are retained.

```
G38 Xx1 Yy1 Ii1 Jj1 Dd1 ;
Xx1, Yy1 : Movement amount
Ii1, Jj1 : Compensation vector direction
Dd1 : Compensation vector length
```

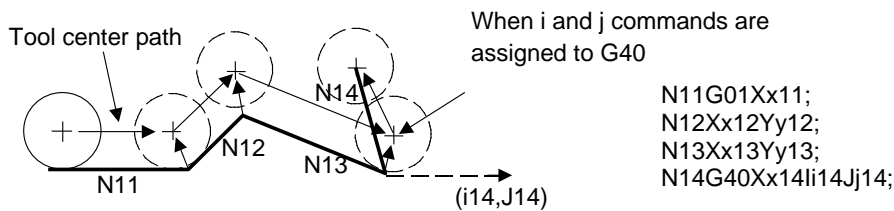
The tool radius compensation vector direction is updated by I and J.



The tool radius compensation is canceled by the following command.

```
G40 Xx1 Yy1 Ii1 Jj1 ;
Xx1, Yy1 : Movement amount
Ii1, Jj1 : Compensation vector direction
```

The vector prior to canceling is prepared by calculating the intersection point with the I and J direction.



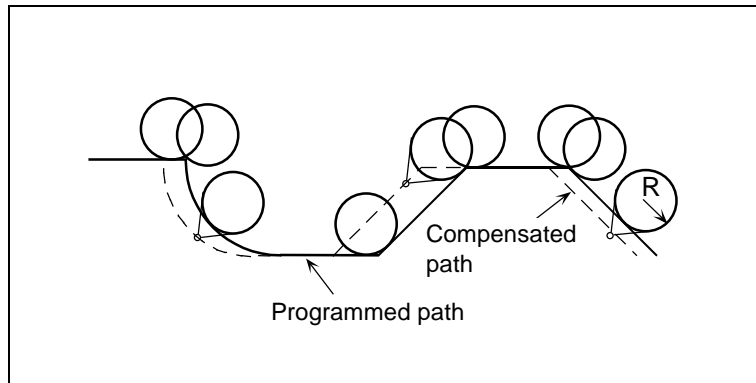
## 9.2.3 Tool Nose Radius Compensation (G40/G41/G42)

M system : -

L system : O

Corresponding to the tool No., the tool nose is assumed to be a half circle of radius R, and compensation is made so that the half circle touches the programmed path.

| G code | Function                          |
|--------|-----------------------------------|
| G40    | Nose R compensation cancel        |
| G41    | Nose R compensation left command  |
| G42    | Nose R compensation right command |

**Nose R interference check**

In the nose radius compensation mode, the program is read up to five blocks ahead including blocks with no movement, and an interference check using the nose radius is conducted up to three blocks ahead in any of those blocks with movement.

9.2.4 Automatic Decision of Nose Radius Compensation Direction (G46/G40)

M system : -

L system : O

The nose radius compensation direction is automatically determined from the tool tip and the specified movement vector.

| G code | Function  |
|--------|---|
| G40    | Nose radius compensation cancel   |
| G46    | Nose radius compensation ON<br>(Automatic decision of compensation direction) |

The compensation directions based on the movement vectors at the tool nose points are as follows:

|  |  | Tool nose direction          |   | Tool nose point |   |   |   |
|--|--|------------------------------|---|-----------------|---|---|---|
|  |  | Tool nose progress direction |   | 1               | 2 | 3 | 4 |
| Mouvement vectors<br>(tool nose points 1 to 4) |  | R                            | R | L               | L |   |   |
|  |  | X                            | R | X               | L |   |   |
|  |  | L                            | R | R               | L |   |   |
|  |  | L                            | X | R               | X |   |   |
|  |  | L                            | L | R               | R |   |   |
|  |  | X                            | L | X               | R |   |   |
|  |  | R                            | L | L               | R |   |   |
|  |  | R                            | X | L               | X |   |   |
| Range of each tool nose point (1 to 4)         |  |                              |   |                 |   |   |   |

|  |  | Tool nose direction          |   | Tool nose point |   |   |   |
|--|--|------------------------------|---|-----------------|---|---|---|
|  |  | Tool nose progress direction |   | 5               | 6 | 7 | 8 |
| Mouvement vectors<br>(tool nose points 5 to 8) |  | X                            | R | X               | L |   |   |
|  |  | L                            | R | R               | L |   |   |
|  |  | L                            | X | R               | X |   |   |
|  |  | L                            | L | R               | R |   |   |
|  |  | X                            | L | X               | R |   |   |
|  |  | R                            | L | L               | R |   |   |
|  |  | R                            | X | L               | X |   |   |
|  |  | R                            | R | L               | L |   |   |
| Range of each tool nose point (5 to 8)         |  |                              |   |                 |   |   |   |

9.3 Tool Offset Amount

9.3.1 Number of Tool Offset Sets

The number of tool compensation sets is as follows.

<M system>

| Number of part systems \ Number of tool compensation sets | 1st part system | 2nd part system | 3rd part system | 4th part system | 5th part system | 6th part system | 7th part system |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 40 sets   | ○               | ○               | ○               | ○               | ○               | ○               | ○               |
| 80 sets   | △               | △               | △               | -               | -               | -               | -               |
| 100 sets  | △               | △               | -               | -               | -               | -               | -               |
| 200 sets  | △               | -               | -               | -               | -               | -               | -               |

**(Note 1)** The number of tool compensation sets in above table indicates the number of sets in each part system.

**(Note 2)** The standard number of tool compensation sets per part system for M system is 40 regardless of number of part systems.

<L system>

| Number of part systems \ Number of tool compensation sets | 1st part system | 2nd part system | 3rd part system |
|---|-----------------|-----------------|-----------------|
| 40 sets   | -               | -               | -               |
| 80 sets   | ○               | ○               | ○               |
| 100 sets  | -               | -               | -               |
| 200 sets  | -               | -               | -               |

**(Note 1)** The number of tool compensation sets per part system for L system is 80 regardless of number of part systems.

9.3.1.2 40 Sets

M system : ○

L system : -

9.3.1.3 80 Sets

M system : △ (80/100)

L system : ○

9.3.1.4 200 Sets

M system : △

L system : -



9.3.2 Offset Memory

9.3.2.1 Tool Shape/Wear Offset Amount

M system : O

L system : O

This function registers the tool shape offset and wear offset amounts. Compensation may encompass two or more axes.

(1) Shape offset amount

The tool length offset amount, tool radius compensation amount, nose radius compensation amount, nose radius imaginary tool tip point or tool width can be set as the shape offset amount.

The compensation amount that can be set and used differs depending on whether offset amount setting type 1, 2 or 3 is used.

(2) Wear offset amount

When the tip of the tool used has become worn, the wear offset amount is used to offset this wear.

Types of wear offset amounts include the tool length wear offset amount, tool radius wear compensation amount, and nose radius wear compensation amount.

The wear offset amount can be used with offset amount setting types 2 and 3, and it is added to the shape offset amount for compensation.

(a) Type 1: 1-axis offset amount [M system]

This is the value that is used by rotary tools.

As the tool length offset amount, among the offset amounts for the position of the tool moving in the direction parallel to the control axis, the offset amount in the longitudinal direction of the rotary tool is registered. The tool length offset amount is set as a minus value.

As the tool radius compensation amount, among the offset amounts for the position of the tool moving in the direction parallel to the control axis, the offset amount in the radial direction of the rotary tool is registered. The tool radius compensation amount is set as a plus value.

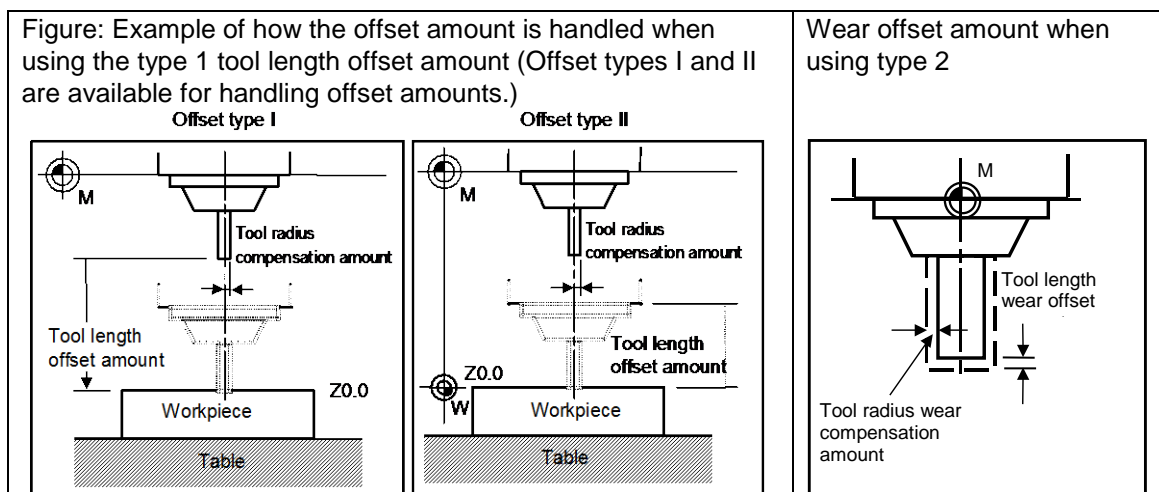
One offset amount data is registered in one offset number, and the offset Nos. are assigned using the address D or H commands. When a No. is assigned by a D address command, offset is provided in the form of the tool radius; when it is assigned by an H address command, it is provided in the form of the tool length.

(b) Type 2: 1-axis offset amounts/with wear offset [M system]

As with type 1, type 2 is for the offset amounts used by rotary tools.

With type 2, four kinds of offset amount data are registered in one offset No.: the tool length offset amount, tool length wear offset amount, tool radius compensation amount, and tool radius wear compensation amount.

When an offset No. is assigned by address D as the offset amount, the tool radius is compensated using the amount obtained by adding the tool radius compensation amount and tool radius wear compensation amount. Further, the tool length is offset using the amount obtained by adding the tool length offset amount and tool length wear offset amount.



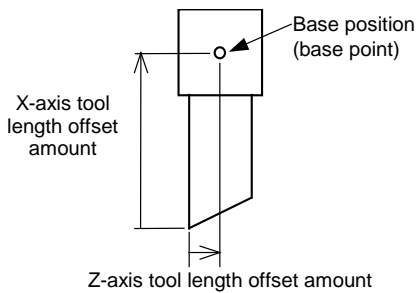
(c) Type 3: 2-axis offset amounts [L system]

Type 3 is for the offset amounts used by non-rotary tools.

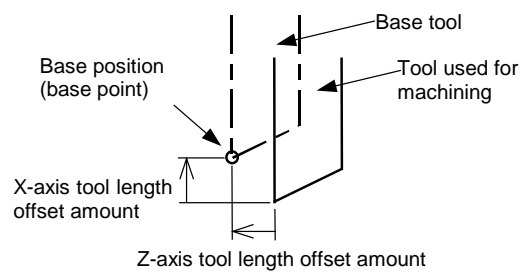
As the offset amounts, the tool length along the X, Z axes and additional axis and the wear amount along each of these axes, the nose radius and nose radius wear amount, tool tip point P and tool width can be registered.

Offset is provided in the directions of the X, Z axes and additional axis from the base position in the program. Generally, the center of the tool rest or the tip of the base tool is used as the programmed base position.

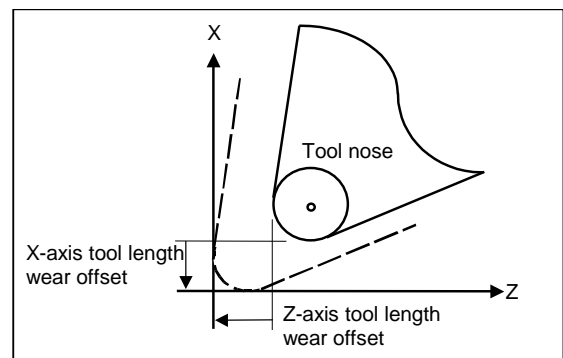
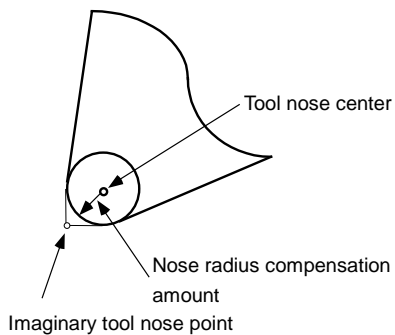
1. The programmed base position is the center of the tool rest:



2. The programmed base position is the tip of the base tool:



The tool tip contour arc radius (nose radius) of a non-rotary tool with an arc (nose radius) at its tip is registered as the nose radius offset amount.



The X-axis tool length offset amount, Z-axis tool length offset amount and nose radius compensation amount are set as plus amounts.

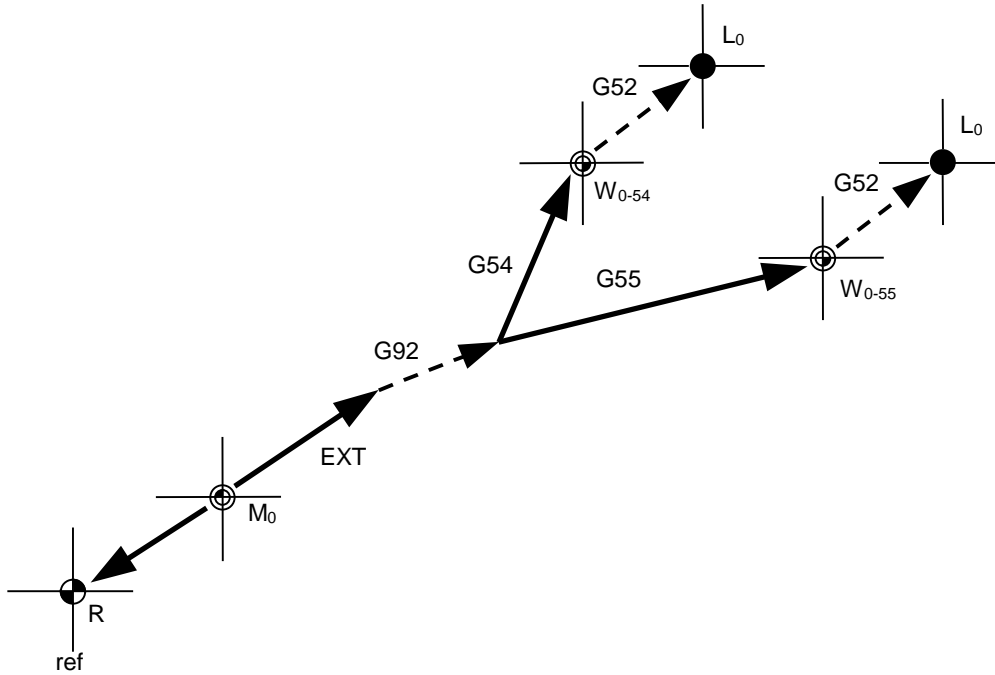
The offset type (1, 2 or 3) is set using a parameter.

## 10. Coordinate System

### 10.1 Coordinate System Type and Setting

The coordinate system handled by the NC is shown below.

The points that can be commanded with the movement command are points on the local coordinate system or machine coordinate system.



- $L_0$  Local coordinate system zero point
- G52 Local coordinate system offset \*1)
- $W_{0-54}$  Workpiece coordinate system zero point (G54)
- $W_{0-55}$  Workpiece coordinate system zero point (G55)
- G54 Workpiece coordinate system (G54) offset \*1)
- G55 Workpiece coordinate system (G55) offset
- G92 G92 coordinate system shift
- EXT External workpiece coordinate offset
- $M_0$  Machine coordinate system zero point
- ref Reference point

- ▶ Offset set with parameters
- - -▶ Offset set with program  
(0 when power is turned ON)

\*1) The G52 offset is available independently for G54 to G59.

## 10.1.1 Machine Coordinate System

M system : O

L system : O

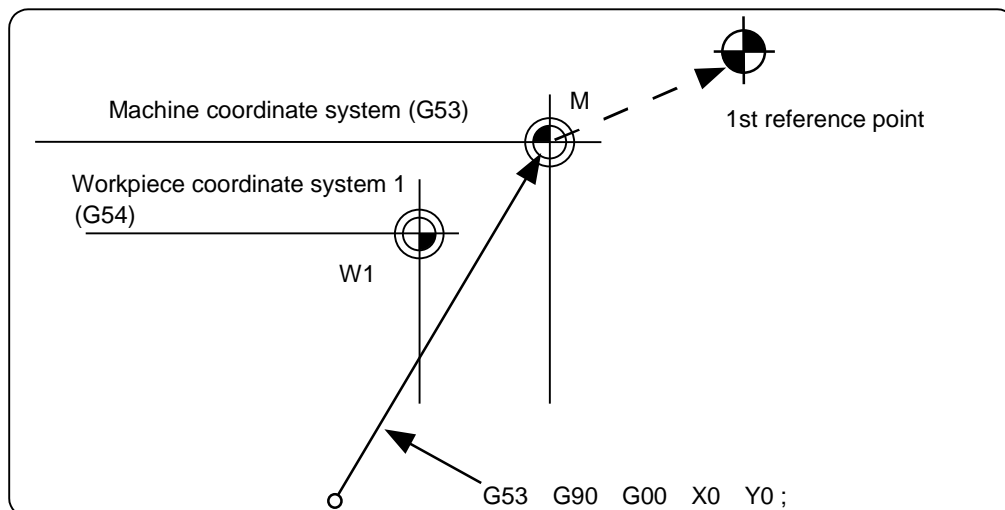
The machine coordinate system is used to express the prescribed positions (such as the tool change position and stroke end position) characteristic to the machine, and it is automatically set immediately upon completion of the first dog-type reference point return after the power has been turned ON or immediately after the power has been turned ON if the absolute position specifications apply.

The programming format for the commands to move the tool to the machine coordinate system is given below.

|               |              |              |   |
|---------------|--------------|--------------|---|
| <b>G53</b>    | <b>(G90)</b> | <b>(G00)</b> | <b>Xx1 Yy1 Zz1 ;</b>                                    |
| G53           |              |              | : Coordinate system selection                           |
| G90           |              |              | : Incremental/absolute commands                         |
| G00           |              |              | : Movement mode [M system]                              |
| Xx1, Yy1, Zz1 |              |              | : End point coordinate on the machine coordinate system |

If the incremental or absolute commands and movement mode have been omitted, operation complies with the modal command that prevails at the time.

G53 (movement on machine coordinate system) is an unmodal command which is effective only in the block where it is assigned. The workpiece coordinate system being selected is not changed by this command.



10.1.2 Coordinate System Setting

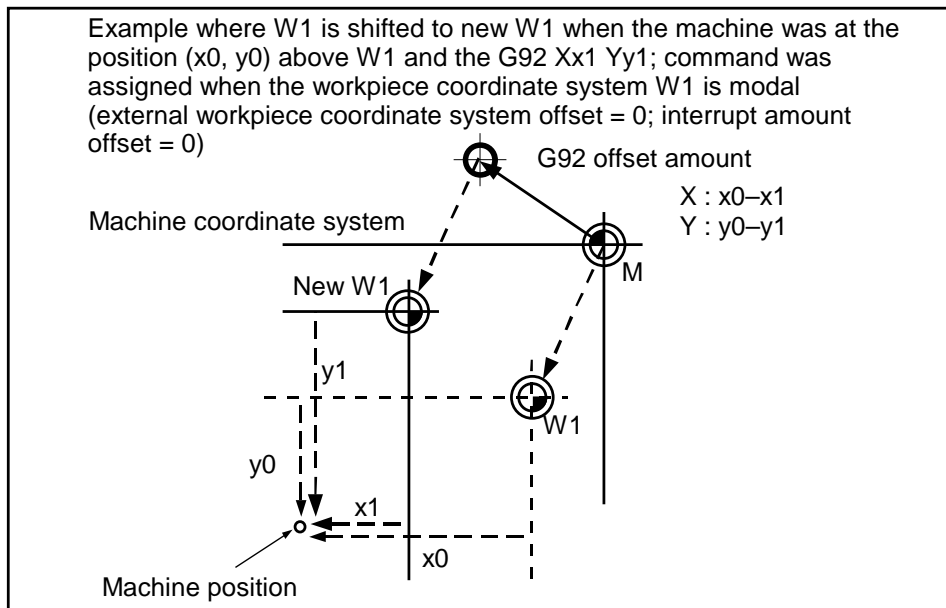
M system : ○

L system : ○

By giving a G92 command, the program coordinate system (zero point of program) can be changed on the workpiece coordinate system.

When a coordinate system setting is assigned using the G92 command, the G92 offset amount is applied so that the machine position in the current workpiece coordinate system is set to the coordinate values assigned by the G92 command, as shown in the figure below, and the workpiece coordinate systems are shifted accordingly. The machine does not run, and all the workpiece coordinate systems from G54 to G59 referenced to the machine coordinate system (or the external workpiece coordinate system if the external workpiece coordinate offset has been set) are shifted.

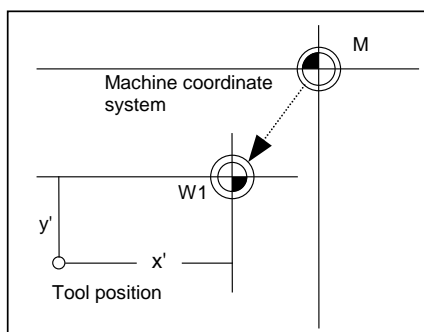
Offset of coordinate system by G92 coordinate system setting



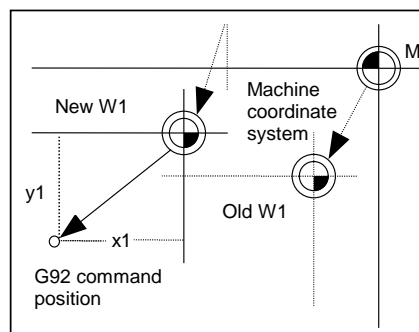
The shifted coordinate system is returned to its original position by dog-type reference point return or the program.

When the coordinate system setting is commanded by G92, all the workpiece coordinate systems from G54 through G59 referenced to the machine coordinate system undergo a shift.

Coordinate system created by automatic coordinate system setting



Coordinate system after coordinate system setting by G92



- (1) All the workpiece coordinates from G54 to G59 move in parallel.
- (2) There are two ways to return a shifted coordinate system to its original position.
  - (a) Carry out dog-type reference point return
  - (b) Move to machine coordinate system zero point and assign G92 and G53 commands in same block to set the machine coordinate system.

|                     |   |
|---------------------|---|
| G90 G53 G00 X0 Y0 ; | Positioning at machine coordinate system zero point.                                    |
| G92 G53 X0 Y0 ;     | Coordinate system zero setting in machine coordinate system.                            |
|                     | This returns all the workpiece coordinates from G54 to G59 to their original positions. |

### 10.1.3 Automatic Coordinate System Setting

**M system :** ○

**L system :** ○

After the power is turned ON, the basic machine coordinate system and the workpiece coordinate system are automatically set without executing the zero point return.

The coordinate systems created are given below.

- (1) Machine coordinate system corresponding to G53
- (2) G54 to G59 workpiece coordinate system
- (3) Local coordinate systems created under G54 to G59 workpiece coordinate systems

The distances from the zero point of G53 machine coordinate system are set to the controller coordinate related parameters. Thus, where the No. 1 reference point is set in the machine is the base for the setting.

10.1.4 Workpiece Coordinate System Selection

10.1.4.1 Workpiece coordinate system selection (6 sets) G54 to G59

M system : ○                      L system : ○

When multiple workpieces with the same shape are to be machined, these commands enable the same shape to be machined by executing a single machining program in the coordinate system of each workpiece. Up to 6 workpiece coordinate systems can be selected.

The G54 workpiece coordinate system is selected when the power is turned ON or the reset signal which cancels the modal information is input.

| G code | Function                           |
|--------|------------------------------------|
| G54    | Workpiece coordinate system 1 (W1) |
| G55    | Workpiece coordinate system 2 (W2) |
| G56    | Workpiece coordinate system 3 (W3) |
| G57    | Workpiece coordinate system 4 (W4) |
| G58    | Workpiece coordinate system 5 (W5) |
| G59    | Workpiece coordinate system 6 (W6) |

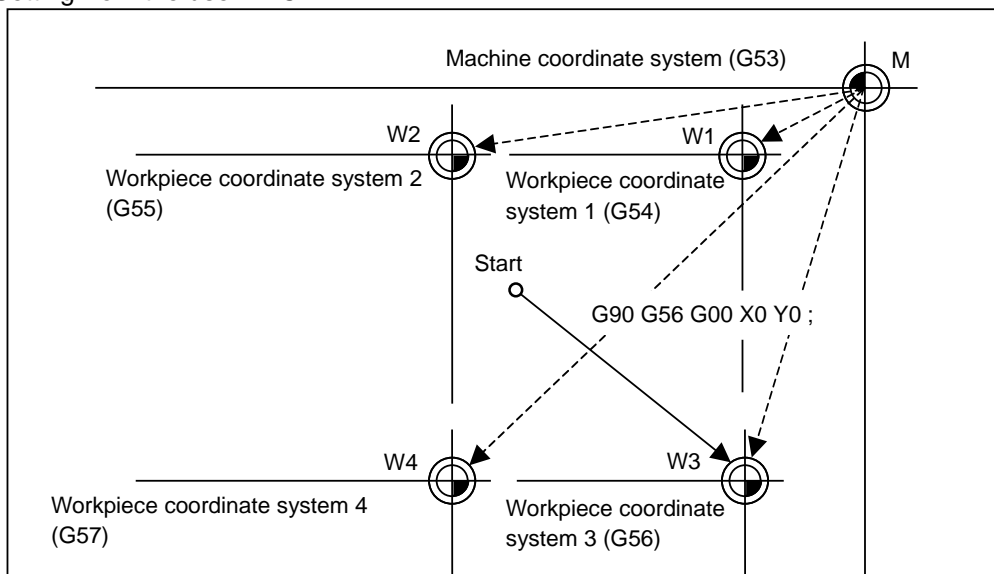
The command format to select the workpiece coordinate system and to move on the workpiece coordinate system are given below.

```
(G90) G54 G00 Xx1 Yy1 Zz1 ;
(G90)      : (Absolute command)
G54       : Coordinate system selection
G00       : Movement mode
Xx1, Yy1, Zz1 : Coordinate position of end point
```

The workpiece coordinate zero points are provided as distances from the zero point of the machine coordinate system.

Settings can be performed in one of the following three ways:

- (a) Setting using the setting and display unit
- (b) Setting using commands assigned from the machining program
- (c) Setting from the user PLC



## 10.1.4.2 Extended workpiece coordinate system selection (48 sets) G54.1P1 to P48

**M system :** Δ**L system :** -

When multiple workpieces with the same shape are to be machined, these commands enable the same shape to be machined by executing a single machining program in the coordinate system of each workpiece. In addition to the six workpiece coordinate systems G54 to G59, 48 workpiece coordinate systems can be used by assigning G54.1Pn command.

The command format to select the workpiece coordinate system using the G54.1Pn command and to move on the workpiece coordinate system are given below.

|  |
|--|
| <b>(G90) G54.1Pn G00 Xx1 Yy1 Zz1 ;</b>           |
| G90 : (Absolute command)                         |
| G54.1Pn : Coordinate system selection            |
| G00 : Movement mode                              |
| Xx1, Yy1, Zz1 : Coordinate position of end point |

The numerical value n of P following G54.1 indicates each workpiece coordinate system. Specify a value between 1 and 48.

The workpiece coordinate zero points are provided as distances from the zero point of the machine coordinate system.

Settings can be performed in one of the following three ways:

- Setting using the setting and display unit
- Setting using commands assigned from the machining program
- Setting from the user PLC

**(Note 1)** While the G54.1Pn (extended workpiece coordinate system selection) is modal, the local coordinate offset is reduced to zero, and the G52 command cannot be used.



10.1.5 External Workpiece Coordinate Offset

M system : ○

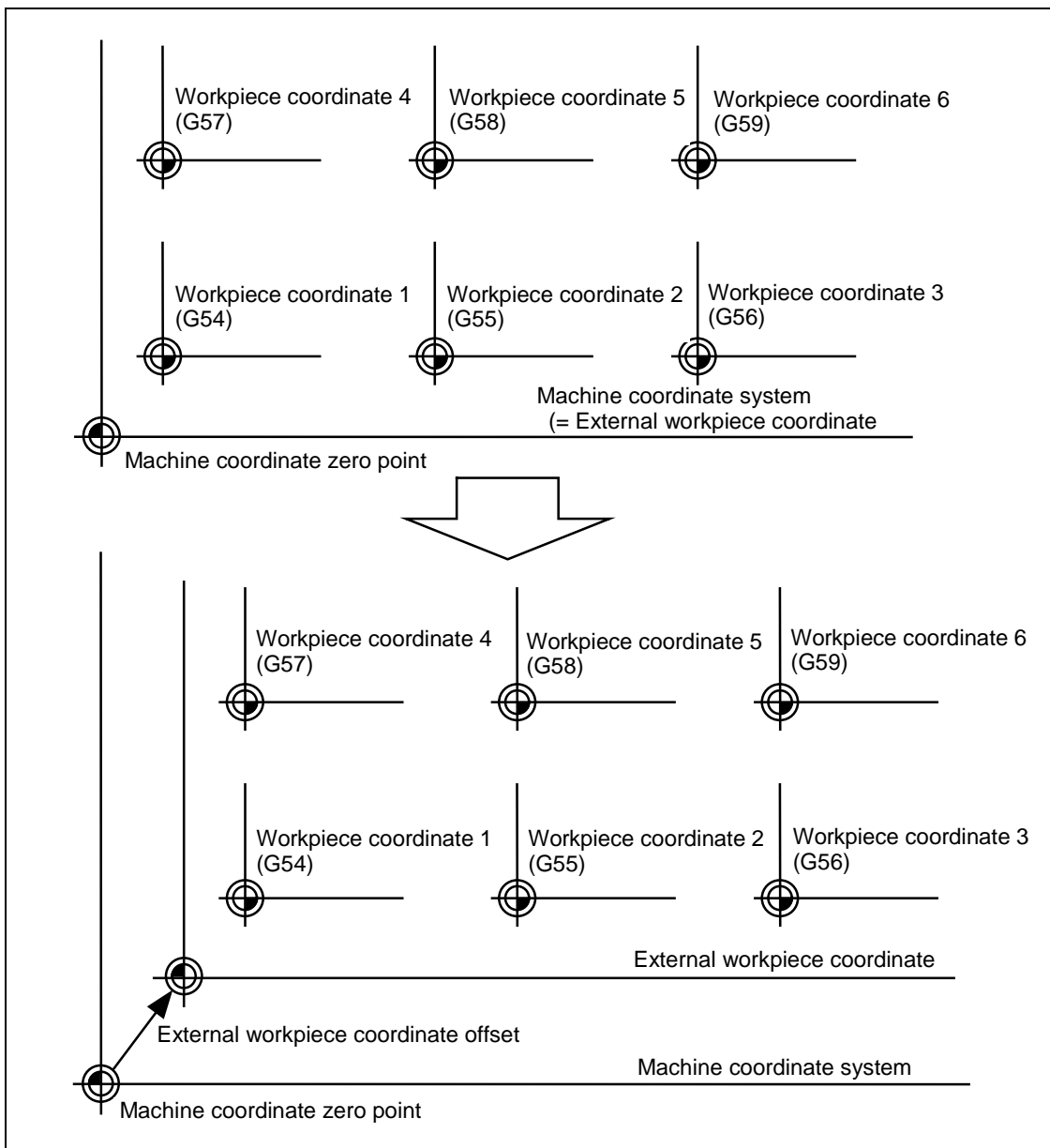
L system : ⊙

An external workpiece coordinate offset that serves as a reference for all the workpiece coordinate systems is available outside the workpiece coordinates.

By setting the external workpiece coordinate offset, the external workpiece coordinate system can be shifted from the machine coordinate system, and all the workpiece coordinate systems can be simultaneously shifted by an amount equivalent to the offset.

When the external workpiece coordinate offset is zero, the external workpiece coordinate systems coincide with the machine coordinate system.

It is not possible to assign movement commands by selecting the external workpiece coordinates.



10.1.7 Local Coordinate System

M system : ○

L system : ○

This function is for assigning a coordinate system on the workpiece coordinate system currently being selected. This enables the workpiece coordinate system to be changed temporarily. The local coordinate system can be selected independently on each workpiece coordinate system G54 to G59.

| G code  | Function   |
|---------|--|
| G54 G52 | Local coordinate system on the workpiece coordinate system 1 |
| G55 G52 | Local coordinate system on the workpiece coordinate system 2 |
| G56 G52 | Local coordinate system on the workpiece coordinate system 3 |
| G57 G52 | Local coordinate system on the workpiece coordinate system 4 |
| G58 G52 | Local coordinate system on the workpiece coordinate system 5 |
| G59 G52 | Local coordinate system on the workpiece coordinate system 6 |

The command format of the local coordinate system is given below.

```
(G54) G52 Xx1 Yy1 Zz1 ;
(G54)           : Workpiece coordinate system selection
G52             : Local coordinate system setting
Xx1, Yy1, Zz1  : Local coordinate offset amount
```

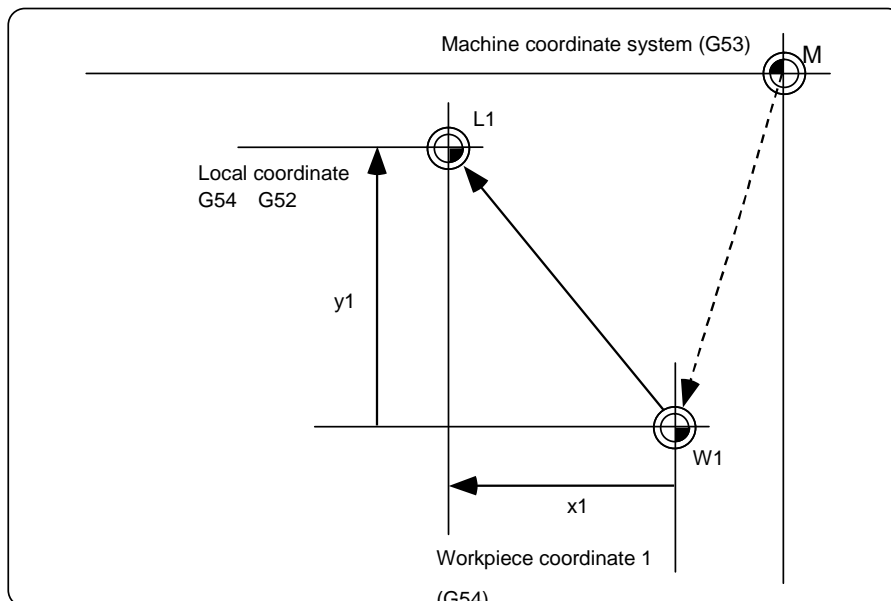
The local coordinate zero points are provided as distances from the zero point of the designated workpiece coordinate system (local coordinate offset).

In the incremental value mode, the position obtained by adding the local coordinate offset amount to the previously specified offset amount serves as the new local coordinate zero point.

If no workpiece coordinates are designated, the local coordinates will be created on the currently selected workpiece coordinates.

This command is unmodal but the local coordinate system created by G52 is valid until the next G52 command is issued.

The local coordinate system is canceled by the input of the reset signal or by manual or automatic dog-type reference point return.



### 10.1.8 Coordinate System for Rotary Axis

**M system** : ○

**L system** : ○

The coordinate system of the rotary axis ranges from 0 to  $\pm 360^\circ$ . Note that, however, it can be displayed from 0 to 359.999.

In absolute value command mode, the rotary axis can make a turn or less (not greater than  $\pm 360^\circ$ ). The turning direction depends on the specified sign. A negative sign (-) turns the axis in the negative direction and a positive sign (+) turns it in the positive (+) direction.

Note that a parameter can be used to move the axis to the end point taking a short cut.

In incremental value command mode, the rotary axis moves the specified distance only.

### 10.1.9 Plane Selection

**M system** : ○

**L system** : ○

G17, G18, and G19 are for specifying the planes for the arc, tool radius compensation, coordinate rotation and other commands.

|                    |                         |
|--------------------|-------------------------|
| <b>G17</b> ; ..... | Xp-Yp plane designation |
| <b>G18</b> ; ..... | Zp-Xp plane designation |
| <b>G19</b> ; ..... | Yp-Zp plane designation |

- (1) A parameter can be used to set either the X, Y or Z axis to which the additional axis is to be parallel.
- (2) A parameter can be used to set the initialization status (when the power has been turned ON or when the reset status has been entered) to G17, G18 or G19.
- (3) The movement commands have no connection with the plane selection.

#### Example

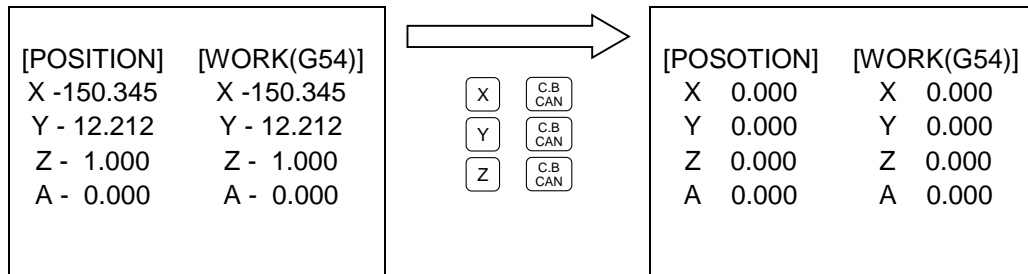
|                  |   |
|------------------|---|
| G19 X100. ;      | With these program commands, X100. is the axis which does not exist on the G19 (Yp, Zp) plane, Yp-Zp are selected by G19 and the X axis moves by 100. mm separately from the plane selection. |
| G17 X100. R50. ; | With these program commands, the Xp-Yp plane is selected by G17 and the arc command is controlled on the X-Y plane by this command.   |

## 10.1.10 Origin Set/Origin Cancel

M system : ○

L system : ○

Using the CNC monitor, the coordinate system (current position and workpiece coordinate position) can be set to "0" by screen operations. This function is the same as the coordinate system setting command "G92 X0 (Y0 or Z0) ;".



When axes are set to "0" in order, the Y and Z axis can be set by pressing C.B  
CAN key successively without pressing Y and Z keys.

## 10.1.11 Counter Set

M system : ○

L system : ○

Using CNC monitor, the position counter display can be changed to "0" by screen operations.

- (1) This operation is the same as the operation of "Origin Set", but press INPUT key instead of C.B  
CAN key.
- (2) Only the [POSITION] counter display is changed to "0", and the other coordinate system counter displays are not changed.

10.2 Return

10.2.1 Manual Reference Position Return

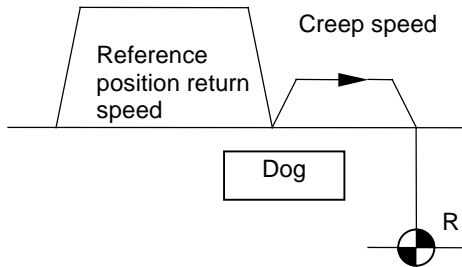
M system : ○

L system : ○

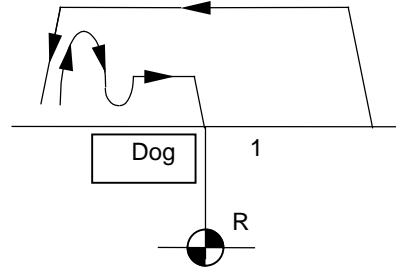
This function enables the tool to be returned manually to the machine's default position (reference position).

(1) Return pattern to reference point

(a) Dog type

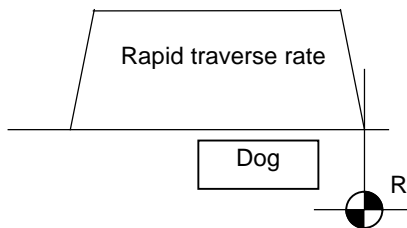


When starting in same direction as final advance direction



When starting in opposite direction as final advance direction

(b) High-speed type



(2) Differences according to detection method

|                                       | First return after power ON | Second return and following                  |
|---------------------------------------|-----------------------------|--|
| Incremental position detection method | Dog-type                    | High-speed/Dog-type (switching by parameter) |
| Absolute position detection method    | High-speed                  | High-speed                                   |

10.2.2 Automatic 1st Reference Position Return

M system : O

L system : O

The machine can be returned to the first reference point by assigning the G28 command during automatic operation. If the interim point is commanded, the machine is moved up to that point by rapid traverse so that it is positioned and then returned separately for each axis to the first reference point. Alternatively, by assigning the G29 command, the machine can be first positioned separately for each axis at the G28 or G30 interim point, and then positioned at the command position.

| G code | Function   |
|--------|--|
| G28    | Automatic 1st reference point return   |
| G29    | Start position return (The tool first returns to the interim position of the 1st reference point return start from the 1st reference point, and then is positioned at the position designated in the program.) |

The G28 programming format is given below.

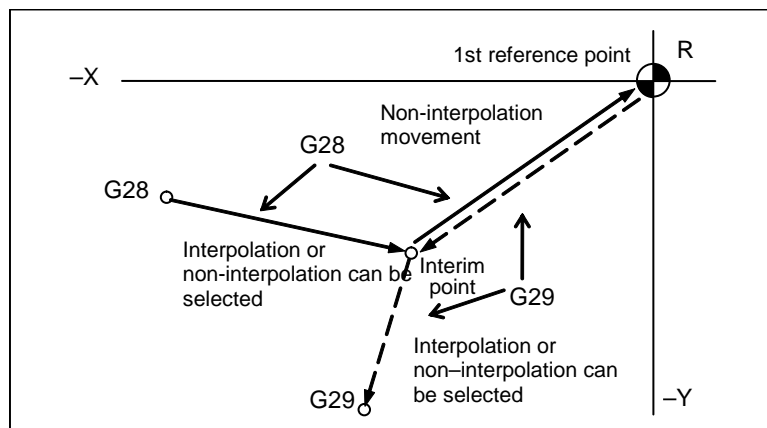
```
G28 Xx1 Yy1 Zz1 ;
G28          : Return command
Xx1, Yy1, Zz1 : Return control axes (interim point)
```

Each axis is first positioned by rapid traverse to the position (interim point) assigned for the assigned axis and then is returned independently to the 1st reference point.

The G29 programming format is given below.

```
G29 Xx1 Yy1 Zz1 ;
G29          : Return command
Xx1, Yy1, Zz1 : Return control axes (assigned position)
```

The tool is first moved by rapid traverse to the interim position which is passed through with G28 or G30, and is then positioned by rapid traverse at the position assigned by the program.



If the position detector is for the incremental detection system, the first reference point return for the first time after the NC power has been turned ON will be the dog-type. However, the second and subsequent returns are to be the high-speed type.

The high-speed type is always used when the position detector is for the absolute position detection system.

- (Note 1)** The automatic 1st reference point return pattern is the same as for manual reference point return.
- (Note 2)** The number of axes for which reference point return can be performed simultaneously depends on the number of simultaneously controlled axes.
- (Note 3)** If, at the time of the first reference point return, the tool radius compensation or nose radius compensation has not been canceled, it will be temporarily canceled by the movement to the interim point. The compensation is restored by the next movement after the return.
- (Note 4)** If, at the time of the first reference point return, the tool length offset has not been canceled, the offset will be canceled by the movement from the interim point to the first reference point, and the offset amount will also be cleared. It is possible to cancel the tool length offset temporarily using a parameter instead. In this case, however, the offset is restored by the next movement command.
- (Note 5)** Interpolation or non-interpolation can be selected using a parameter for the movement up to the G28 interim point or for the movement from the G29 interim point to the command point. Non-interpolation applies for movement from the G28 interim point to the reference point and movement up to the G29 interim point.
- (Note 6)** The machine will not stop at the interim point even when a single block is selected.

## 10.2.3 2nd, 3rd, 4th Reference Position Return

M system : ○

L system : ○

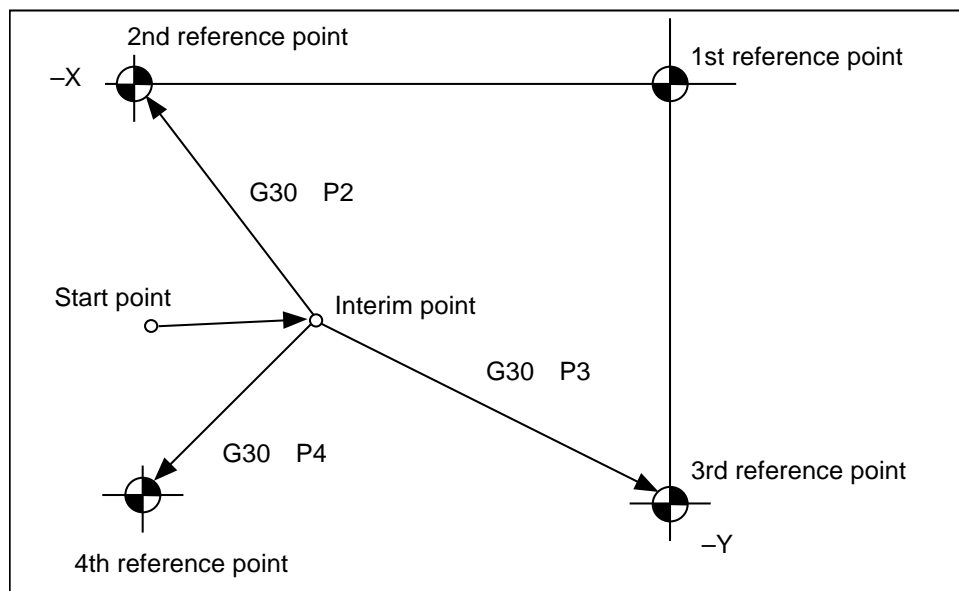
As with automatic 1st reference point return, commanding G30Pn during automatic operation enables the tool to be returned to the set points (2nd, 3rd or 4th reference points) characteristic to the machine. The 2nd, 3rd and 4th reference points can be set by parameters.

| G code | Function                   |
|--------|----------------------------|
| G30 P2 | 2nd reference point return |
| G30 P3 | 3rd reference point return |
| G30 P4 | 4th reference point return |

The G30 programming format is given below.

|               |                                       |
|---------------|---------------------------------------|
| <b>G30</b>    | <b>Xx1 Yy1 Zz1 Pp1 ;</b>              |
| G30           | : Return command                      |
| Xx1, Yy1, Zz1 | : Return control axes (interim point) |
| Pp1           | : Return position No.                 |

The tool is first positioned by rapid traverse to the interim point commanded for the assigned axis and then is returned independently to the reference point.



- (Note 1)** The second reference point return is performed if the P address is omitted.
- (Note 2)** The number of axes for which reference point return can be performed simultaneously depends on the number of simultaneously controlled axes.
- (Note 3)** If, at the time of the reference point return, the tool radius compensation has not been canceled, it will be temporarily canceled by the movement up to the interim point. The compensation is restored by the next movement command after the return.
- (Note 4)** If, at the time of the reference point return, the tool length offset has not been canceled, it will be canceled and the offset amount also cleared upon completion of reference point return. The tool length offset can also be canceled temporarily using a parameter. In this case, however, the tool offset is restored by the next movement command.
- (Note 5)** Whether interpolation or non-interpolation is to apply to the movement up to the interim point can be selected using a parameter. Non-interpolation applies for movement from the interim point to each of the reference points.
- (Note 6)** The machine will not stop at the interim point even when a single block is selected.



### 10.2.4 Reference Position Check

**M system** : ○

**L system** : ○

By commanding G27, a machining program, which has been prepared so that the tool starts off from the reference point and returns to the reference point, can be checked to see whether the tool will return properly to the reference point.

The G27 programming format is given below.

|               |            |            |            |            |                                    |
|---------------|------------|------------|------------|------------|------------------------------------|
| <b>G27</b>    | <b>Xx1</b> | <b>Yy1</b> | <b>Zz1</b> | <b>Pp1</b> | <b>;</b>                           |
| G27           |            |            |            |            | : Verification command             |
| Xx1, Yy1, Zz1 |            |            |            |            | : Return control axes              |
| Pp1           |            |            |            |            | : Verification No.                 |
|               |            |            |            | P1         | : 1st reference point verification |
|               |            |            |            | P2         | : 2nd reference point verification |
|               |            |            |            | P3         | : 3rd reference point verification |
|               |            |            |            | P4         | : 4th reference point verification |

The assigned axis is first positioned by rapid traverse to the commanded position and then, if this is the reference point, the reference point arrival signal is output.

When the address P is omitted, the first reference point verification will be applied.

- (Note 1)** The number of axes for which reference point verification can be performed simultaneously depends on the number of simultaneously controlled axes.
- (Note 2)** An alarm results unless the tool is positioned at the reference point upon completion of the command.
- (Note 3)** Whether interpolation or non-interpolation is to apply to the movement can be selected using a parameter.

## 10.2.5 Absolute Position Detection

M system : Δ

L system : Δ

The absolute position detection function holds the relation of the actual machine position and the machine coordinates in the controller with a battery even when the power is turned OFF. When the power is turned ON again, automatic operation can be started without executing reference point return. (High-speed return will always be used for the reference point return command.)

For the absolute position detection method, there are two method such as the dog-type and dog-less type according to how the zero point is established.

| Method        |                               | Details  | Establishment of zero point   | Adjustment of zero point position  |  |
|---------------|-------------------------------|--|---|--|--|
| Dog-less type | Machine end stopper method    | Manual   | The zero point is established by manually pressing the machine against a set point on the machine.  | The zero point is established when a torque limit is applied on the servo and the torque limit is reached by pressing against the machine stopper. | The value equivalent to the shift amount is set in the absolute position setting screen. |
|               |                               | Automatic  | The zero point is established by automatically pressing the machine against a set point on the machine.   | The zero point is established when a torque limit is applied on the servo and execute an automatic pressing twice.                                 |  |
|               | Marked point alignment method | Method I   | The zero point is established by aligning with a marked point on the machine. It is established after aligning with a marked point and then returning to the grid point.    | The zero point is established by input in the absolute position setting screen.  | The value equivalent to the shift amount is set in the absolute position setting screen. |
|               |                               | Method II  | The zero point is established by aligning with a marked point on the machine. It is established after aligning with a marked point and but not returning to the grid point. |  |  |
| Dog-type      |                               | Same method as the dog-type of incremental detection method. | The zero point is established with dog-type reference point return completion.  | The value is set in the parameter of zero point shift amount.  |  |

## Diagnosis during absolute position detection

- (1) The machine position at power OFF and ON can be confirmed on the absolute position monitor screen.
- (2) If the amount that the axis is moved during power OFF exceeds the tolerable value (parameter), a warning signal will be output.
- (3) An alarm will be output if the absolute position information is lost.
- (4) An alarm will be output if the voltage of the battery for backing up the absolute position data drops.

# 11. Operation Support Functions



## 11.1 Program Control

### 11.1.1 Optional Block Skip

M system : ○

L system : ○

When "/" (slash code) is programmed at the head of a block, and the optional block skip input signal from the external source is turned ON for automatic operation, the block with the "/" code is skipped. If the optional block skip signal is turned OFF, the block with the "/" code will be executed without being skipped.

| Programming example | Optional block skip  |   |
|---------------------|--|---|
|                     |  Switch OFF |  Switch ON |
| N1 ;                | N1   | N1  |
| N2 ;                | N2   | N2  |
| N3 ;                | N3   | N3  |
| /1N4 ; (Note 2)     | N4   | <div style="border: 1px dashed black; height: 20px; width: 100%;"></div>                    |
| /2N5 ;              | N5   |   |
| N6 ;                | N6   | N6  |
| N7 ;                | N7   | N7  |
| :                   | :  | :   |

Optional block skip 1 is ON

Optional block skip 2 is ON

(Note 1) There are nine optional block skip switches corresponding to "/".

(Note 2) "1" of "/1N4" can be omitted.

### 11.1.2 Optional Block Skip Addition

M system : ○

L system : ○

When "/n (n:1 to 9)" (slash code) is programmed at the head of a block, and the optional block skip n input signal from the external source is turned ON for automatic operation, the block with the "/n" code is skipped.

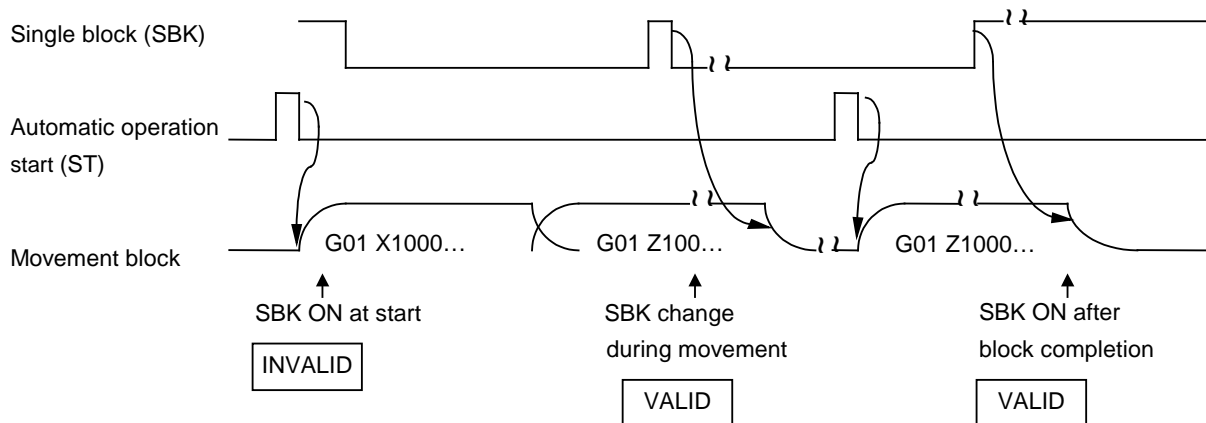
11.1.3 Single Block

M system : ○

L system : ○

The commands for automatic operation can be executed one block at a time (block stop) by turning ON the single block input signal. When the single block input signal is turned ON temporarily during continuous operation, the machine will stop after that block has been executed.

When operation is switched to another automatic operation mode (for example, memory operation mode to MDI operation mode) during continuous operation, the machine will stop after that block has been executed. Single block in the multi-part system also functions as the above single block in each independent part system.



## 11.2 Program Test

### 11.2.1 Dry Run

**M system :** ○

**L system :** ○

F code feed commands for automatic operation can be switched to the manual feed rate data of the machine operation board by turning ON the dry run input signal.

| Command                      | Dry run switch ON                  |                                   |
|------------------------------|------------------------------------|-----------------------------------|
|                              | Rapid traverse selector switch OFF | Rapid traverse selector switch ON |
| G00, G27, G28, G29, G30, G60 | Manual feed rate ( <b>Note 1</b> ) | Rapid traverse rate               |
| G01, G02, G03                | Manual feed rate                   | Cutting clamp speed               |

**(Note 1)** The dry run should be valid by the parameter setting.

### 11.2.2 Machine Lock

**M system :** ○

**L system :** ○

When the machine lock input signal is set to ON, the NC operations can be executed without actually moving the NC axis.

The command speed is the feed rate during machine lock.

Cutting override and rapid traverse override are valid.

The M, S, T and B commands are executed as usual, and so machine lock is completed by returning the FIN signal.

- (1) Reference point return (manual, G28, G29, G30) is controlled as far as the interim point in the machine lock status but when the interim point is reached the counter is moved to the zero point and the block is completed.
- (2) Machine lock is effective in the signal status applying when the axis has stopped.
- (3) Block stop will be applied if the machine lock signal is turned ON and OFF or OFF and ON during automatic operation.
- (4) On PLC programming, the signal for machine lock has for automatic operation and manual operation of each axis. Normally, all signals are simultaneously turned ON and OFF. However when Z axis cancellation function is executed, the machine lock signal for Z axis is turned ON and OFF.

### 11.2.3 Miscellaneous Function Lock

**M system :** ○

**L system :** ○

The M, S, T and B (2nd miscellaneous function) output signals are not output to the machine or PLC when the miscellaneous function lock signal of external input is turned ON. This function can be used when checking only the movement commands in a program check.

The start signals of the M command are output for the M00, M01, M02 and M30 commands, and so a completion signal must be returned.

- (1) Fixed cycle spindle functions containing an S code and any M, S, T or B function assigned by a manual numerical command or in automatic operation will not be executed. The code data and strobe (MF, SF, TF, BF) outputs are stopped.
- (2) If this signal is set ON after the code data has already been output, the output is executed as it would normally be executed until the end (until FIN1 or FIN2 is received and the strobe is turned OFF).
- (3) Even when this signal is ON, the M00, M01, M02 and M30 commands among the miscellaneous functions are executed, and the decode signal, code data and strobe signals are also output as they would be normally.
- (4) Any miscellaneous functions which are executed only inside the controller and not output (M96, M97, M98, M99) are executed as they would be normally even if this signal is ON.

## 11.3 Program Search/Start/Stop

### 11.3.1 Program Search

**M system :** ○                      **L system :** ○

The program No. of the program to be operated automatically can be designated and called up. Upon completion of search, the head of the program searched is displayed. Machining programs are stored in the memory inside the NC system.

### 11.3.2 Sequence Number Search

**M system :** ○                      **L system :** ○

Blocks can be indexed by setting the program No., sequence No. and block No. of the program to be operated automatically.

The searched program is displayed upon completion of the search. Machining programs are stored in the memory inside the NC system.

### 11.3.4 Program Restart

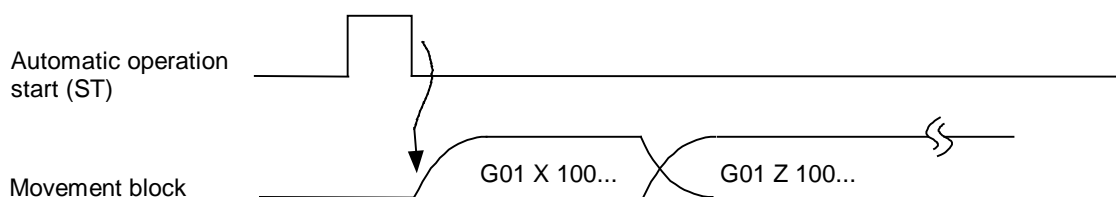
**M system :** Δ                      **L system :** Δ

When resuming a machining program after a suspension due to tool damage or other reasons, this function searches the program and the block to be resumed and enables machining to be resumed from the block. This search function is different from the regular operation search in that this runs a program search while updating coordinate values and modal data as when the program is actually being operated. Thus it enables to resume machining in the middle of a program as if it had been continuously operated from the beginning without a suspension.

### 11.3.5 Automatic Operation Start

**M system :** ○                      **L system :** ○

With the input of the automatic operation start signal (change from ON to OFF), automatic operation of the program that was found by an operation search is started by the controller (or the halted program is restarted).



Automatic operation startup is performed on a part system by part system basis.

11.3.6 NC Reset

M system : ○

L system : ○

This function enables the controller to be reset.

|   | Signal name               | Reset 1                 | Reset 2                  | Reset & Rewind                          |
|---|---------------------------|-------------------------|--------------------------|---|
| 1 | G command modals          | Retained                | Initialized              | Initialized                             |
| 2 | Tool compensation data    | Retained                | Canceled (no operations) | Canceled                                |
| 3 | Memory indexing           | Executed                | Not executed             | Executed                                |
| 4 | Errors/alarms             | Reset                   | Reset                    | Reset                                   |
| 5 | M, S and T code outputs   | Retained                | Retained                 | Retained                                |
| 6 | M code independent output | OFF                     | OFF                      | OFF                                     |
| 7 | Control axis moving       | Decelerated and stopped | Decelerated and stopped  | Decelerated and stopped                 |
| 8 | Output signals            | "In reset" signal       | "In reset" signal        | "In reset" signal<br>"In rewind" signal |

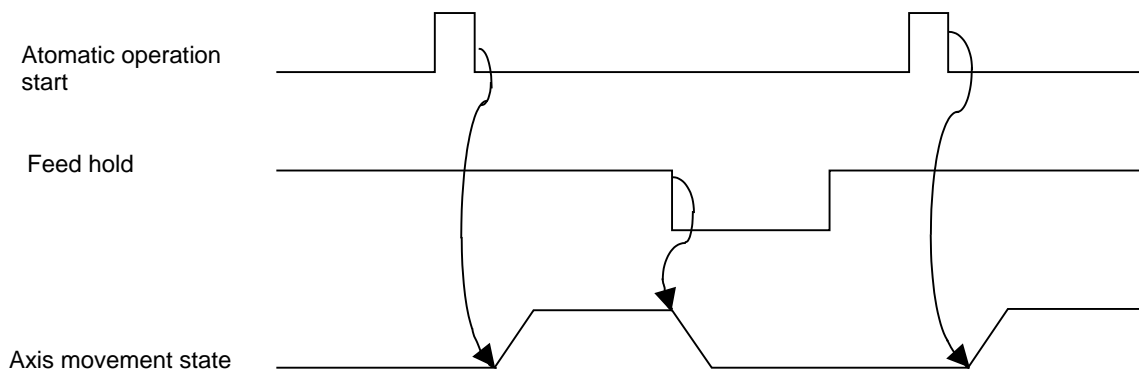
11.3.7 Feed Hold

M system : ○

L system : ○

When the feed hold signal is set to ON during cycle start, the machine feed is immediately decelerated and stopped. The machine is started again by the "Automatic operation start (cycle start)" signal.

- (1) When the feed hold mode is entered during cycle start, the machine feed is stopped immediately, but the M, S, T and B commands in the same block are still executed as programmed.
- (2) When the mode is switched during automatic operation to manual operation (jog feed, handle feed or incremental feed), the feed hold stop mode is entered.
- (3) An interrupt operation based on manual operation (jog feed, handle feed or incremental feed) can be executed during feed hold.



11.3.8 Search & Start

M system : ○

L system : ○

If the "Search & Start" signal is input when the memory mode is selected, the designated machining program is searched and executed from the beginning.

If the search & start signal has been input during automatic operation in the memory mode, search & start is executed after resetting.

The machining program No. to be searched are designated by PLC program.

11.4 Interrupt Operation

11.4.1 Manual Interruption

M system : ○

L system : ○

Manual interrupt is a function that enables manual operations to be performed during automatic operation. The systems used to select the operation mode are as follows:

- System which initiates the interrupt by switching from the automatic mode to manual mode
- System which initiates the interrupt by selecting the manual mode at the same time as the automatic mode  
(Refer to "11.4.9 Simultaneous Operation of Manual and Automatic Modes".)

Whether the manual interrupt amount is to be retained and automatic operation is to be continued is determined by setting manual absolute mode ON or OFF (refer to "11.4.3 Manual Absolute Mode ON/OFF").

11.4.2 Automatic Operation Handle Interruption

M system : ○

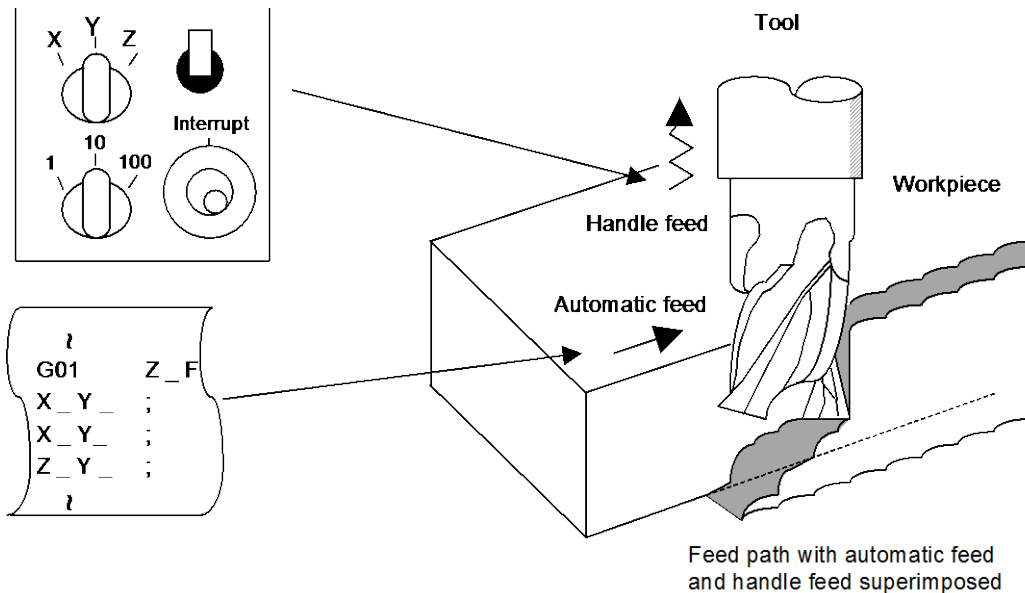
L system : ○

The handle command can interrupt and be superimposed onto a command without suspending automatic operation, and the machine can be moved by rotating the manual pulse generator during automatic operation.

If the spindle load is greatly exceeded when cutting a workpiece as per the machining program due to a high rough cutting amount in face machining, for instance, automatic handle interrupt makes it possible to raise the Z surface and reduce the load easily without suspending feed in the automatic operation mode.

Automatic handle interrupt is conducted by setting the "automatic handle interrupt" valid switch which is provided separately from the "manual operation mode". The axis selection and pulse scale factor operation are conducted as for manual handle feed.

Whether, after an interrupt, to return to the path of the machining program by automatic operation or remain offset by the amount equivalent to the interrupt amount is determined using a parameter.



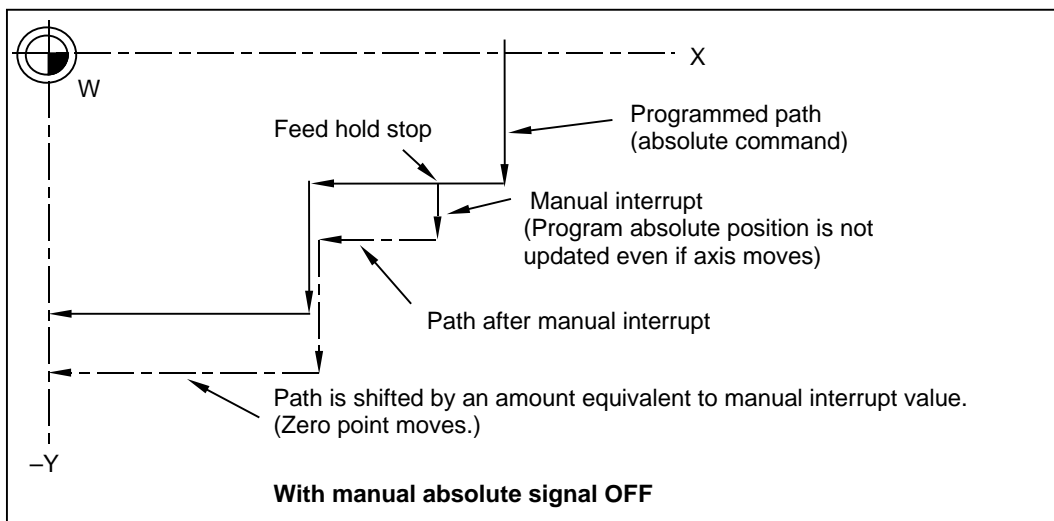
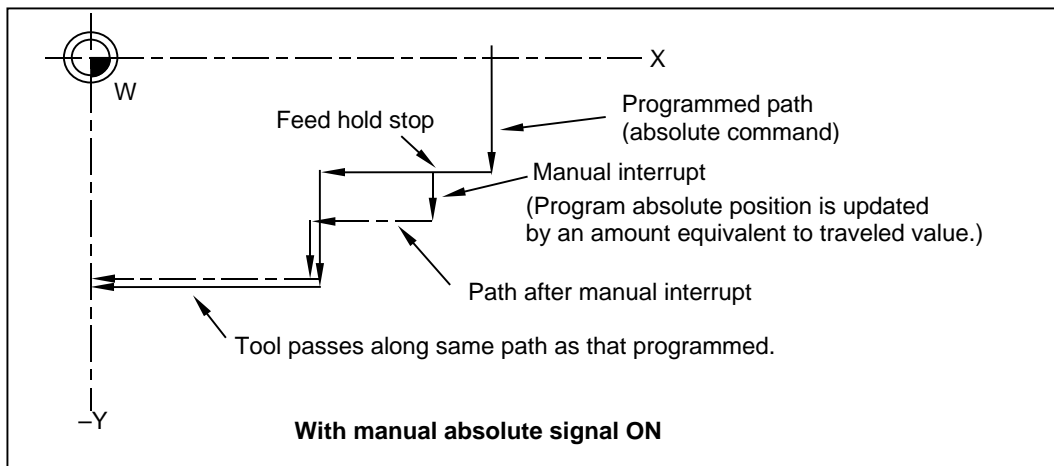


11.4.3 Manual Absolute Switch

M system : ○

L system : ○

The program absolute positions are updated by an amount equivalent to the distance by which the tool is moved by hand when the manual absolute switch signal is turned ON. In other words, the coordinate system based on the original program will not shift even if the tool (machine) is moved by hand. Thus, if automatic operation is started in this case, the tool will return to the path before manual movement.

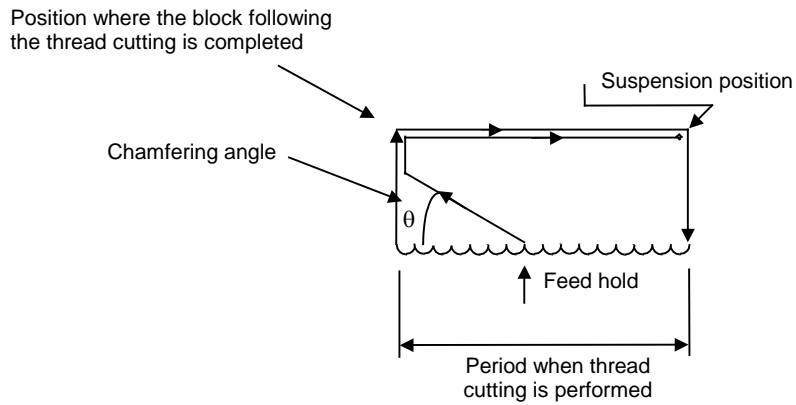


## 11.4.4 Thread Cutting Cycle Retract

**M system : -****L system :  $\Delta$** 

This function enables to interrupt machining process without damaging a thread ridge when a feed hold signal has been input during thread cutting process in a thread cutting cycle.

If a feed hold signal is input during chamfering or thread cutting without chamfering, operation stops at the position where the block following the thread cutting is completed.

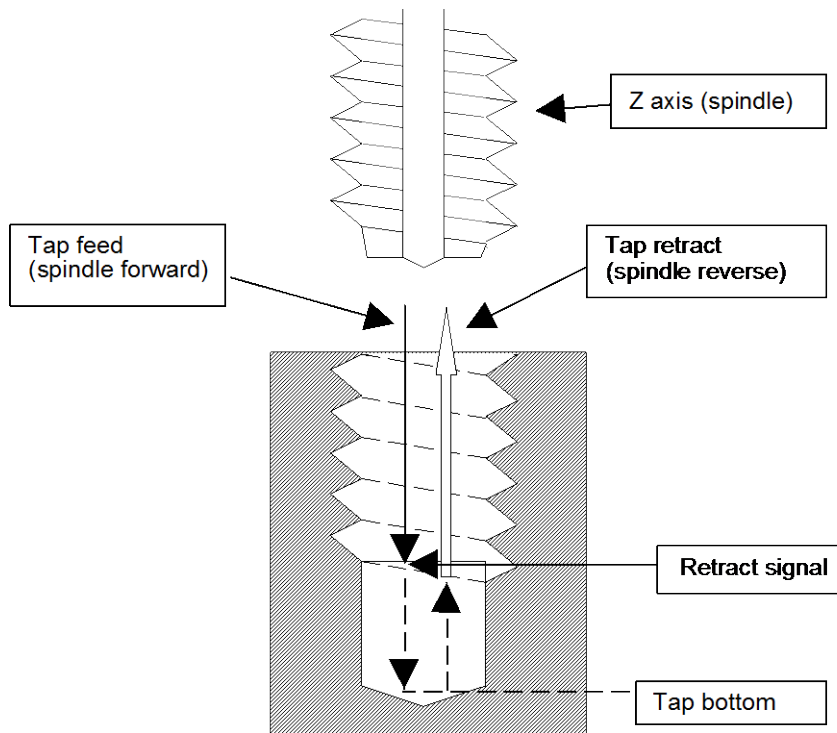


## 11.4.5 Tapping Retract

M system : O

L system : O

If tapping is interrupted by a reset or emergency stop signal that is input during tapping and the tap is left engaged inside the workpiece, the tap tool engaged inside the workpiece can be rotated in the reverse direction so that it will be disengaged by inputting the tap retract signal.



This function can be used by an interruption initiated by reset or emergency stop. A return is made to the initial point by tap retract.

## 11.4.6 Manual Numerical Value Command

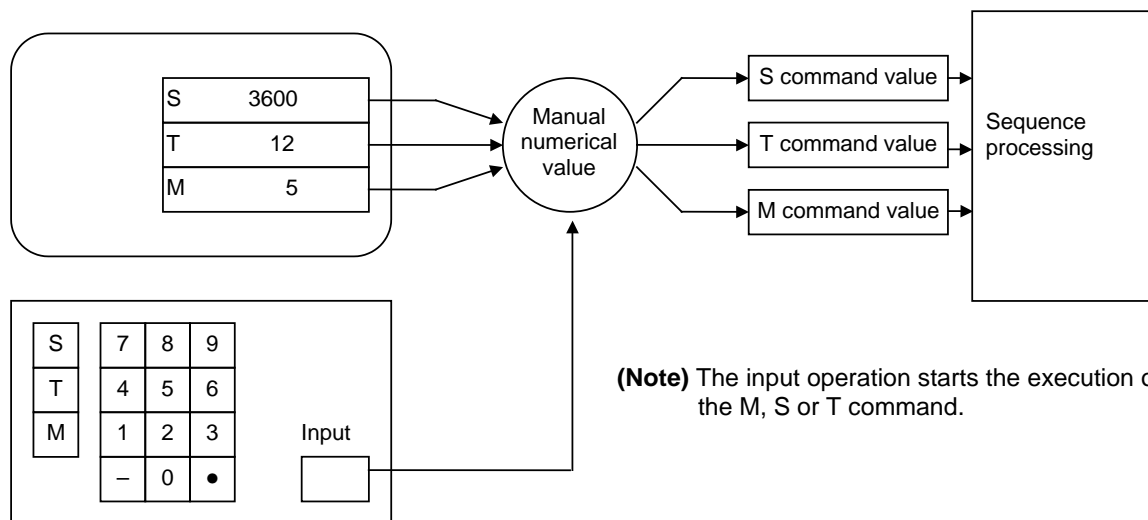
M system : ○

L system : ○

On the screen of the setting and display unit, the M, S and T (and B when 2nd miscellaneous function is valid) commands can be executed by setting numerical values and pressing [INPUT].

This enables operations such as spindle speed changing, starting, stopping, calling and selecting assigned tools and replacing of the spindle tools to be done easily without having to prepare or revise the machining program. Even in an automatic operation mode, these operations can be conducted with block stop.

Furthermore, the M and T commands can be issued even on the tool offset amount setting and display screen, therefore at the manual tool length measurement, the tools can be called successively to the spindle and measured very simply without having to change the screen page.



**(Note)** The input operation starts the execution of the M, S or T command.

## 11.4.8 MDI Interruption

M system : ○

L system : ○

This function enables MDI programs to be executed during automatic operation in the single block stop status. When the modal status is changed in the MDI program, the modal status in the automatic operation mode is also changed.

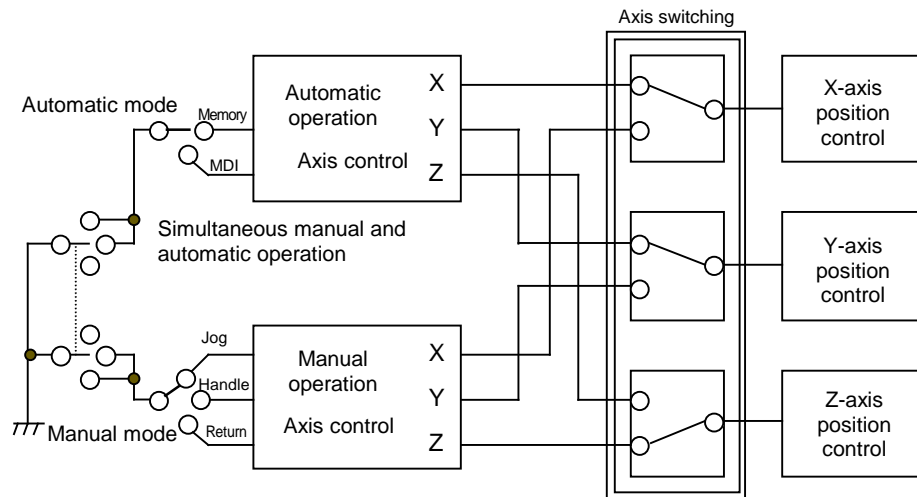
## 11.4.9 Simultaneous Operation of Manual and Automatic Modes

M system : ○

L system : ○

This function enables manual operations to be performed during automatic operation by selecting an automatic operation mode (MDI or memory) and manual mode (handle, step, jog or manual reference point return) simultaneously.

(Arbitrary feed based on the PLC is also possible.)



The feed rates for the axes subject to automatic commands and the feed rates for axes subject to manual command are set separately. The acceleration/deceleration modes (rapid traverse, cutting feed) are also set separately. Rapid traverse override, cutting feed override and second cutting feed override are valid both for axes subject to automatic commands and axes subject to manual commands. Override cancel is valid for axes subject to automatic commands. Manual interlock is applied to axes subject to manual commands; automatic interlock is applied to axes subject to automatic commands.

## 12. Program Support Functions

### 12.1 Machining Method Support Functions

#### 12.1.1 Program

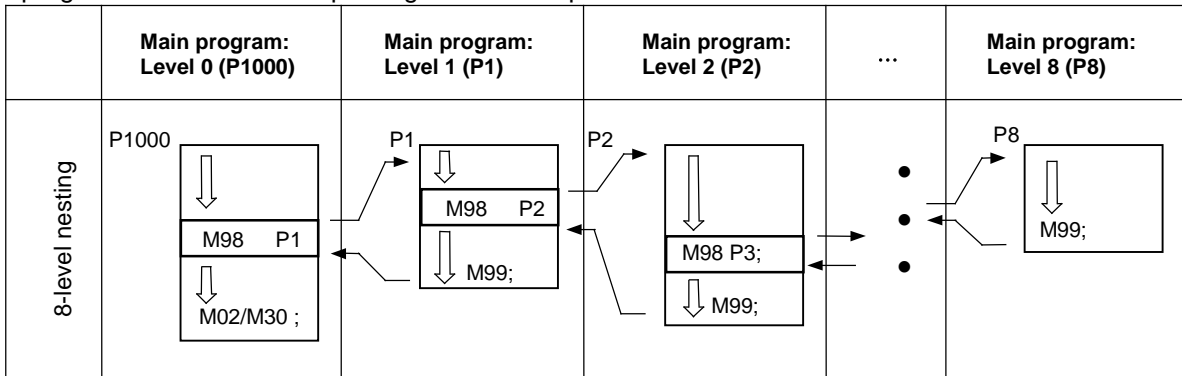
##### 12.1.1.1 Subprogram Control

**M system : O 8 layers      L system : O 8 layers**

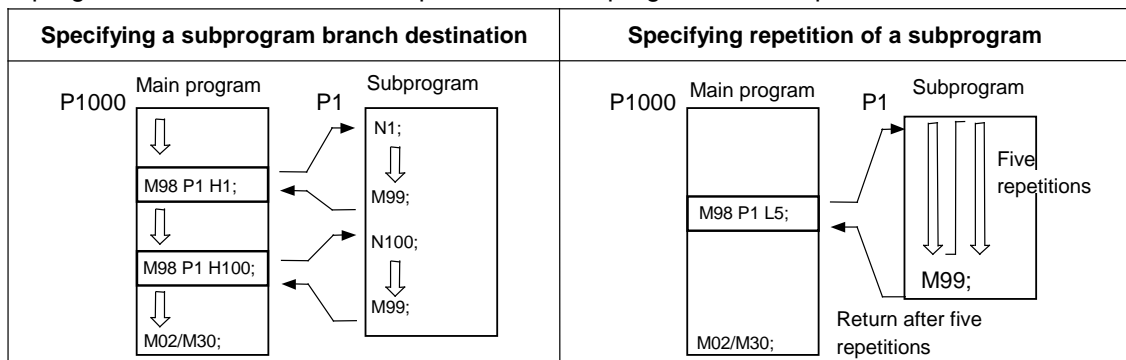
When the same pattern is repeated during machining, the machining pattern is registered as one subprogram and the subprogram is called from the main program as required, thereby realizing the same machining easily. Efficient use of program is possible. The call is designated with the program number and sequence number.

|            |                                |            |            |          |
|------------|--------------------------------|------------|------------|----------|
| <b>M98</b> | <b>Pp1</b>                     | <b>Hh1</b> | <b>LI1</b> | <b>;</b> |
| M98        | : Call command                 |            |            |          |
| Pp1        | : Subprogram number            |            |            |          |
| Hh1        | : Sequence number              |            |            |          |
| LI1        | : Number of repetitions        |            |            |          |
|            | (Branch to subprogram)         |            |            |          |
|            | Op1 (Subprogram)               |            |            |          |
|            | :                              |            |            |          |
|            | Nh1                            |            |            |          |
|            | :                              |            |            |          |
|            | M99 ; (Return to main program) |            |            |          |

Subprograms can be nested up to eight levels deep.



A subprogram branch destination or repetition of a subprogram can be specified.



## 12.1.2 Macro Program

## 12.1.2.1 User Macro

**M system : Δ 4 layers      L system : Δ 4 layers**

## (1) Macro commands (1) ; G65 to G67

In order to execute one integrated function, a group of control and arithmetic instructions can be used and registered as a macro program. Furthermore, subprograms with a high degree of expandability can be configured by setting these macro programs as types which are capable of conducting control and arithmetic operations using variable commands.

| <b>G code</b> | <b>Function</b>          |
|---------------|--------------------------|
| G65           | Macro call (Sample call) |
| G66           | Macro modal call A       |
| G66.1         | Macro modal call B       |
| G67           | Macro modal call cancel  |

The program formats are given below.

|            |            |            |                            |
|------------|------------|------------|----------------------------|
| <b>G65</b> | <b>Pp1</b> | <b>LI1</b> | <b>Argument ;</b>          |
| G65        |            |            | : Call command             |
| Pp1        |            |            | : Program No.              |
| LI1        |            |            | : No. of repetitions       |
| Argument   |            |            | : Variable data assignment |

The macro program is called immediately by this command.

|            |            |            |                            |
|------------|------------|------------|----------------------------|
| <b>G66</b> | <b>Pp1</b> | <b>LI1</b> | <b>Argument ;</b>          |
| G66        |            |            | : Call command             |
| Pp1        |            |            | : Program No.              |
| LI1        |            |            | : No. of repetitions       |
| Argument   |            |            | : Variable data assignment |

The macro program is executed from the block with the axis command following this command.

|              |            |            |                            |
|--------------|------------|------------|----------------------------|
| <b>G66.1</b> | <b>Pp1</b> | <b>LI1</b> | <b>Argument ;</b>          |
| G66.1        |            |            | : Call command             |
| Pp1          |            |            | : Program No.              |
| LI1          |            |            | : No. of repetitions       |
| Argument     |            |            | : Variable data assignment |

The macro program is executed with the word data of each block as the argument.

The following macro command functions are available.

|   |   |
|---|---|
| Arithmetic commands                             | #1 = <Expression> ;<br>Various arithmetic operations can be conducted between variables by the above. "<Expression>" is a combination of constants, variables, functions and operators.   |
| Assignment of priority of arithmetic operations | The portion in which the operator is to be given priority can be enclosed in [ ]. Up to five pairs of square parentheses [ ] including the function [ ] can be used. The normal priority of operation is functions and multiplication/division followed by addition/subtraction.  |
| Control commands                                | (1) IF [<Conditional expression>] GOTO n ;<br>(2) WHILE [<Conditional expression>] DO m ;<br>...<br>END m ;<br>The flow of the program can be controlled by these commands. "n" denotes the sequence numbers of the branching destination. "m" is an identification number, and 1 to 127 can be used. Note that only 27 nestings can be used. |

#### (2) Macro commands (2)

Specific G commands and the miscellaneous commands (M, S, T, B) can be used for macro call.

##### (a) Macro call using G codes

Simply by assigning a G code, it is possible to call user macro programs with the prescribed program number.

##### Format

|            |                                    |
|------------|------------------------------------|
| <b>G**</b> | <b>&lt;Argument&gt;</b> ;          |
| G**        | : G code for performing macro call |

The correspondence between the G\*\* code which performs macro call and the program number for the macro to be called is set by a parameter.

Up to 10 codes from G00 to G255 can be used for this command. (Whether to use codes such as G00, G01 or G02 which have already been clearly assigned for specific applications by the EIA standards as macro codes can be changed over using a parameter.)

##### (b) Macro call using miscellaneous commands (M, S, T, B code macro call)

Simply by designating an M (or S, T, B) code, it is possible to call user macro programs with the prescribed program number. (Entered M codes and all S, T and B codes can be used.)

##### Format

|                 |   |
|-----------------|---|
| <b>Mm</b> ;     | <b>(or Ss, Tt, Bb;)</b>                         |
| Mm (Ss, Tt, Bb) | : M (or S, T, B) code for performing macro call |

The correspondence between the Mm code which performs macro call and the program number for the macro to be called is set by a parameter. Up to 10 M codes from M00 to M95 can be entered. Select codes to be entered which are not the codes basically required by the machine and which are not M codes M0, M1, M2, M30 and M96 through M99.

**(Note 1)** G commands in G code macro programs are not subject to macro calls but normal G commands. M commands in M code macro programs are not subject to macro calls but normal M commands. (The same applies to S, T and B codes.)

**(Note 2)** The registration of the program number used for calling the G code macro or M code macro can be done independently for each system. [M system]



## 12.1.2.2 Machine Tool Builder Macro

**M system** : Δ**L system** : Δ

This function enables macro programs exclusively designed for use by the machine builders to be registered in addition to the regular user macro programs.

As opposed to the conventional macro program, the macro program display/editing can be protected with a password. This is suitable for maintaining the machine tool builder's original macro program confidentiality.

Machine tool builder macro programs are stored in a dedicated area which means that the user program registration area is not reduced in the process.

When registering a machine tool builder macro, secure its space by formatting.

64 KB of registration area is secured in the machine tool builder macro program, and up to 100 programs can be registered there.

Macro program that is registered as a machine tool builder macro can be executed by defining it with the machine definition program and calling the defined G code.

This macro program can also be registered in G code macro or M code macro.

The macro program is described in the same manner as a conventional machining program.

User subprograms or machine tool builder macros can also be called from the machine tool builder macros. Up to 4 nesting levels are available. G65, G66 and G66.1 commands do not call the machine tool builder macro programs.

Variables for the machine tool builder macros can be used within the machine tool builder macros. These variables can be used commonly within the machine tool builder macro programs.

## Call format

|             |   |
|-------------|---|
| <b>G***</b> | <b>Argument ;</b>   |
| ***         | : G code defined in macro definition program  |
| Argument    | : Argument is used when a local variable must be delivered to the macro program.<br>Designate a real value after the address. |

**(Note)** If the macro parameter and the macro definition program share a G code, the macro parameter definition will have the priority.

12.1.2.3 Macro Interruption

**M system : Δ**

**L system : Δ**

By inputting a user macro interrupt signal from the PLC, the program being currently executed is interrupted and other programs can be called instead.

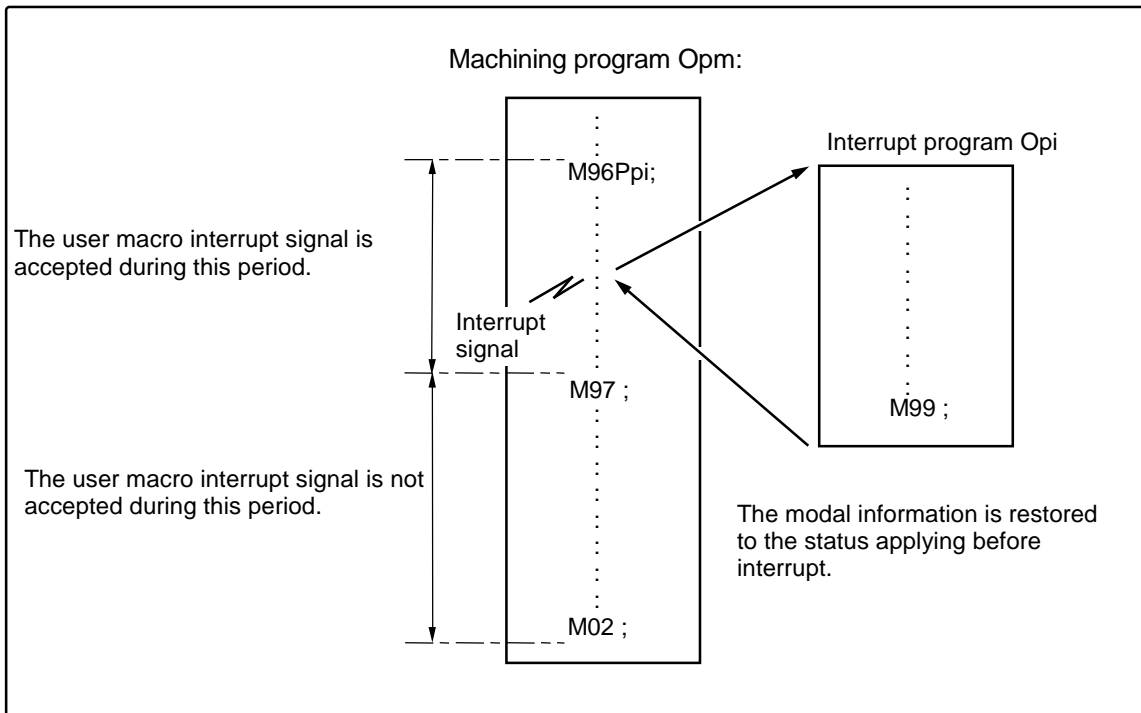
Retract or return operations when tools have been damaged, for instance, and other kinds of restoration operations to be conducted when trouble has occurred are programmed in the interrupt programs. There are two types of interrupts, type 1 and type 2, as described below, and they are selected using a parameter.

[Interrupt type 1] The block being executed is immediately interrupted, and the interrupt program is run immediately.

[Interrupt type 2] After the block being executed is complete, the interrupt program is executed.

The command format is given below.

|            |             |             |   |                                     |
|------------|-------------|-------------|---|-------------------------------------|
| <b>M96</b> | <b>P</b> __ | <b>H</b> __ | ; | <b>User macro interrupt valid</b>   |
| <b>M97</b> | ;           |             |   | <b>User macro interrupt invalid</b> |
| P          |             |             | : | Interrupt program No.               |
| H          |             |             | : | Interrupt sequence No.              |



## 12. Program Support Functions

### 12.1 Machining Method Support Functions

#### 12.1.2.4 Variable Command

Programming can be given flexible and general-purpose capabilities by designating variables instead of directly assigning numbers for addresses in programs and by supplying the values of those variables as required when running the programs.

Arithmetic operations (adding, subtracting, multiplying and dividing) can also be conducted for the variables.

#### Number of variable sets specifications

The numbers of common variable sets depend on the options, and are as follows.

| Type                                 |              | Number (inside the brackets indicate No. of variable sets) |                      | Function  |
|--------------------------------------|--------------|--|----------------------|---|
| Common variables                     |              | Common variables 1   | Common variables 2   | Can be used commonly for main, sub and each macro program.<br><br>S: Number of part systems                 |
| For 1-part system specifications     | 100 sets (A) | 500 to 549 (50)  | 100 to 149 (50)      |   |
|                                      | 200 sets (B) | 500 to 599 (100)   | 100 to 199 (100)     |   |
|                                      | 300 sets (C) | 500 to 699 (200)   | 100 to 199 (100)     |   |
|                                      | 600 sets (D) | 500 to 999 (500)   | 100 to 199 (100)     |   |
| For multi-part system specifications | 100 sets (A) | 500 to 549 (50)  | 100 to 149 (50) × S  |   |
|                                      | 200 sets (B) | 500 to 599 (100)   | 100 to 199 (100) × S |   |
|                                      | 300 sets (C) | 500 to 699 (200)   | 100 to 199 (100) × S |   |
|                                      | 600 sets (D) | 500 to 999 (500)   | 100 to 199 (100) × S |   |
| Local variables                      |              | 1 to 33 (33)   |                      | Can be used as local variable in macro program.   |
| System variables                     |              | 1000 to 1395   |                      | Macro interface input/output  |
|                                      |              | 2000 to 2800<br>10000 to 18000                             |                      | Read and write of tool compensation data.   |
|                                      |              | 3000   |                      | Macro alarm message   |
|                                      |              | 3001, 3002   |                      | Integrated time   |
|                                      |              | 3003   |                      | Changing the validity (valid or invalid) of single block/miscellaneous function.                            |
|                                      |              | 3004   |                      | Changing the validity (valid or invalid) of feed hold.  |
|                                      |              | 3006   |                      | Message display and block stop  |
|                                      |              | 3007   |                      | Changing the validity (valid or invalid) of mirror image.   |
|                                      |              | 3011, 3012   |                      | Reading and writing of current date and time.   |
|                                      |              | 3901, 3902   |                      | Reading and writing of the number of the workpiece machining and the maximum number of workpiece machining. |
|                                      |              | 4001 to 4021, 4101 to 4130<br>4201 to 4221, 4301 to 4330   |                      | Reading of G command modal and other modal information.   |
|                                      |              | 5001 to 5141   |                      | Reading information of various positions.   |

| Type                  | Number (inside the brackets indicate No. of variable sets) | Function  |
|-----------------------|--|---|
| (cont.)               | 5201 to 532n   | Reading and writing of workpiece coordinate system offset data.   |
|                       | 30060 to 30068   | Reading the coordinate rotation parameter.  |
|                       | 31001 to 31023   | Reading and writing of a rotation axis configuration parameter.   |
|                       | 31100, 31101   | Reading the number of available blocks for reverse run and the counter of available blocks for reverse run. |
|                       | 50000 to 51199   | Reading and writing of the data between NC machining program and PLC program.                               |
|                       | 60000 to 64700   | Reading and writing of the tool life management data,   |
| Fixed cycle variables | 1 to 32 (32)   | Local variables in a fixed cycle program.   |

**(Note 1)** All common variables are held even when the power is turned OFF.

**(Note 2)** The common variables can be emptied by resetting or turning the power OFF when the parameters are set accordingly.

**(Note 3)** Common variables can be classified into the following two types.

Common variable 1: Variables that can be commonly used throughout all the part systems.

Common variable 2: Variables that can be used in the program of the target part system.

**(Note 4)** Variable names can be set for #500 to #519.

**(Note 5)** Re-format is not required even after changing the option parameter of the number of variable sets. After changing the option parameter, the changed number of sets can be used by recycling the power.

**(Note 6)** System variables 50000 to 51199 are held even when the power is turned OFF.

**(Note 7)** System variables 50000 to 51199 are common among part systems.

### Variable expressions

|            |                                   |             |
|------------|-----------------------------------|-------------|
| Variable:  | : # Numerical value               | #100        |
|            | (Numerical value: 1, 2, 3, .....) |             |
|            | : # [Expression]                  | #100        |
| Expression | : Numerical value                 |             |
|            | : Variable                        |             |
|            | : Expression Operator Expression  | #100 + #101 |
|            | : - (minus) Expression            | -#120       |
|            | : [Expression]                    | [#110]      |
|            | : Function [Expression]           | SIN [#110]  |

### Variable definition

Variable = expression

**(Note 4)** Variables cannot be used with addresses "O" and "N".

**12.1.2.4.1 100 Sets****M system : ○****L system : ○****12.1.2.4.2 200 Sets****M system : Δ****L system : Δ****12.1.2.4.3 300 Sets****M system : Δ****L system : Δ****12.1.2.4.4 600 Sets****M system : Δ****L system : Δ****12.1.2.4.7 (50+50 × Number of Part Systems) Sets****M system : ○****L system : ○****12.1.2.4.8 (100+100 × Number of Part Systems) Sets****M system : Δ****L system : Δ****12.1.2.4.9 (200+100 × Number of Part Systems) Sets****M system : Δ****L system : Δ****12.1.2.4.10 (500+100 × Number of Part Systems) Sets****M system : Δ****L system : Δ**

12.1.2.101 N Code Macro

M system : Δ

L system : Δ

This function calls the macro program using a pre-registered N code.  
 The N No. and the macro program are registered using parameter setting, and up to eight can be registered.  
 Argument (P, N, L, G) which cannot be used by a usual calling macro can be used.  
 In addition, the argument G can be used up to four.

(1) Macro call by N code

**Format**

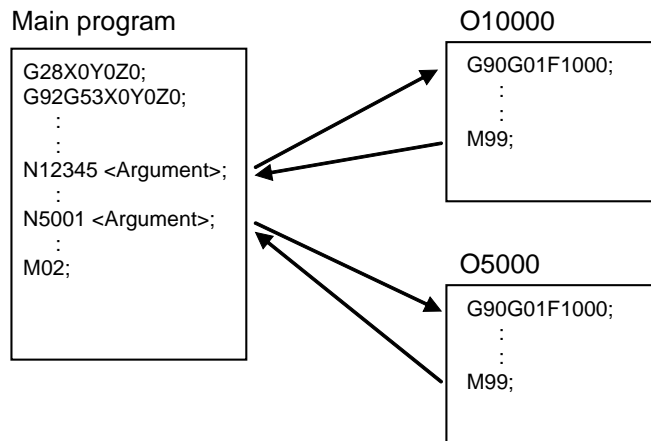
|               |                                    |          |
|---------------|------------------------------------|----------|
| <b>N*****</b> | <b>&lt;Argument&gt;</b>            | <b>;</b> |
| N*****        | : N code for performing macro call |          |

- (a) The macro is called by N code. (The calling is same as G65.)
- (b) The called N No. is registered by the parameter setting. Wild-card (,) can be used for N No. registration.

**Example for setting**

|       | <Code> | <Program No.> |   |
|-------|--------|---------------|---|
| N[01] | 12345  | 10000         | ... N No. : 12345, program No. : 10000            |
| N[02] | 5...   | 5000          | ... To N No. 5000 to 5999, for program No. : 5000 |

- (c) N code call diverges to the macro as the arguments entire address data in same block, and returns to the head of the next block.
- (d) The macro subprogram can be called in up to four levels using N code macro call.



**(Note 1)** When prohibiting the display and edit of the macro program, set the macro program No. to O9000 to O9999, and change properly the parameter setting of edit lock C and the program display lock.

12.1.2.102 Macro Interface Extension (1200 sets)

M system : Δ

L system : Δ

These variables enable direct reading/writing of the data between CNC machining program and PLC program.

12.1.3 Fixed Cycle

List of fixed cycles

| Type of fixed cycle                                    | M system        | L system        |                 | Remarks                                  |
|--|-----------------|-----------------|-----------------|--|
|  | G code system 1 | G code system 2 | G code system 3 |  |
| Fixed cycle for drilling                               | G70             | G80             | G80             | Refer to 12.1.3.1.<br>Refer to 4.5.3.    |
|  | :               | :               | :               |  |
|  | G89             | G89             | G89             |  |
|  |                 | G79             | G83.2           |  |
|  | G98             | G98             | G98             |  |
|  | G99             | G99             |                 |  |
| Special fixed cycles                                   | G34             |                 |                 | Refer to 12.1.3.2.                       |
|  | G35             | -               | -               |  |
|  | G36             |                 |                 |  |
| Fixed cycles for turning machining                     |                 | G90             | G77             | Refer to 12.1.3.3.                       |
|  | -               | G92             | G78             |  |
|  |                 | G94             | G79             |  |
| Multiple repetitive fixed cycles for turning machining |                 | G70             | G70             | Refer to 12.1.3.4.<br>Refer to 12.1.3.5. |
|  |                 | :               | :               |  |
|  | -               | G76             | G76             |  |
|  |                 | G76.1           | G76.1           |  |
|  |                 | G76.2           | G76.2           |  |

12.1.3.1 Fixed Cycle for Drilling

M system : O

L system : O

(1) M system ; G70 to G89, G88, G99

These functions enable drilling, tapping and other hole machining cycles to be assigned in a simple 1-block program.

| G code | Function                      |
|--------|-------------------------------|
| G70    |                               |
| G71    |                               |
| G72    |                               |
| G73    | Step cycle                    |
| G74    | Reverse tapping cycle         |
| G75    |                               |
| G76    | Fine boring                   |
| G77    |                               |
| G78    |                               |
| G79    |                               |
| G80    | Fixed cycle cancel            |
| G81    | Drilling, spot drilling cycle |
| G82    | Drilling, counterboring cycle |
| G83    | Deep hole drilling cycle      |
| G84    | Tapping cycle                 |
| G85    | Boring cycle                  |
| G86    | Boring cycle                  |
| G87    | Backboring cycle              |
| G88    | Boring cycle                  |
| G89    | Boring cycle                  |

There are two levels of hole machining axis return which apply upon completion of the fixed cycle machining operation.

| G code | Function                   |
|--------|----------------------------|
| G98    | Initial point level return |
| G99    | R point level return       |

The basic program format for the fixed cycle commands is shown below.

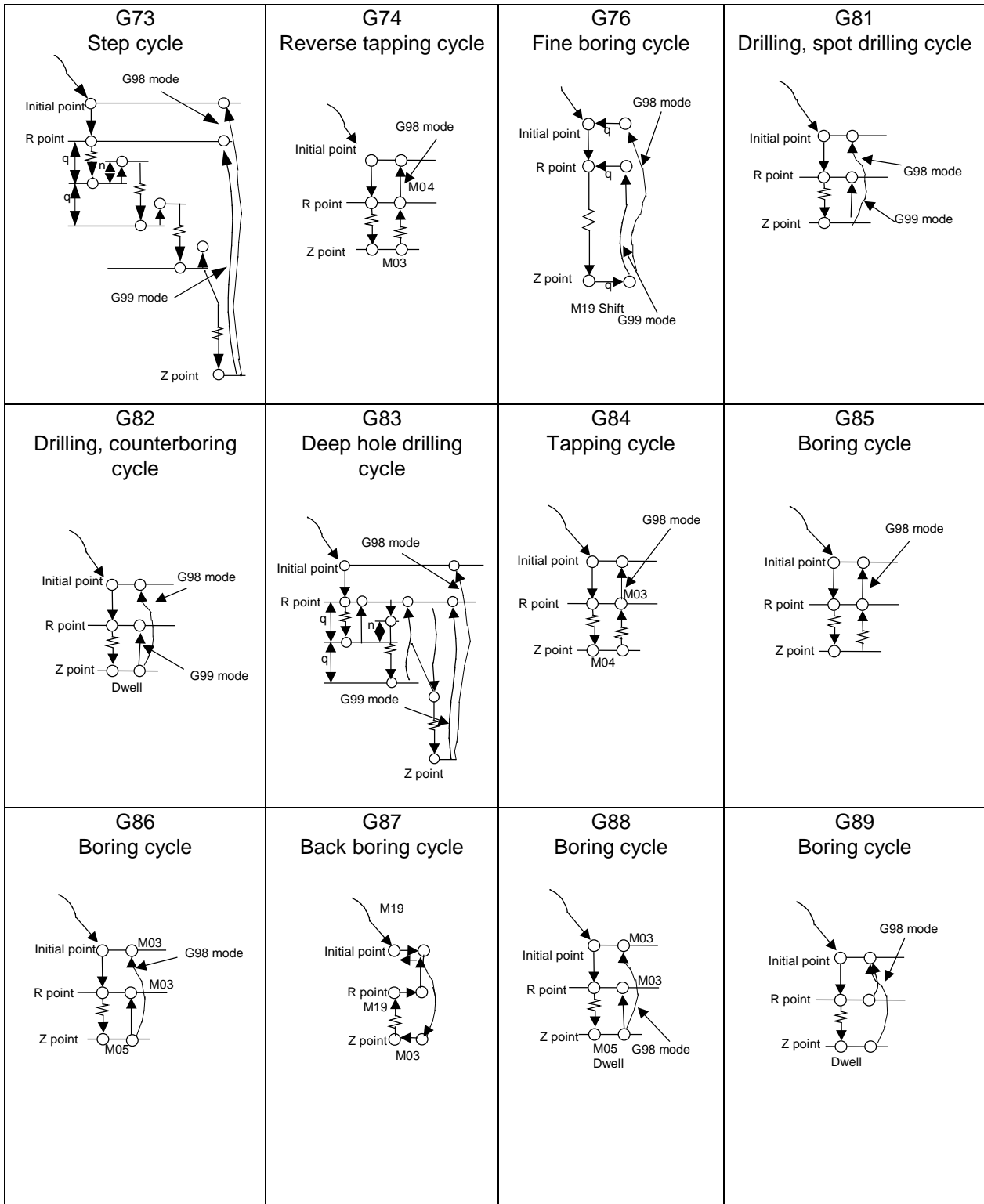
| G81      | Xx1 | Yy1 | Zz1  | Rr1 | Qq1 | Pp1 | LI1 | Ff1 | ; |
|----------|-----|-----|--|-----|-----|-----|-----|-----|---|
| G81      |     | :   | Hole drilling mode   |     |     |     |     |     |   |
| Xx1, Yy1 |     | :   | Hole position data; X-axis, Y-axis hole drilling position command (rapid traverse) |     |     |     |     |     |   |
| Zz1      |     | :   | Hole machining data; Hole bottom position designation (incremental/absolute)       |     |     |     |     |     |   |
| Rr1      |     | :   | Hole machining data; Hole R point designation (incremental/absolute)               |     |     |     |     |     |   |
| Qq1      |     | :   | Hole machining data; Depth of cut per pass in G73, G83 cycle (incremental)         |     |     |     |     |     |   |
|          |     | :   | Shift amount in G76, G87 cycle   |     |     |     |     |     |   |
|          |     | :   | Depth of cut per pass in pecking tapping, deep hole tapping of G74, G84 cycle      |     |     |     |     |     |   |
| Pp1      |     | :   | Hole machining data; Dwell time at hole bottom                                     |     |     |     |     |     |   |
| LI1      |     | :   | Hole machining data; Number of fixed cycle repetitions                             |     |     |     |     |     |   |
| Ff1      |     | :   | Cutting feed rate  |     |     |     |     |     |   |

For details on the synchronous tapping cycle, refer to the section "4.5.3 Synchronous Tapping".



## 12. Program Support Functions

### 12.1 Machining Method Support Functions



## 12. Program Support Functions

### 12.1 Machining Method Support Functions

(2) L system; G83 to G89, G80

In the fixed cycle for drilling, a machining program such as drilling, tapping, or boring and positioning can be executed for a given machining sequence in 1-block commands.

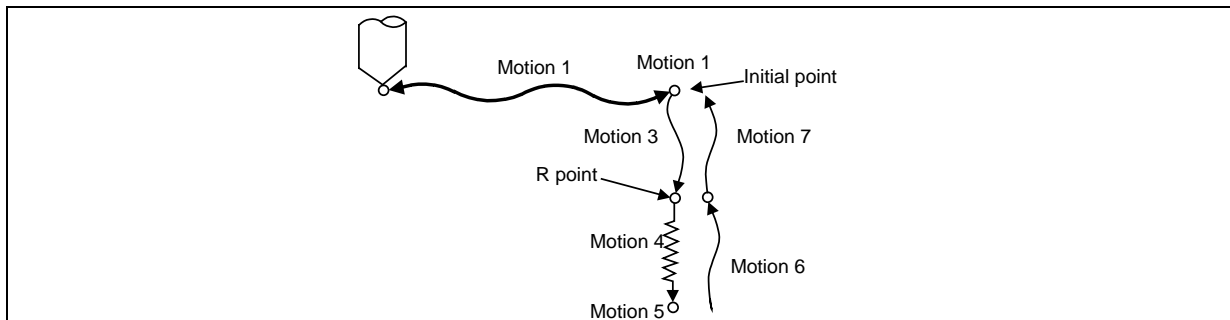
| G code | Drilling axis | Drilling work start               | Motion at hole bottom                     | Return motion          | Use                                      |
|--------|---------------|-----------------------------------|---|------------------------|--|
| G80    | -----         | -----                             | -----                                     | -----                  | Cancel                                   |
| G83    | Z             | Cutting feed<br>Intermittent feed | In-position check<br>Dwell                | Rapid<br>traverse feed | Deep-hole drilling cycle1                |
| G84    | Z             | Cutting feed                      | In-position check<br>Dwell<br>Spindle CCW | Cutting feed           | Tapping cycle<br>(Reverse tapping cycle) |
| G85    | Z             | Cutting feed                      | In-position check<br>Dwell                | Cutting feed           | Boring cycle                             |
| G87    | X             | Cutting feed<br>Intermittent feed | In-position check<br>Dwell                | Rapid<br>traverse feed | Deep-hole drilling cycle1                |
| G88    | X             | Cutting feed                      | In-position check<br>Dwell<br>Spindle CCW | Cutting feed           | Tapping cycle<br>(Reverse tapping cycle) |
| G89    | X             | Cutting feed                      | In-position check<br>Dwell                | Cutting feed           | Boring cycle                             |
| G83.2  | Z/X           | Cutting feed<br>Intermittent feed | In-position check<br>Dwell                | Rapid<br>traverse feed | Deep-hole drilling cycle2                |

The fixed cycle mode is canceled when a G command of the G80 or G01 group is specified. Data is also cleared simultaneously.

Command format

|                         |  |
|-------------------------|--|
| <b>G83/G84/G85</b>      | <b>Xx1 Cc1 Zz1 Rr1 Qq11 Pp1 Ff1 Kk1 (Mm1) Ss1 ,Ss1 Dd1 ,Rr1 ;</b>  |
| <b>G87/G88/G89</b>      | <b>Xx1 Cc1 Zz1 Rr1 Qq11 Pp1 Ff1 Kk1 (Mm1) Ss1 ,Ss1 Dd1 ,Rr1 ;</b>  |
| G83/G84/G85             | : Fixed cycle mode of drilling (G83, G87), tapping (G84, G88), or boring (G85, G89)  |
| G87/G88/G89             | The drilling command is modal. Once it is given, it is effective until another drill command is given or drilling fixed cycle cancel command is given.   |
| Xx1, Cc1                | : Data for positioning X (Z) and C axes<br>The data is unmodal. To execute the same hole machining mode consecutively, specify the data for each block.  |
| Zz1, Rr1, Qq11, Pp1, Ff | : Actual machining data in machining<br>Only Q is unmodal. Specify Q in G83 or G87 for each block whenever the data is required.   |
| Kk1                     | : To repeat in a single cycle for hole machining at equal intervals, specify the number of repetitions in the range of 0 to 9999 (no decimal point can be used). It is unmodal and is effective only in the block in which the number of repetitions is specified.<br>If the number of repetitions is omitted, K1 is assumed to be specified. If K0 is specified, hole machining data is stored, but hole machining is not performed. Hole machining data; R point position (incremental value from initial point) designation (sign ignored). |
| Mm1                     | : If axis C clamp M command (parameter setting) is given, the M code is output at the initial point, and after return motion, C axis unclamp M code (clamp M code + 1) is output and the dwell time set in a given parameter is executed.  |
| Ss1                     | : Designates spindle rotation speed  |
| ,Ss1                    | : Designates spindle rotation speed at retract   |
| Dd1                     | : Designates tap spindle No. for G84 (G88)   |
| ,Rr1                    | : Changes between synchronous/asynchronous in G84 (G88)  |

The drilling cycle motions generally are classified into the following seven.



- Motion 1 :** Rapid positioning up to the initial point of X (Z) and C axes.  
If the "positioning axis in-position width" is designated, the in-position check is conducted upon completion of the block.
- Motion 2 :** Output if the C axis clamp M code is given.
- Motion 3 :** Rapid positioning up to the R point.
- Motion 4 :** Hole machining at cutting feed.  
If the "drilling axis in-position width" is designated, the in-position check is conducted upon completion of the block. However, in the case of deep-hole drilling cycles 1 and 2, the in-position check is not conducted with the drilling of any holes except the last one. The in-position check is conducted at the commanded hole bottom position (last hole drilling).
- Motion 5 :** Motion at the hole bottom position. It varies depending on the fixed cycle mode. Spindle CCW (M04), spindle CW (M03), dwell, etc., are included.
- Motion 6:** Return to the R point.
- Motion 7:** Return to the initial point at rapid traverse feed.  
(Operations 6 and 5 may be conducted as a single operation depending on the fixed cycle mode.)

**(Note 1)** With a synchronous tap command, the in-position check is conducted in accordance with the parameters.

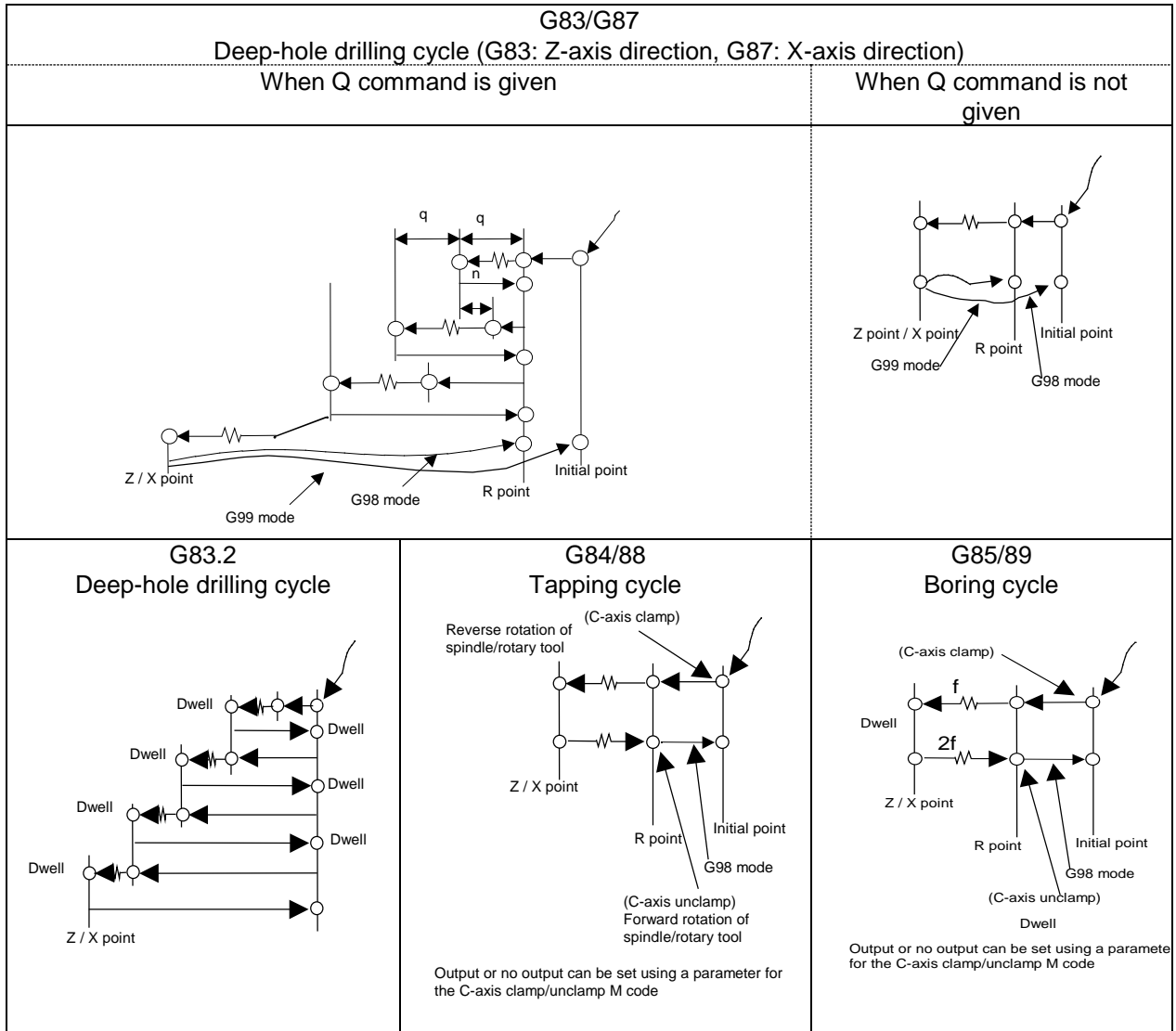
Whether the fixed cycle is complete with motion 6 or 7 can be specified by using either of the following G commands:

G98: Initial level return

G99: R point level return

These commands are modal. For example, once G98 is given, the G98 mode is entered until G99 is given. The G98 mode is entered in the initial state when the controller is ready.

Deep-hole drilling cycle (G83, G87)



There are two levels of hole machining axis return which apply upon completion of the fixed cycle machining operation. (see the figure above)

| G code | Function                   |
|--------|----------------------------|
| G98    | Initial point level return |
| G99    | R point level return       |

12.1.3.3 Special Fixed Cycle

M system : Δ

L system : -

These functions enable drilling, tapping and other hole machining cycles to be assigned in a simple 1-block program.

Special fixed cycles must always be used in combination with fixed cycles.

The special fixed cycles are as follows:

| G code | Function         |
|--------|------------------|
| G34    | Bolt hole circle |
| G35    | Line at angle    |
| G36    | Arc              |
| G37.1  | Grid             |

(1) Bolt hole circle (G34)

The tool starts at the point forming angle  $\theta$  with the X axis on the circumference of a circle with radius R whose center is the coordinates designated by X and Y, and it drills "n" number of holes at "n" equal intervals along the circumference of that circle. The drilling data for the standard fixed cycle of the G81 or other such command is retained for the drilling operation at each hole position.

All movements between the hole positions are conducted in the G00 mode. The data is not retained upon completion of the G34 command.

|  |   |           |           |           |           |   |
|--|---|-----------|-----------|-----------|-----------|---|
| <b>G34</b>   | <b>Xx</b>   | <b>Yy</b> | <b>Ir</b> | <b>Jθ</b> | <b>Kn</b> | ; |
| Xx, Yy   | : Center position of bolt hole circle; this is affected by the G90/G91 commands.                                      |           |           |           |           |   |
| Ir   | : Radius "r" of circle; it is based on the least input increment and is provided using a positive number.             |           |           |           |           |   |
| Jθ   | : Angle $\theta$ at point to be drilled initially; the counterclockwise direction is taken to be positive.            |           |           |           |           |   |
| Kn   | : Number "n" of holes to be drilled; any number of holes from 1 through 9999 can be designated; 0 cannot be assigned. |           |           |           |           |   |
| When 0 has been designated, the alarm will occur. A positive number provides positioning in the counterclockwise direction; a negative number provides positioning in the clockwise direction. |   |           |           |           |           |   |

(Example)

With 0.001mm least input increment

```

N001 G91 ;
N002 G81 Z-10.000 R5.000 L0 F200 ;
N003 G90 G34 X200.000 Y100.000 I100.000 J20.000 K6 ;
N004 G80 ; .....(G81 cancel)
N005 G90 G0 X500.000 Y100.000 ;
    
```

Position prior to execution of G34 command (500 mm, 100 mm)

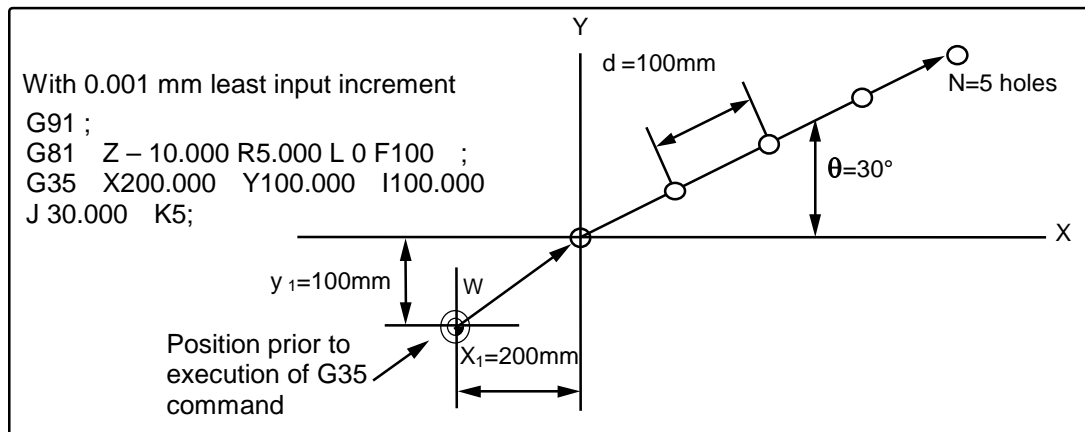
G0 command in N005

As shown in the figure, the tool is positioned above the final hole upon completion of the G34 command. This means that when it is to be moved to the next position, it will be necessary to calculate the coordinates in order to issue the command or commands with incremental values, and so it is convenient to use the absolute value mode.

## (2) Line at angle (G35)

With the starting point at the position designated by X and Y, the tool drills "n" number of holes each at interval "d" in the direction forming angle  $\theta$  with the X axis. A standard fixed cycle applies for the drilling operation at each of the hole positions and so there is a need to retain beforehand the drilling data (drilling mode and drilling data). All movements between the hole positions are conducted in the G00 mode. The data is not retained upon completion of the G35 command.

|            |   |           |           |                             |           |   |
|------------|---|-----------|-----------|-----------------------------|-----------|---|
| <b>G35</b> | <b>Xx</b>   | <b>Yy</b> | <b>Id</b> | <b>J<math>\theta</math></b> | <b>Kn</b> | ; |
| Xx, Yy     | : The starting point coordinates; they are affected by the G90/G91 commands.  |           |           |                             |           |   |
| Id         | : Interval "d"; it is based on the least input increment and when "d" is negative, drilling proceeds in the point symmetrical direction centered on the starting point. |           |           |                             |           |   |
| J $\theta$ | : Angle $\theta$ ; the counterclockwise direction is taken to be positive.  |           |           |                             |           |   |
| Kn         | : Number "n" of holes to be drilled including the starting point; any number of holes from 1 through 9999 can be assigned.  |           |           |                             |           |   |

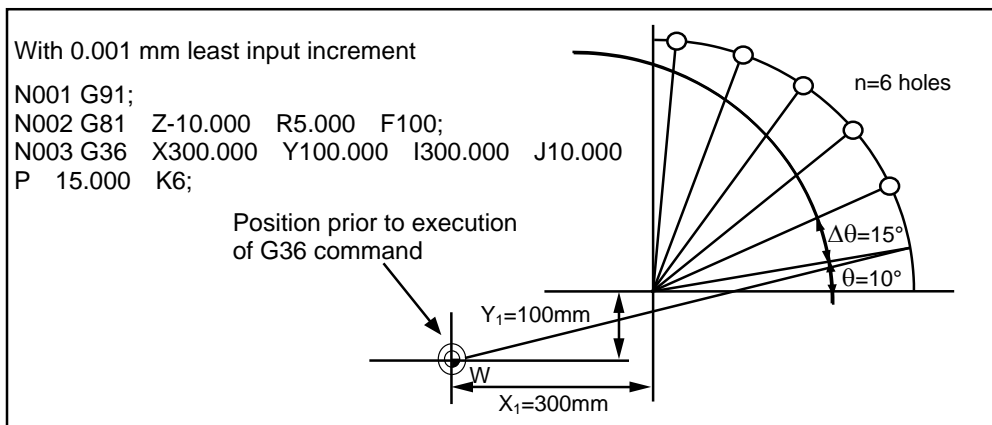
**(Example)**

## (3) Arc (G36)

The tool starts at the point forming angle  $\theta$  with the X axis on the circumference of a circle with radius "r" whose center is the coordinates designated by X and Y, and it drills "n" number of holes aligned at angle interval  $\Delta\theta$ . As with the bolt hole circle function, the drilling operation at each of the hole positions is based on a hold drilling fixed cycle and so there is a need to retain the drilling data beforehand. All movements between the hole positions are conducted in the G00 mode. The data is not retained upon completion of the G36 command.

| G36              | Xx  | Yy | Ir | J $\theta$ | P $\Delta\theta$ | Kn | ; |
|------------------|---|----|----|------------|------------------|----|---|
| Xx, Yy           | : Center coordinates of arc; they are affected by the G90/G91 commands.   |    |    |            |                  |    |   |
| Ir               | : Radius "r" of arc; it is based on the least input increment and is provided with a positive number.   |    |    |            |                  |    |   |
| J $\theta$       | : Angle $\theta$ at the point to be drilled initially; the counterclockwise direction is taken to be positive.  |    |    |            |                  |    |   |
| P $\Delta\theta$ | : Angle interval $\Delta\theta$ ; when it is positive, the tool drills in the counterclockwise direction and when it is negative, it drills in the clockwise direction. |    |    |            |                  |    |   |
| Kn               | : Number "n" of holes to be drilled; any number of holes from 1 through 9999 can be assigned.   |    |    |            |                  |    |   |

## (Example)

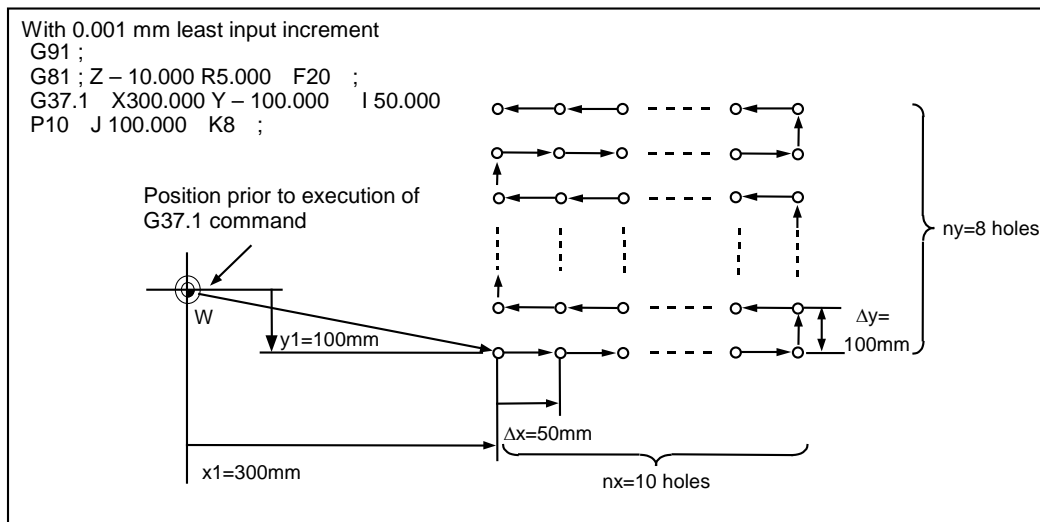


#### (4) Grid (G37.1)

With the starting point at on the position designated by X and Y, this function enables the tool to drill the holes on the lattice with "nx" number of holes at parallel intervals of  $\Delta x$  to the X axis. Drilling proceeds in the X-axis direction. The drilling operation at each of the hole positions is based on a standard fixed cycle and so there is a need to command the drilling data (drilling mode and drilling data) beforehand. All movements between the hole positions are conducted in the G00 mode. The data is not retained upon completion of the G37.1 command.

| <b>G37.1 Xx1 Yy1 I<math>\Delta</math>x Pnx J<math>\Delta</math>y Kny ;</b> |  |
|--|--|
| Xx, Yy   | : The starting point coordinates; they are affected by the G90/G91 commands.   |
| I $\Delta$ x   | : X-axis interval $\Delta x$ ; it is based on the least input increment; when $\Delta x$ is positive, the intervals are provided in the positive direction as seen from the starting point and when it is negative, they are provided in the negative direction. |
| Pnx  | : Number of holes "nx" in the X-axis direction; any number of holes from 1 through 9999 can be assigned.   |
| J $\Delta$ y   | : Y-axis interval $\Delta y$ ; it is based on the least input increment; when $\Delta y$ is positive, the intervals are provided in the positive direction as seen from the starting point and when it is negative, they are provided in the negative direction. |
| Kny  | : Number of holes "ny" in the Y-axis direction; any number of holes from 1 through 9999 can be assigned.   |

#### (Example)





## 12.1.3.4 Fixed Cycle for Turning Machining

M system : -

L system : O

The shape normally programmed in several blocks for rough cutting, etc., in the turning machining can be commanded in one block. This function is useful for machining program simplification. The fixed cycles are as follows:

| G code | Function                   |
|--------|----------------------------|
| G77    | Longitudinal cutting cycle |
| G78    | Thread cutting cycle       |
| G79    | Face cutting cycle         |

**Format:**

|  |
|--|
| <b>GΔΔ X/U Z/W I_K_R_F_(G18 plane)</b> |
|--|

Each fixed cycle command for turning machining is a modal G code and is effective until another command of the same modal group or a cancel command is given.

The fixed cycle can be canceled by using any of the following G codes:

G00, G01, G02, G03

G09

G10, G11

G27, G28, G29, G30

G31

G33, G34

G37

G92

G52, G53

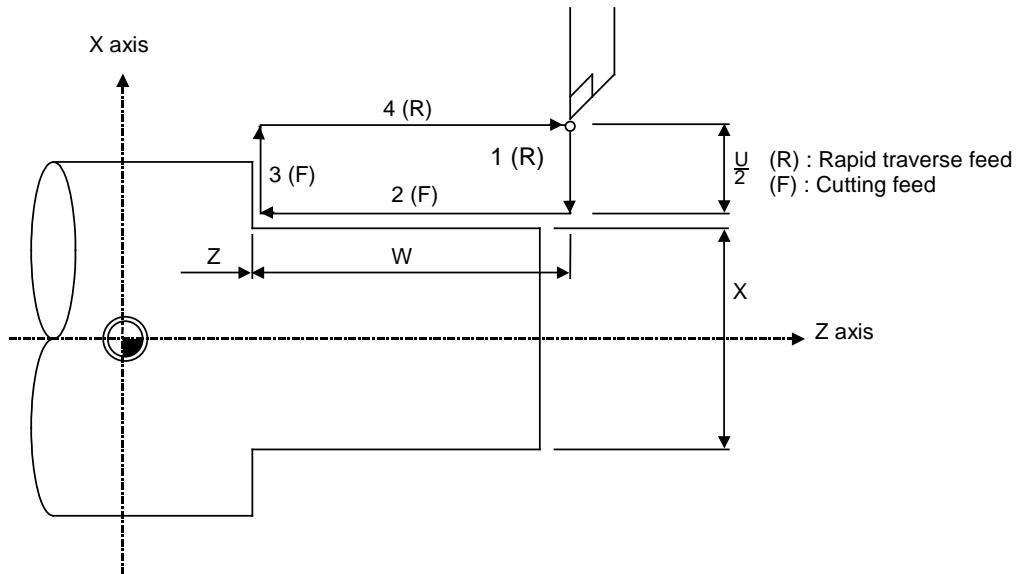
G65

(1) Longitudinal cutting cycle (G77)

(a) Longitudinal cutting

Straight cutting in the longitudinal direction can be performed consecutively by the following block:

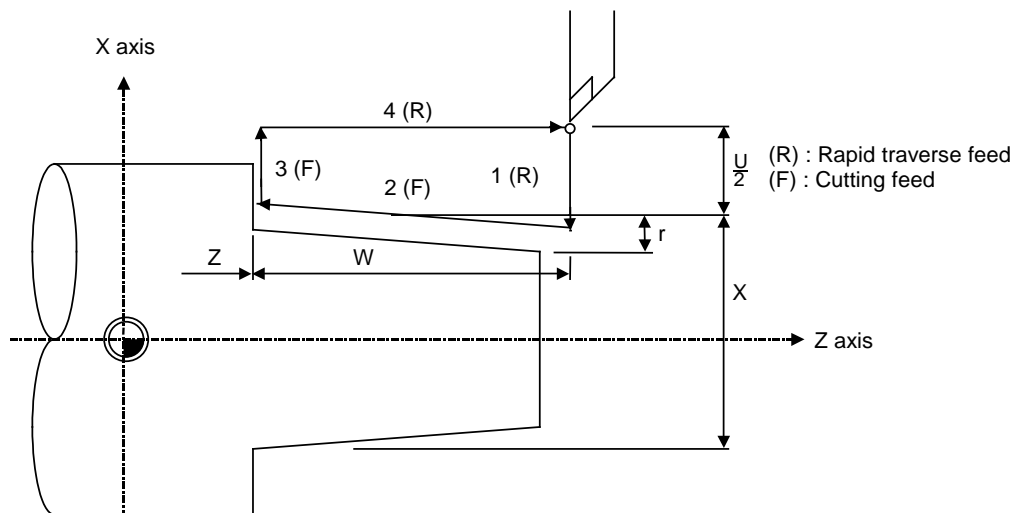
```
G77 X/U_Z/W_F_;
```



(b) Taper cutting

Taper cutting in the longitudinal direction can be performed consecutively by the following block:

```
G77 X/U_Z/W_R/F_;
```



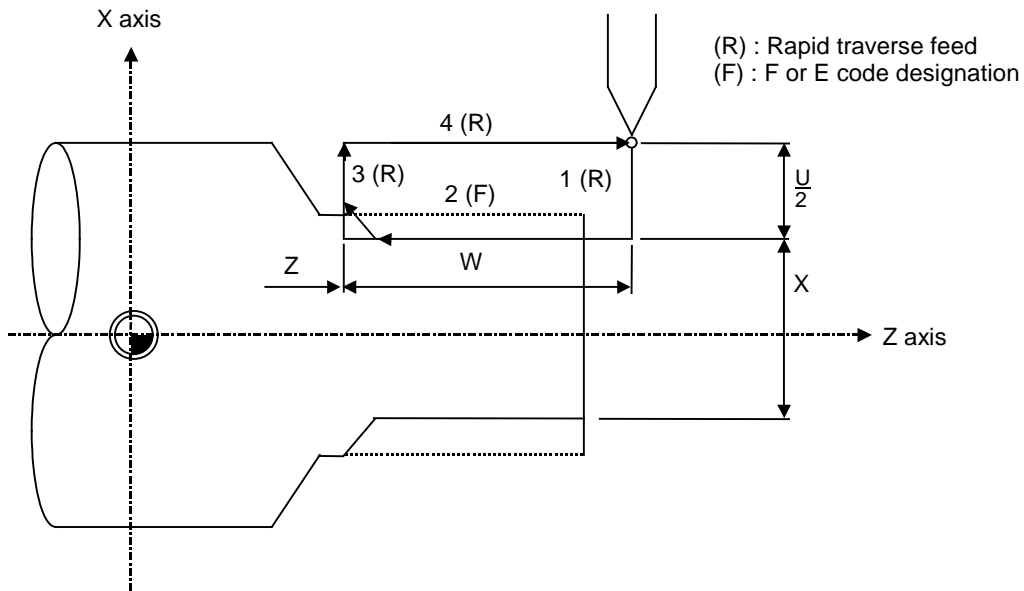
r: Taper part depth (radius designation, incremental value, sign is required)

(2) Thread cutting cycle (G78)

(a) Straight thread cutting

Straight thread cutting can be performed by the following block:

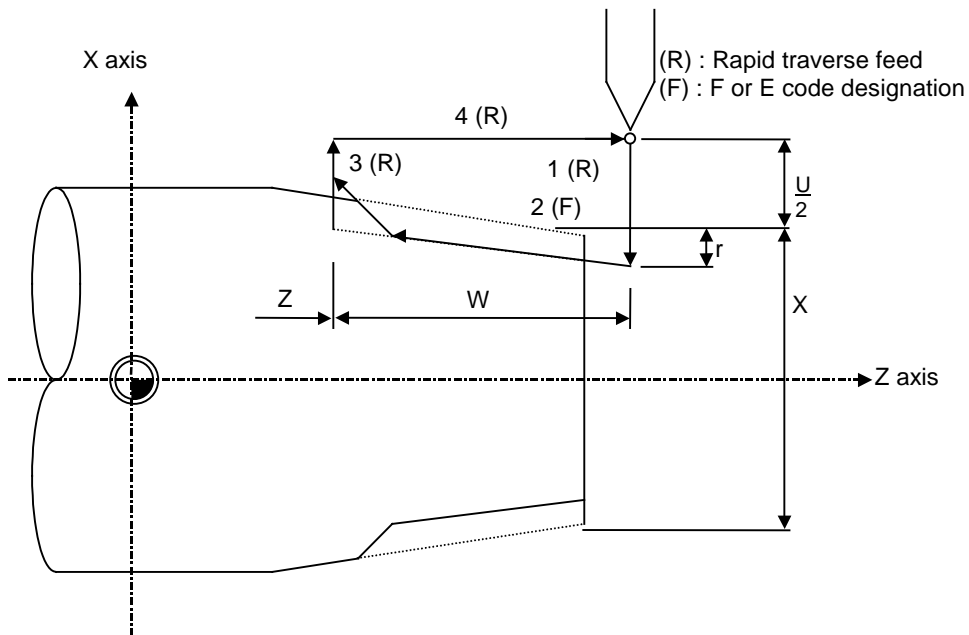
```
G78 X/U_ Z/W_ F/E_ ;
```



(b) Taper thread cutting

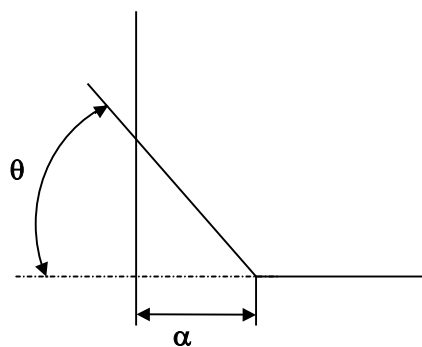
Taper thread cutting can be performed by the following block:

```
G78 X/U_ Z/W_ R_ F/E_ ;
```



r: Taper part depth (radius designation, incremental value, sign is required)

## Chamfering



$\alpha$  : Thread cutting-up amount  
Assuming that thread lead is L, the thread cutting-up amount can be set in a given parameter in 0.1L steps in the range of 0 to 12.7L.

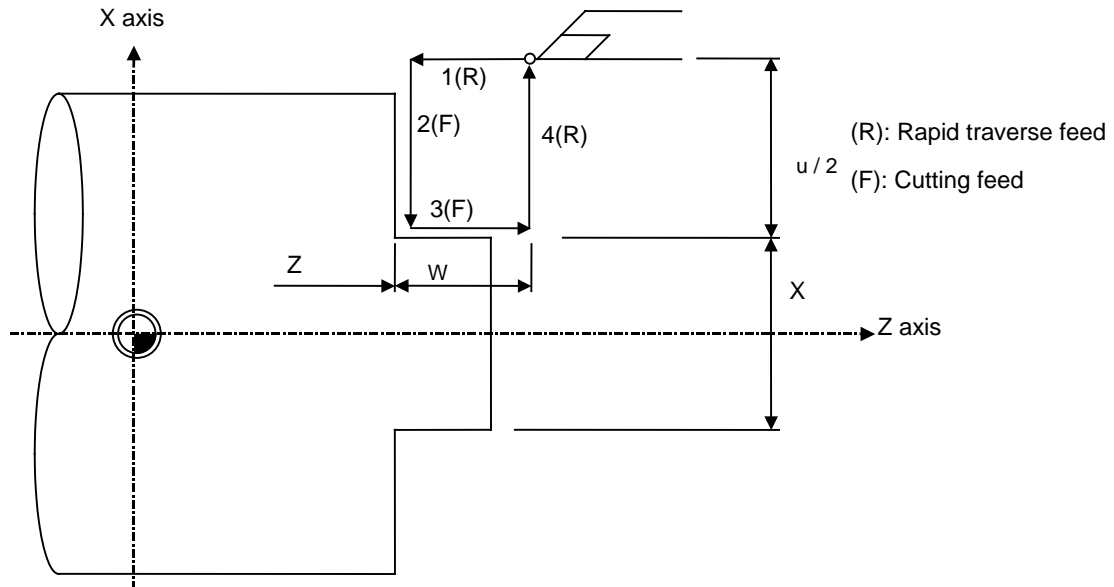
$\theta$  : Thread cutting-up angle  
The thread cutting-up angle can be set in a given parameter in 1° steps in the range of 0 to 89°.

(3) Face cutting cycle (G79)

(a) Straight cutting

Straight cutting in the end face direction can be performed consecutively by the following block:

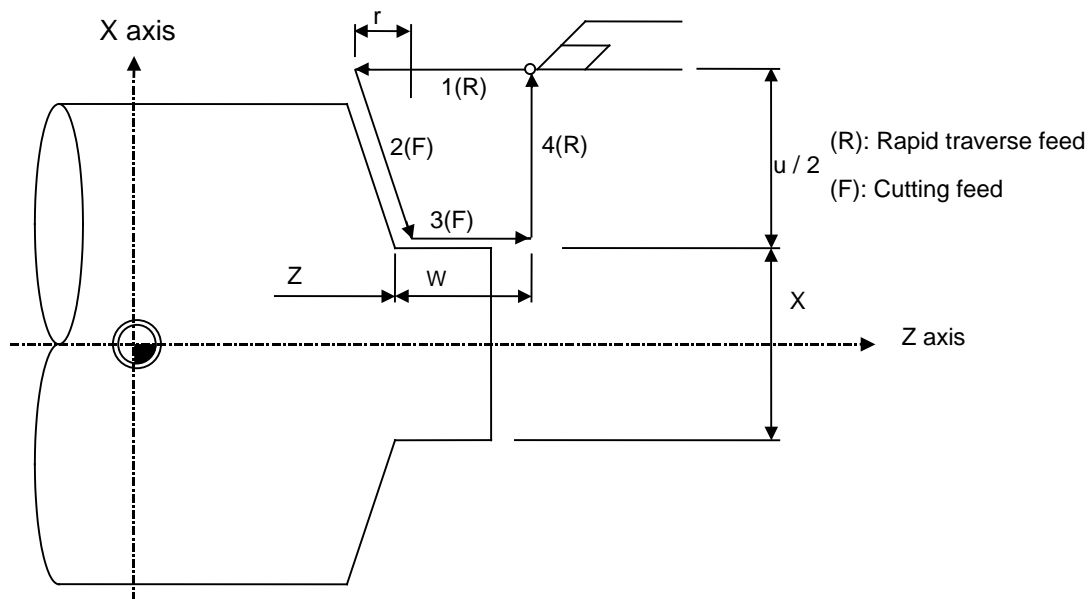
```
G79 X/U_ Z/W_ F_ ;
```



(b) Taper cutting

Taper cutting in the end face direction can be performed consecutively by the following block:

```
G79 X/U_ Z/W_ R_ F_ ;
```



r: Taper part depth (radius designation, incremental value, sign is required)

12.1.3.5 Compound Type Fixed Cycle for Turning Machining

M system : -

L system : O

The shape normally programmed in several blocks for rough cutting, etc., in the turning machining can be commanded in one block. This function is useful for machining program simplification.

Compound type fixed cycle for turning machining are as follows:

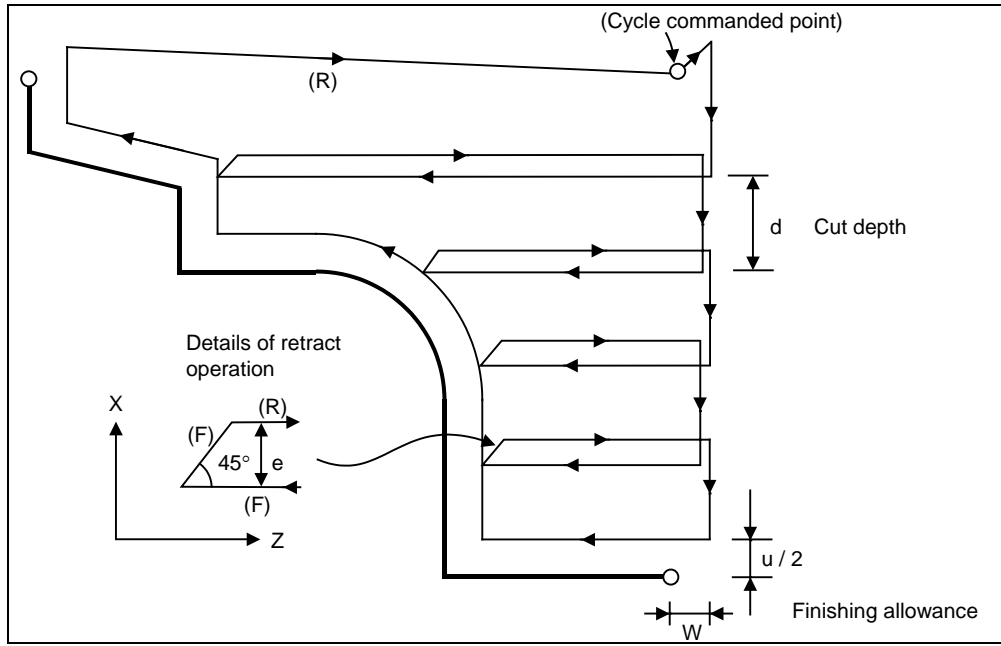
| G code | Function                                 |
|--------|--|
| G71    | Longitudinal rough cutting cycle         |
| G72    | Face rough cutting cycle                 |
| G73    | Molding material in rough cutting cycle  |
| G70    | Finish cycle                             |
| G74    | Face cutting-off cycle                   |
| G75    | Longitudinal cutting-off cycle           |
| G76    | Multiple repetitive thread cutting cycle |

(1) Longitudinal rough cutting cycle (G71)

The finish shape program is called, and straight rough cutting is performed while intermediate path is being calculated automatically.

The machining program is commanded as follows.

|            |  |   |
|------------|--|---|
| <b>G71</b> | <b>Ud Re ;</b>   |   |
| <b>G71</b> | <b>Aa Pp Qq Uu Ww Ff Ss Tt ;</b>   |   |
| Ud         | : Cut depth d. (When P,Q command is not given). (Modal)  |   |
| Re         | : Retract amount e. (Modal)  |   |
| Aa         | : Finish shape program No. (If it is omitted, the program being executed is assumed to be designated.)   |   |
| Pp         | : Finish shape start sequence No. (If it is omitted, the program top is assumed to be designated.)   |   |
| Qq         | : Finish shape end sequence No. (If it is omitted, the program end is assumed to be designated.)<br>However, if M99 precedes the Q command, up to M99. |   |
| Uu         | : Finishing allowance in the X axis direction. (When P, Q command is given). (Diameter or radius designation)  |   |
| Ww         | : Finishing allowance in the Z axis direction.   |   |
| Ff         | : Cutting feed rate.   | } F, S, and T command in the finish shape program are ignored, and the value in the rough cutting command or the preceding value becomes effective. |
| Ss         | : Spindle speed.   |   |
| Tt         | : Tool command.  |   |

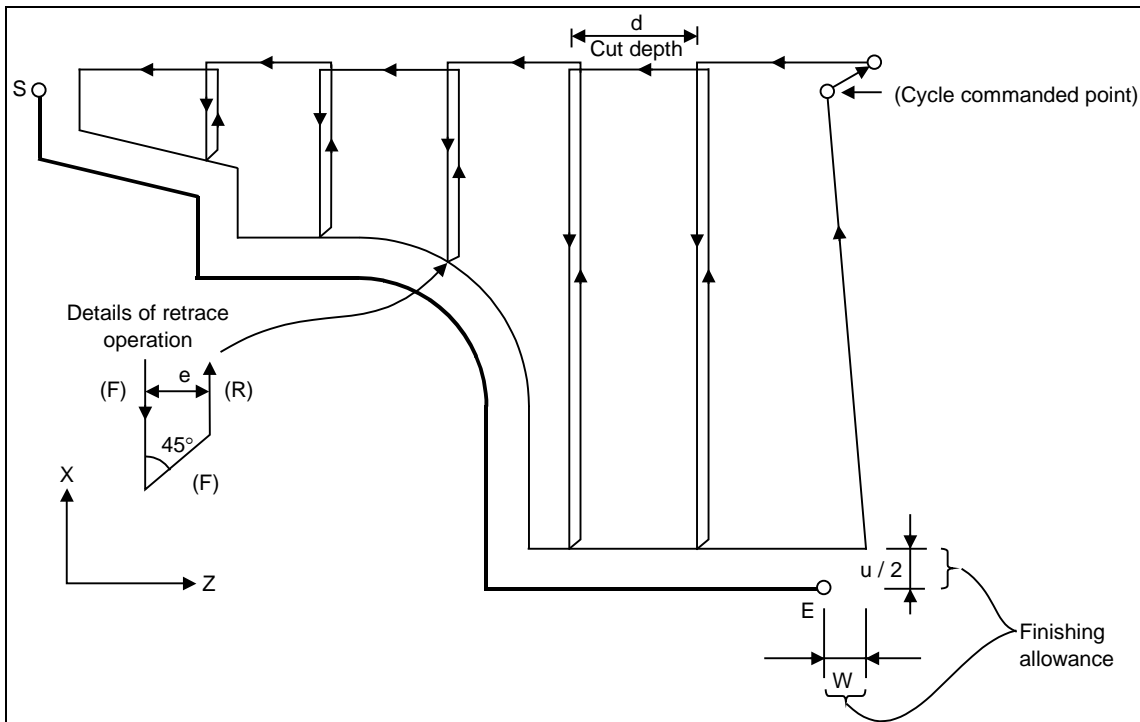


(2) Face rough cutting cycle (G72)

The finish shape program is called, and rough turning is performed in the end face direction while intermediate path is being calculated automatically.

The machining program is commanded as follows.

|            |                                  |  |
|------------|----------------------------------|--|
| <b>G72</b> | <b>Wd Re ;</b>                   |  |
| <b>G72</b> | <b>Aa Pp Qq Uu Ww Ff Ss Tt ;</b> |  |
| Wd         | :                                | Cut depth d. (When P,Q command is not given). (Modal)  |
| Re         | :                                | Retract amount e. (Modal)  |
| Aa         | :                                | Finish shape program No. (If it is omitted, the program being executed is assumed to be designated.)   |
| Pp         | :                                | Finish shape start sequence No. (If it is omitted, the program top is assumed to be designated.)   |
| Qq         | :                                | Finish shape end sequence No. (If it is omitted, the program end is assumed to be designated.)<br>However, if M99 precedes the Q command, up to M99. |
| Uu         | :                                | Finishing allowance in the X axis direction.   |
| Ww         | :                                | Finishing allowance in the Z axis direction. (When P, Q command is given.)   |
| Ff         | :                                | Cutting feed rate.   |
| Ss         | :                                | Spindle speed.   |
| Tt         | :                                | Tool command.  |
|            |                                  | F, S, and T command in the finish shape program are ignored, and the value in the rough cutting command or the preceding value becomes effective.    |



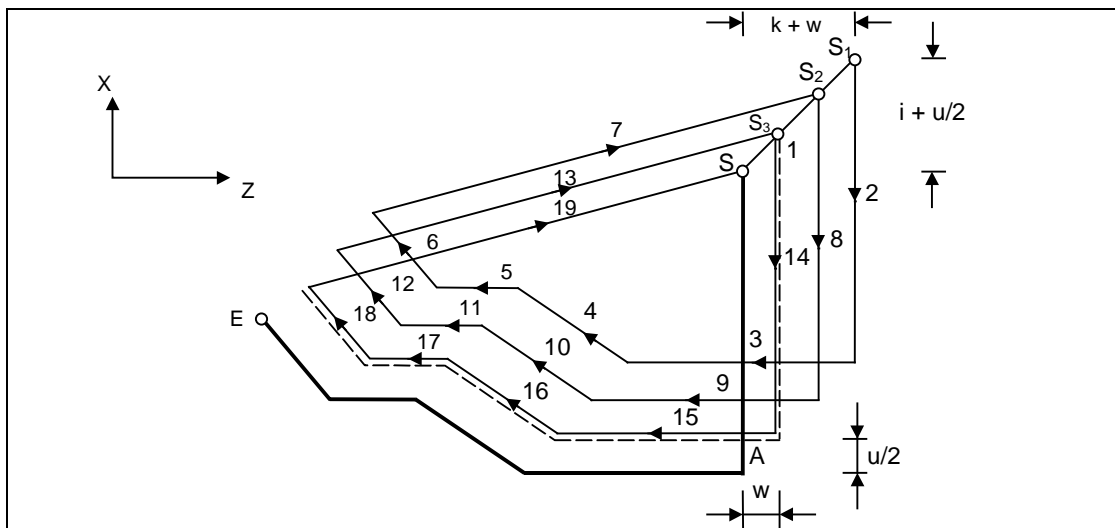


(3) Molding material in rough cutting cycle (G73)

The finish shape program is called. Intermediate path is automatically calculated and rough cutting is performed conforming to the finish shape.

The machining program is commanded as follows.

|            |   |           |             |           |  |  |           |           |   |
|------------|---|-----------|-------------|-----------|--|--|-----------|-----------|---|
| <b>G73</b> | <b>Ui</b>                                     | <b>Wk</b> | <b>Rd</b> ; |           |  |  |           |           |   |
| <b>G73</b> | <b>Aa</b>                                     | <b>Pp</b> | <b>Qq</b>   | <b>Uu</b> | <b>Ww</b>  | <b>Ff</b>  | <b>Ss</b> | <b>Tt</b> | ; |
| Ui         | : Cutting allowance in the X axis direction   |           |             | i         | } • Cutting allowance when P, Q command is not given.<br>• Modal data<br>• Sign is ignored.<br>• Cutting allowance is given with a radius designation.   |  |           |           |   |
| Wk         | : Cutting allowance in the Z axis direction   |           |             | k         |  |  |           |           |   |
| Rd         | : Split count                                 |           |             | d         |  |  |           |           |   |
| Aa         | : Finish shape program No.                    |           |             |           |  | (If it is omitted, the present program is assumed to be designated.)   |           |           |   |
| Pp         | : Finish shape start sequence No.             |           |             |           |  | (If it is omitted, the program top is assumed to be designated.)   |           |           |   |
| Qq         | : Finish shape end sequence No.               |           |             |           |  | (If it is omitted, the program end is assumed to be designated.)<br>However, if M99 precedes the Qq command, up to M99.                                  |           |           |   |
| Uu         | : Finishing allowance in the X axis direction |           |             | u         | } • Finishing allowance when P, Q command is given.<br>• Sign is ignored.<br>• Diameter or radius is designated according to the parameter.<br>• The shift direction is determined by the shape. |  |           |           |   |
| Ww         | : Finishing allowance in the Z axis direction |           |             | w         |  |  |           |           |   |
| Ff         | : Cutting feed rate (F function)              |           |             |           |  | } The F, S, and T commands in the finish shape program are ignored, and the value in the rough cutting command or the preceding value becomes effective. |           |           |   |
| Ss         | : Spindle speed (S function)                  |           |             |           |  |  |           |           |   |
| Tt         | : Tool selection (T function)                 |           |             |           |  |  |           |           |   |



(4) Finish cycle (G70)

After rough cutting is performed by using G71 to G73, finish turning can be performed by using the G70 command.

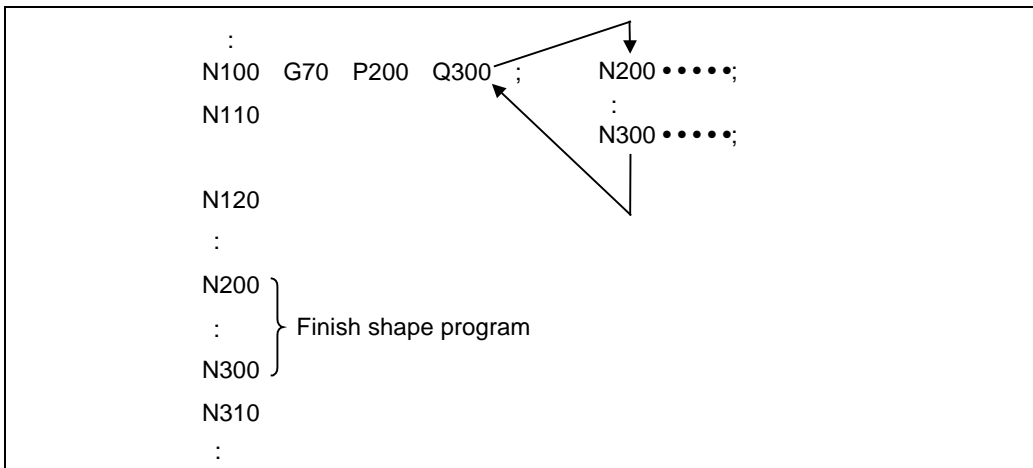
The machining program is commanded as follows.

```

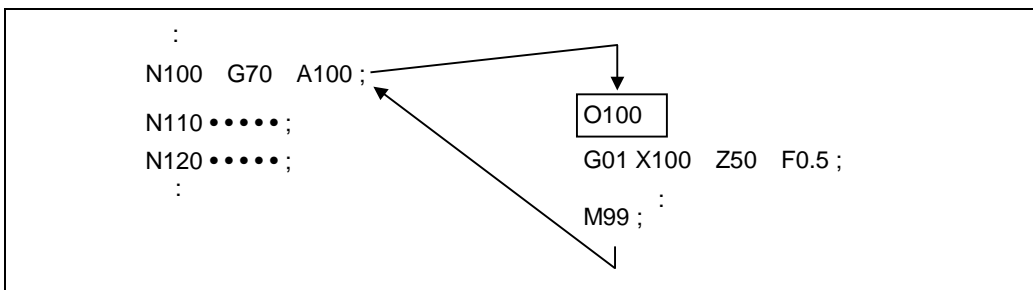
G70 A_P_Q ;
A      : Finish shape program number. (If it is omitted, the program being executed is
        : assumed to be designated.)
P      : Finish shape start sequence number. (If it is omitted, the program top is
        : assumed to be designated.)
Q      : Finish shape end sequence number. (If it is omitted, the program end is
        : assumed to be designated.)
        :
        : However, if M99 precedes the Q command, up to M99.
    
```

- (a) The F, S, and T commands in the rough cutting cycle command G71 to G73 blocks are ignored, and the F, S, and T commands in the finish shape program become effective.
- (b) The memory address of the finish shape program executed by G71 to G72 is not stored. Whenever G70 is executed, a program search is made.
- (c) When the G70 cycle terminates, the tool returns to the start point at the rapid traverse feed rate and the next block is read.

**(Example 1)** Sequence No. designation



**(Example 2)** Program No. designation

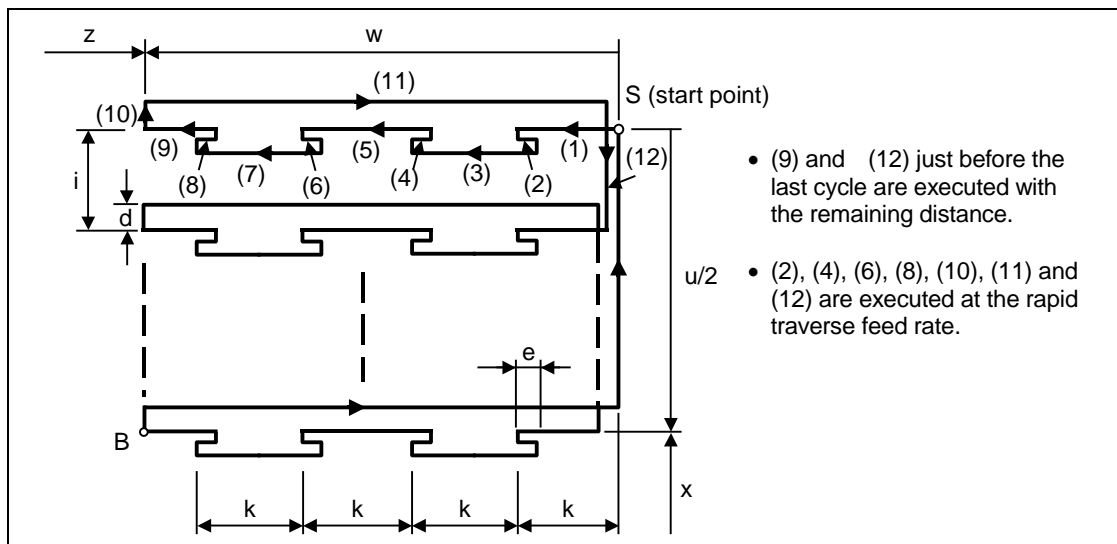


In either example 1 or 2, after the N100 cycle is executed, the N110 block is executed.

#### (5) Face cutting-off cycle (G74)

When the slotting end point coordinates, cut depth, cutting tool shift amount, and cutting tool relief amount at the cut bottom are commanded, automatic slotting is performed in the end face direction of a given bar by G74 fixed cycle. The machining program is commanded as follows.

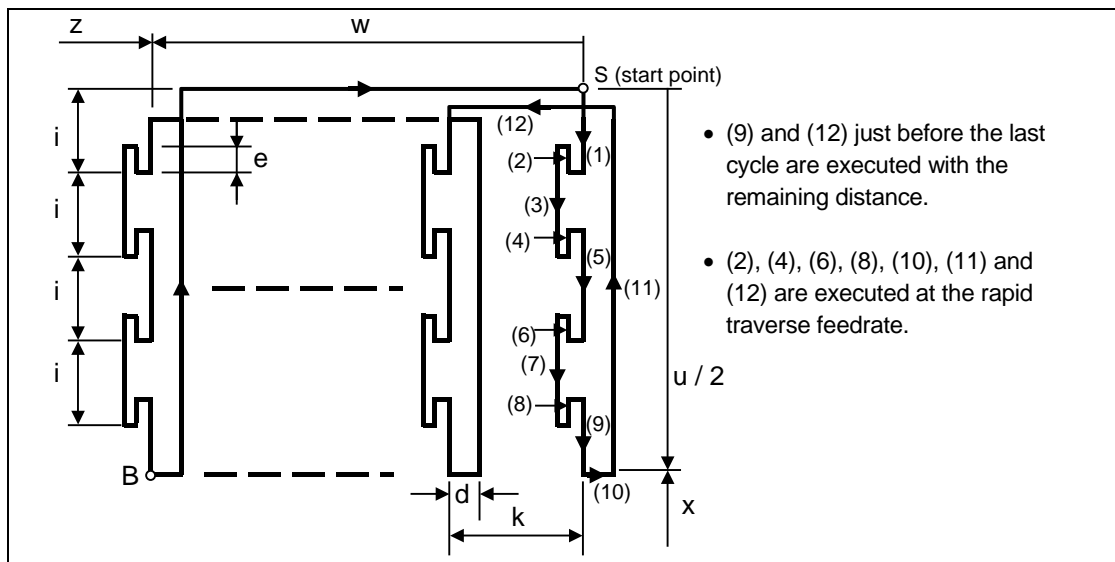
|            |  |
|------------|--|
| <b>G74</b> | <b>Re ;</b>  |
| <b>G74</b> | <b>X/(U) Z/(W) Pi Qk Rd Ff ;</b>   |
| Re         | : Retract amount e (when X/U, Z/W command is not given) (Modal)  |
| X/U        | : B point coordinate (absolute/incremental)  |
| Z/W        | : B point coordinate (absolute/incremental)  |
| Pi         | : Tool shift amount (radius designation, incremental, sign not required)   |
| Qk         | : Cut depth k (radius designation, incremental, sign not required)   |
| Rd         | : Relief amount at cut bottom d (If sign is not provided, relief is made at the first cut bottom. If minus sign is provided, relief is made not at the first cut bottom but at the second cut bottom and later.) |
| Ff         | : Feed rate  |



#### (6) Longitudinal cutting-off cycle (G75)

When the slotting end point coordinates, cut depth, cutting tool shift amount, and cutting tool relief amount at the cut bottom are commanded, automatic slotting is performed in the longitudinal direction of a given bar by G75 fixed cycle. The machining program is commanded as follows.

|            |  |
|------------|--|
| <b>G75</b> | <b>Re ;</b>  |
| <b>G75</b> | <b>X/(U) Z/(W) Pi Qk Rd Ff ;</b>   |
| Re         | : Retract amount e (when X/U, Z/W command is not given) (Modal)  |
| X/U        | : B point coordinate (absolute/incremental)  |
| Z/W        | : B point coordinate (absolute/incremental)  |
| P          | : Tool shift amount (radius designation, incremental, sign not required)   |
| Qk         | : Cut depth k (radius designation, incremental, sign not required)   |
| Rd         | : Relief amount at cut bottom d (If sign is not provided, relief is made at the first cut bottom. If $\ominus$ sign is provided, relief is made not at the first cut bottom but at the second cut bottom and later.) |
| Ff         | : Feed rate  |



## (7) Multiple repetitive thread cutting cycle (G76)

When the thread cutting start and end points are commanded, cut at any desired angle can be made by automatically cutting so that the cut section area (cutting torque) per time becomes constant in the G76 fixed cycle.

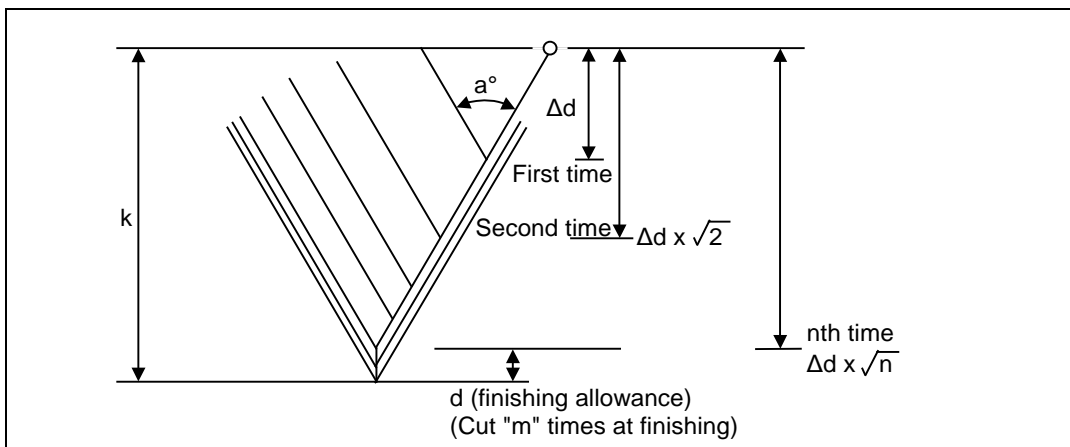
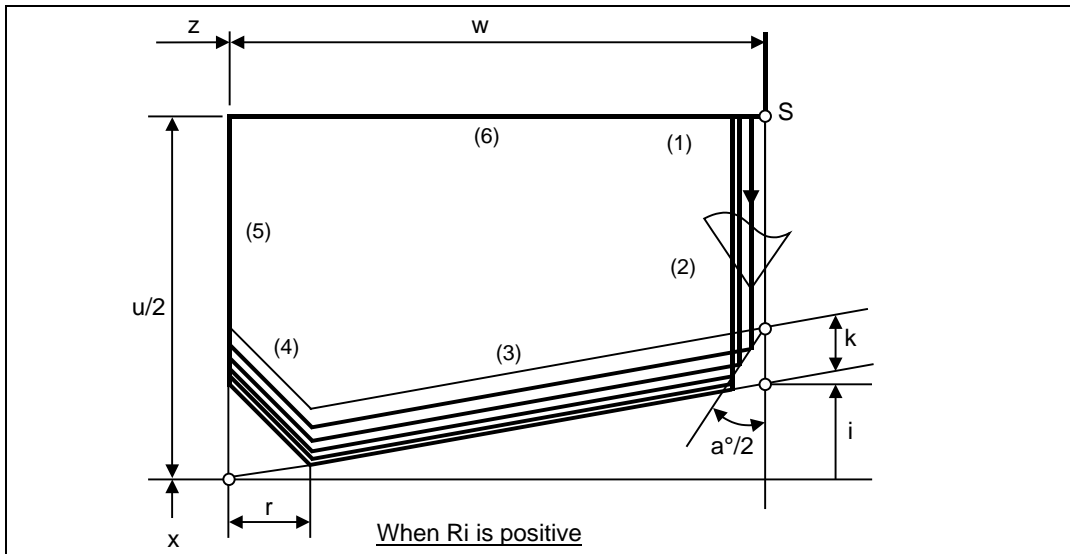
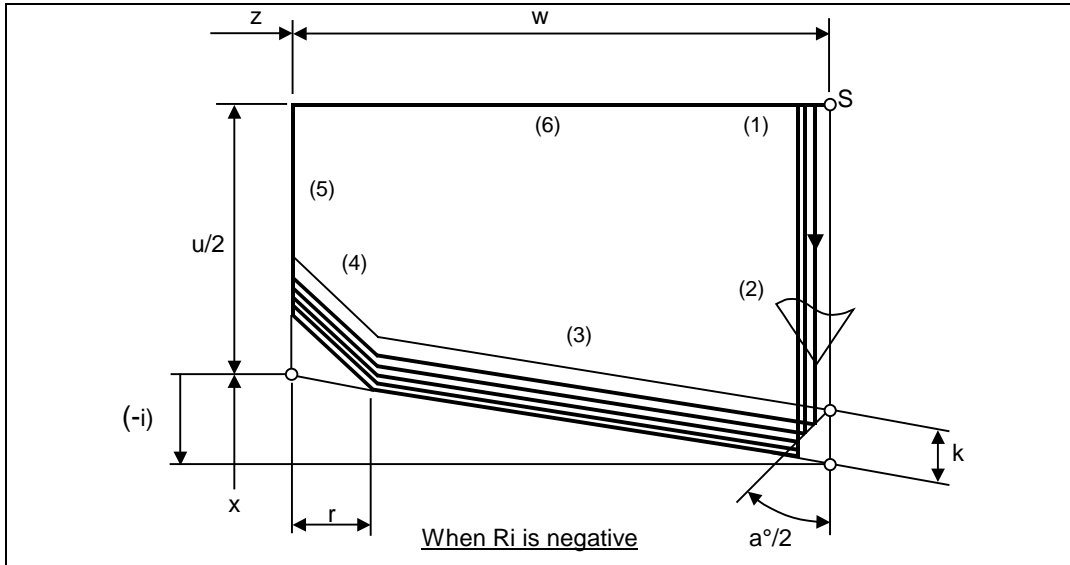
Various longitudinal threads can be cut by considering the thread cutting end point coordinate and taper height constituent command value.

**Command Format**

|            |  |
|------------|--|
| <b>G76</b> | <b>Pmra Rd ;</b>   |
| <b>G76</b> | <b>X/U Z/W Ri Pk QΔd FI ;</b>  |
| m          | : Cut count at finishing 01 to 99 (modal)  |
| r          | : Chamfering amount 00 to 99 (modal). Set in 0.1-lead increments.  |
| a          | : Nose angle (included angle of thread) 00 to 99 (modal) Set in 1-degree increments.   |
| d          | : Finishing allowance (modal)  |
| X/U        | : X axis end point coordinate of thread part.<br>Designate the X coordinate of the end point in the thread part in an absolute or incremental value. |
| Z/W        | : Z axis end point coordinate of thread part.<br>Designate the Z coordinate of the end point in the thread part in an absolute or incremental value. |
| i          | : Taper height constituent in thread part (radius value). When i = 0 is set, straight screw is made.   |
| k          | : Thread height. Designate the thread height in a positive radius value.   |
| Δd         | : Cut depth. Designate the first cut depth in a positive radius value.   |
| l          | : Thread lead  |

**Configuration of one cycle**

In one cycle, (1), (2), (5), and (6) move at rapid traverse feed and (3) and (4) move at cutting feed designated in F.



## 12.1.4 Mirror Image

## 12.1.4.3 Mirror Image by G Code

**M system : O****L system : -**

Using a program for the left or right side of an image, this function can machine the other side of the image when a left/right symmetrical shape is to be cut.

Mirror image can be applied directly by a G code when preparing a machining program.

The program format for the G code mirror image is shown below.

|               |            |            |            |                                      |
|---------------|------------|------------|------------|--------------------------------------|
| <b>G51.1</b>  | <b>Xx1</b> | <b>Yy1</b> | <b>Zz1</b> | ;                                    |
| G51.1         |            |            |            | : Mirror image on                    |
| Xx1, Yy1, Zz1 |            |            |            | : Command axes and command positions |

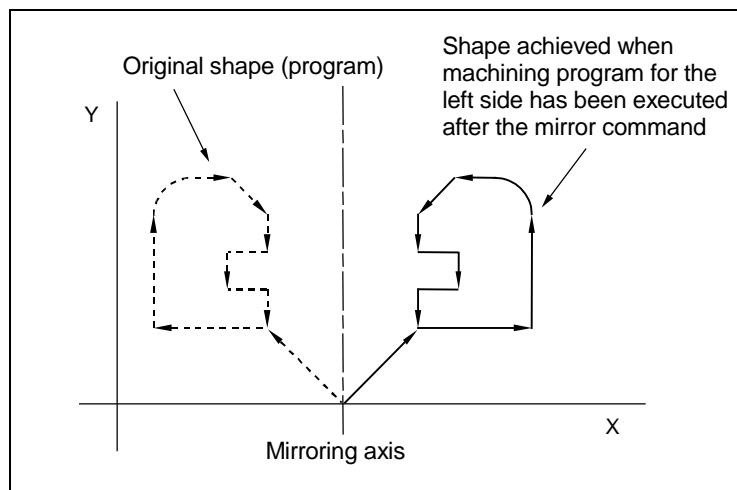
With the local coordinate system, the mirror image is applied with the mirror positioned respectively at x1, y1 and z1.

The program format for the G code mirror image cancel is shown below.

|               |            |            |            |                       |
|---------------|------------|------------|------------|-----------------------|
| <b>G50.1</b>  | <b>Xx1</b> | <b>Yy1</b> | <b>Zz1</b> | ;                     |
| G50.1         |            |            |            | : Mirror image cancel |
| Xx1, Yy1, Zz1 |            |            |            | : Command axes        |

The coordinate word indicates the axes for which the mirror image function is to be canceled and the coordinates are ignored.

In the case of G51.1 Xx1



## 12.1.4.4 Mirror Image for Facing Tool Posts

**M system** : -**L system** :  $\Delta$ 

With machines in which the base tool post and facing tool post are integrated, this function enables the programs prepared for cutting at the base side to be executed by the tools on the facing side. The distance between the two posts is set beforehand with the parameter.

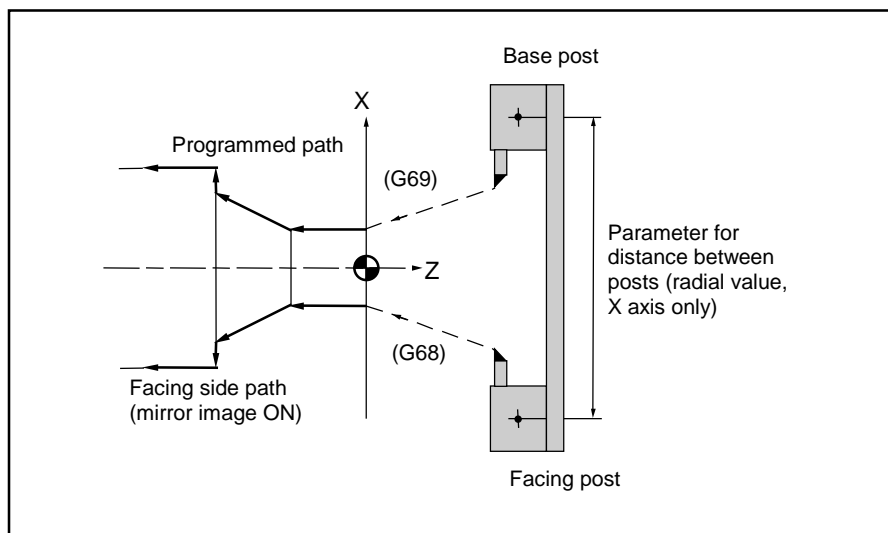
The command format is given below.

|             |                                   |
|-------------|-----------------------------------|
| <b>G68;</b> | Facing tool post mirror image ON  |
| <b>G69;</b> | Facing tool post mirror image OFF |

When the G68 command is issued, the subsequent program coordinate systems are shifted to the facing side and the movement direction of the X axis is made the opposite of that commanded by the program. When the G69 command is issued, the subsequent program coordinate systems are returned to the base side.

The facing tool post mirror image function can be set to ON or OFF automatically by means of T (tool) commands without assigning the G68 command.

A parameter is used to set ON or OFF for the facing tool post mirror image function corresponding to the T commands.





12.1.5 Coordinate System Operation

12.1.5.1 Coordinate Rotation by Program

M system : Δ

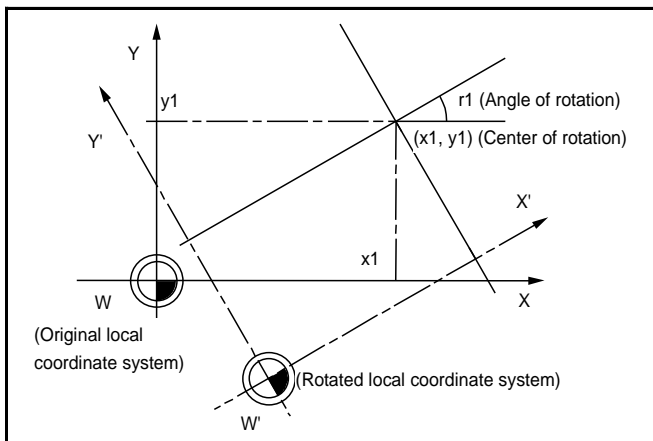
L system : Δ

When it is necessary to machine a complicated shape at a position that has been rotated with respect to the coordinate system, you can machine a rotated shape by programming the shape prior to rotation on the local coordinate system, and then specifying the parallel shift amount and rotation angle by means of this coordinate rotation command.

The program format for the coordinate rotation command is given below.

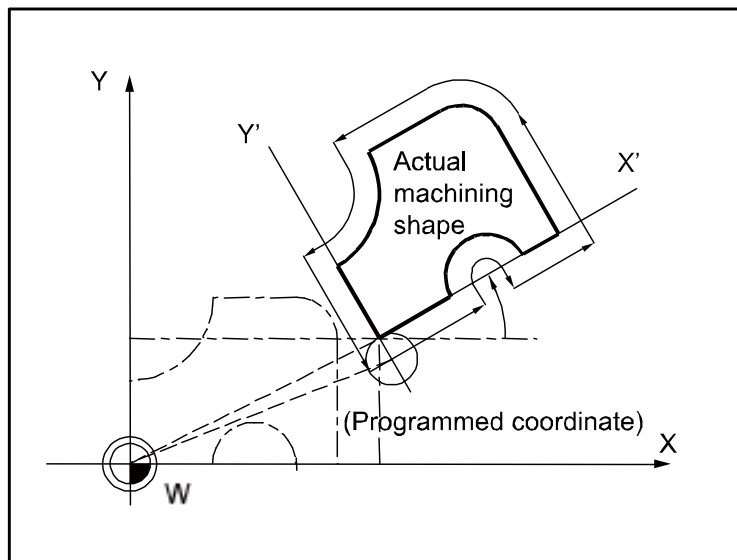
(1) M system

|                 |                      |                             |
|-----------------|----------------------|-----------------------------|
| <b>G68</b>      | <b>Xx1 Yy1 Rr1 ;</b> | Coordinate rotation ON      |
| <b>G69</b>      | <b>;</b>             | Coordinate rotation cancel  |
| <b>G68</b>      | <b>:</b>             | Coordinate rotation command |
| <b>Xx1, Yy1</b> | <b>:</b>             | Rotation center coordinates |
| <b>Rr1:</b>     | <b>:</b>             | Angle of rotation           |



- (1) Angle of rotation "r1" can be set in least input increment from  $-360^\circ$  to  $360^\circ$ .
- (2) The coordinates are rotated counterclockwise by an amount equivalent to the angle which is designated by angle of rotation "r1".
- (3) The counter is indicated as the point on the coordinate system prior to rotation.
- (4) The rotation center coordinates are assigned with absolute values.

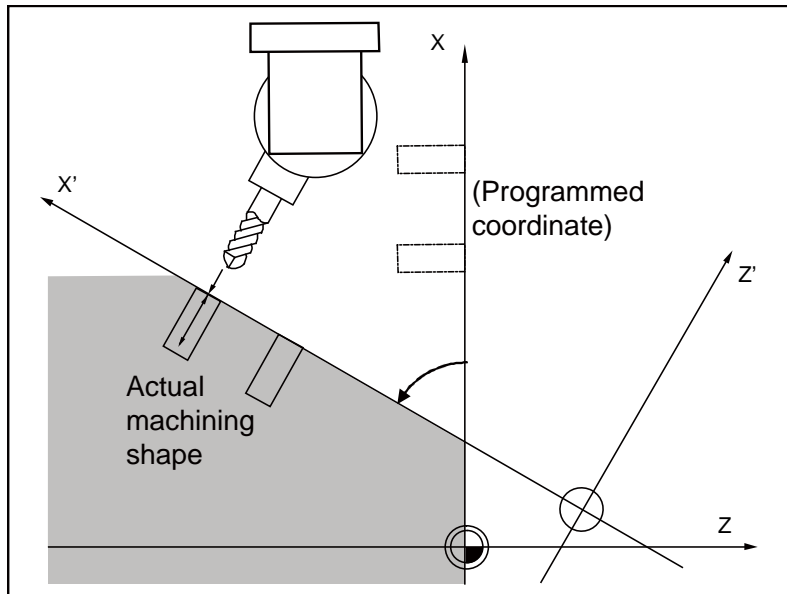
(Example)



(2) L system

|              |            |            |            |   |                             |
|--------------|------------|------------|------------|---|-----------------------------|
| <b>G68.1</b> | <b>Xx1</b> | <b>Zz1</b> | <b>Rr1</b> | ; | Coordinate rotation ON      |
| <b>G69.1</b> |            |            |            | ; | Coordinate rotation cancel  |
| G68.1        |            |            |            | : | Coordinate rotation command |
| Xx1, Zz1     |            |            |            | : | Rotation center coordinates |
| Rr1:         |            |            |            | : | Angle of rotation           |

(Example)



## 12.1.6 Dimension Input

## 12.1.6.1 Corner Chamfering/Corner R

M system :  $\Delta$ L system :  $\Delta$ 

This function executes corner processing by automatically inserting a straight line or arc in the commanded amount between two consecutive movement blocks (G01/G02/G03). The corner command is executed by assigning the ",C" or ",R" command for the block at whose end point the corner is inserted.

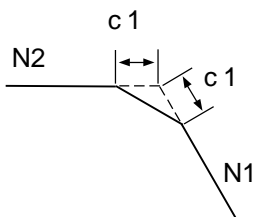
## (1) Corner chamfering / Corner R I

When ",C" or ",R" is commanded for linear interpolation, corner chamfering or corner R can be inserted between linear blocks.

- Corner chamfering

## Example:

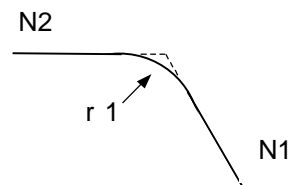
```
N1 G01 Xx1 Zz1, Cc1 ;
N2 Zz2 ;
```



- Corner R

## Example:

```
N1 G01 Xx1 Zz1, Rr1 ;
N2 Zz2 ;
```

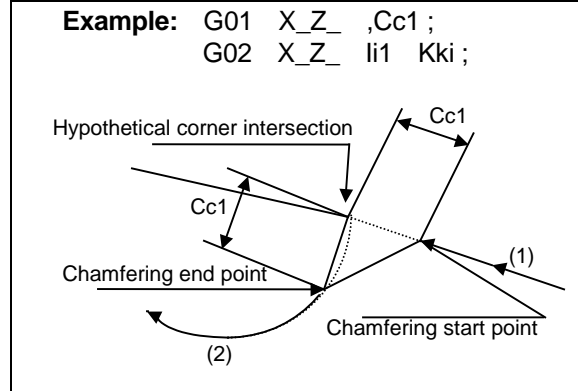


**(Note 1)** If a corner chamfering or corner R command is issued specifying a length longer than the N1 or N2 block, a program error occurs.

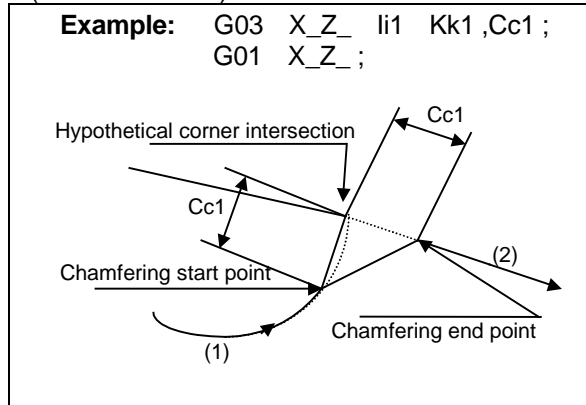
(2) Corner chamfering / corner R II (L system)

When ",C" or ",R" is command in a program between linear-circular, corner chamfering or corner R can be inserted between blocks.

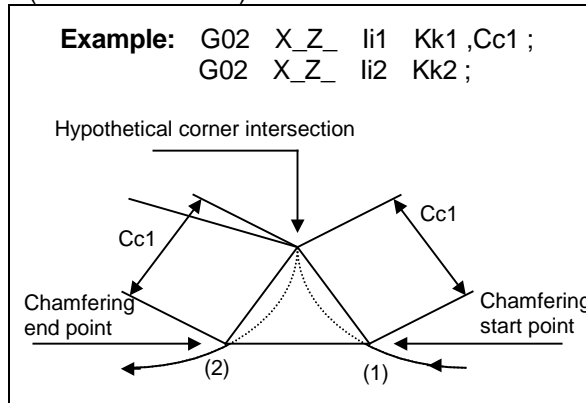
(a) Corner chamfering II (Linear - circular)



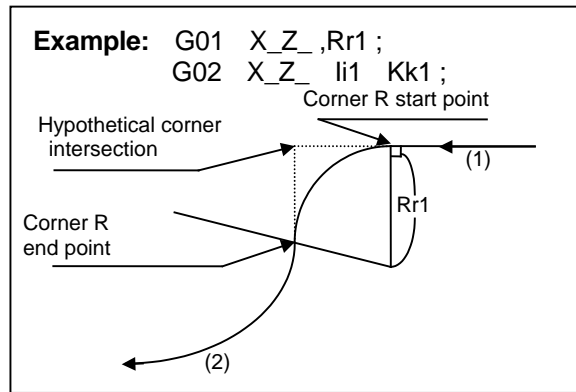
(b) Corner chamfering II (Circular - linear)



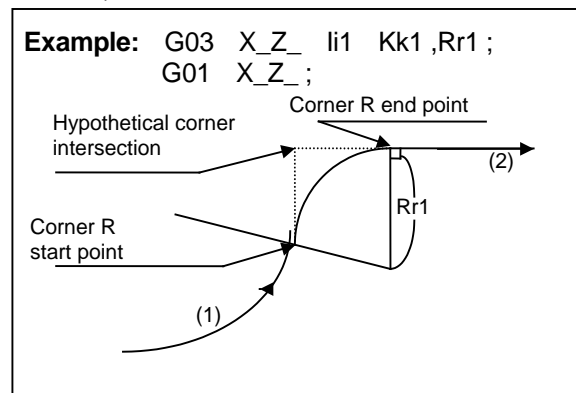
(c) Corner chamfering II (Circular - circular)



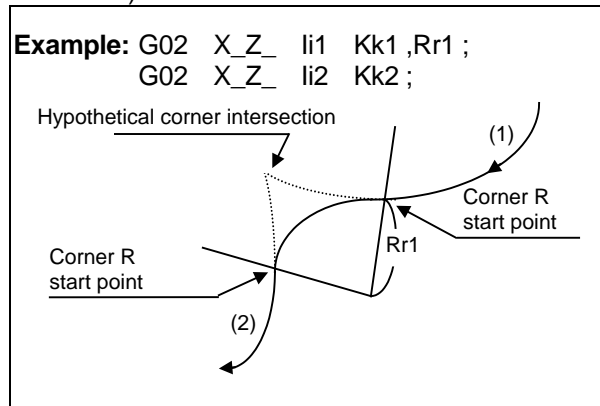
(d) Corner R II (Linear - circular)



(e) Corner R II (Circular - linear)

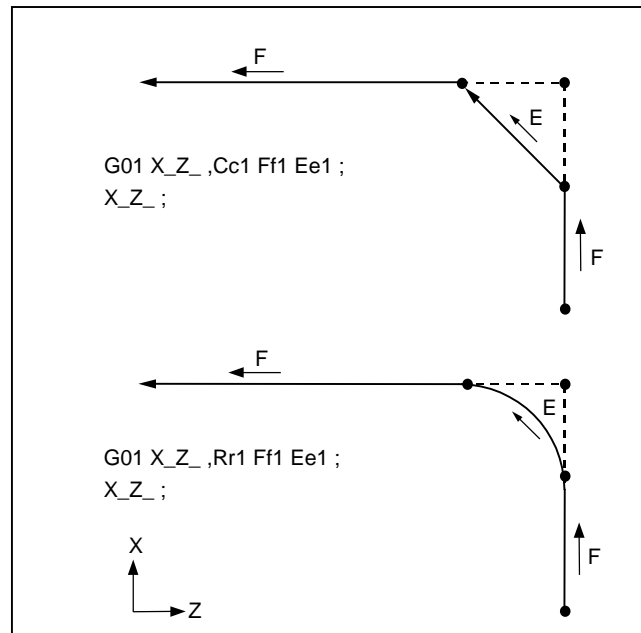


(f) Corner R II (Circular - circular)



## (3) Specification of corner chamfering / corner R speed E

An E command can be used to specify the speed for corner chamfering or corner R.  
This enables a corner to be cut to a correct shape.

**(Example)**

An E command is a modal and remains effective for feeding in next corner chamfering or corner R.

An E command has two separate modals: synchronous and asynchronous feed rate modals. The effective feed rate is determined by synchronous (G95) or asynchronous (G94) mode.

If an E command is specified in 0 or no E command has been specified, the feed rate specified by an F command is assumed as the feed rate for corner chamfering or corner R.

Hold or non-hold can be selected (M system only) using a parameter for the E command modal at the time of resetting. It is cleared when the power is turned OFF (as it is with an F command).

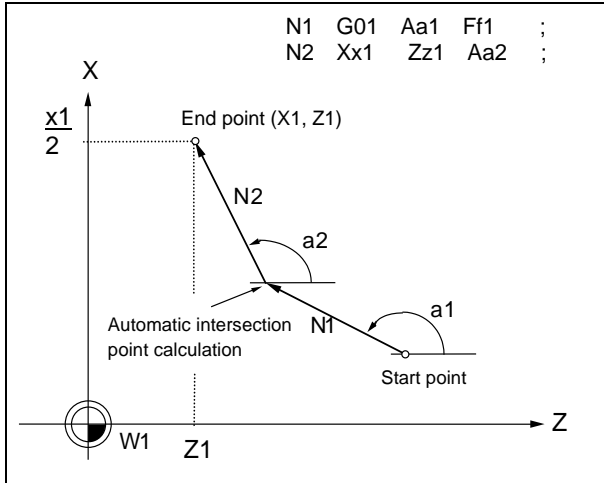
12.1.6.3 Geometric Command

M system : -

L system : O

When it is difficult to find the intersection point of two straight lines with a continuous linear interpolation command, this point can be calculated automatically by programming the command for the angle of the straight lines.

Example



a: Angle (°) formed between straight line and horizontal axis on plane.  
 The plane is the selected plane at this point.

**(Note 1)** This function cannot be used when using the A axis or 2nd miscellaneous function A.

(1) Automatic calculation of two-arc contact

When two continuous circular arcs contact with each other and it is difficult to find the contact, the contact is automatically calculated by specifying the center coordinates or radius of the first circular arc and the end point absolute coordinates and center coordinates or radius of the second circular arc.

**Example**

```

G18 G02 Ii1 Kk1 Ff1 ;
      G03 Xxc Zzx Ii2 Kk2 Ff2 ;
or
G18 G02 Ii1 Kk1 Ff1 ;
      G03 Xxc Zzc Rr2 Ff2 ;
or
G18 G02 Rr1 Ff1 ;
      G03 Xxc Zzc Ii2 Kk2 Ff2 ;
    
```

I and K are circular center coordinate incremental values; distances from the start point in the first block or distances from the end point in the second block. P and Q commands (X, Z absolute center coordinates of circular arc) can be given instead of I and K commands.

(2) Automatic calculation of linear-arc intersection

When it is difficult to find the intersections of a given line and circular arc, the intersections are automatically calculated by programming the following blocks.

**Example**

```

G18 G01 Aa1 Ff1 ;
      G02 Xxc Zzc Ii2 Kk2 Hh2 Ff2 ;
    
```

I and K : Incremental coordinates from circular end point  
 P and Q : Absolute center coordinates of circular arc  
 H = 0 : Intersection with shorter line  
 H = 1 : Intersection with longer line



(3) Automatic calculation of arc-linear intersection

When it is difficult to find the intersections of a given circular arc and line, the intersections are automatically calculated by programming the following blocks.

**Example**

```
G18 G03 Ii1 Kk1 Hh1 Ff1 ;
      G01 Xxc Zzc Aa1 Ff2 ;
```

I and K : Incremental coordinates from circular end point  
 P and Q : Absolute center coordinates of circular arc  
 H = 0 : Intersection with shorter line  
 H = 1 : Intersection with longer line

(4) Automatic calculation of linear-arc contact

When it is difficult to find the contact of a given line and circular arc, the contact is automatically calculated by programming the following blocks.

**Example**

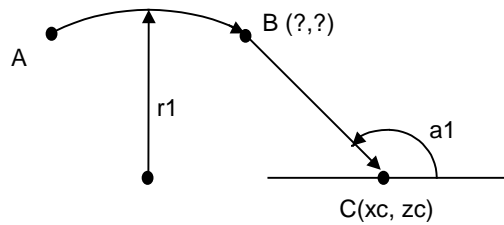
```
G01 Aa1 Ff1 ;
      G03 Xxc Zzc Rr1 Ff2 ;
```

## (5) Automatic calculation of arc-linear contact

When it is difficult to find the contact of a given circular arc and line, the contact is automatically calculated by programming the following blocks.

**Example**

```
G02 Rr1 Ff1 ;  
G01 Xxc Zzc Aa1 Ff2 ;
```



## 12.1.7 Axis Control

## 12.1.7.1 Chopping

## 12.1.7.1.1 Chopping

M system :  $\Delta$ L system :  $\Delta$ 

With this function, the chopping axis constantly moves back and forth independently of the program operation during executing the machining program. During the grinding operation, chopping can produce a better surface accuracy than using abrasive grain.

**G81.1 Z\_ Q\_ F\_ ; Starting the chopping operation**

Z\_ : The upper dead point (Select the chopping axis with commanded axis address)

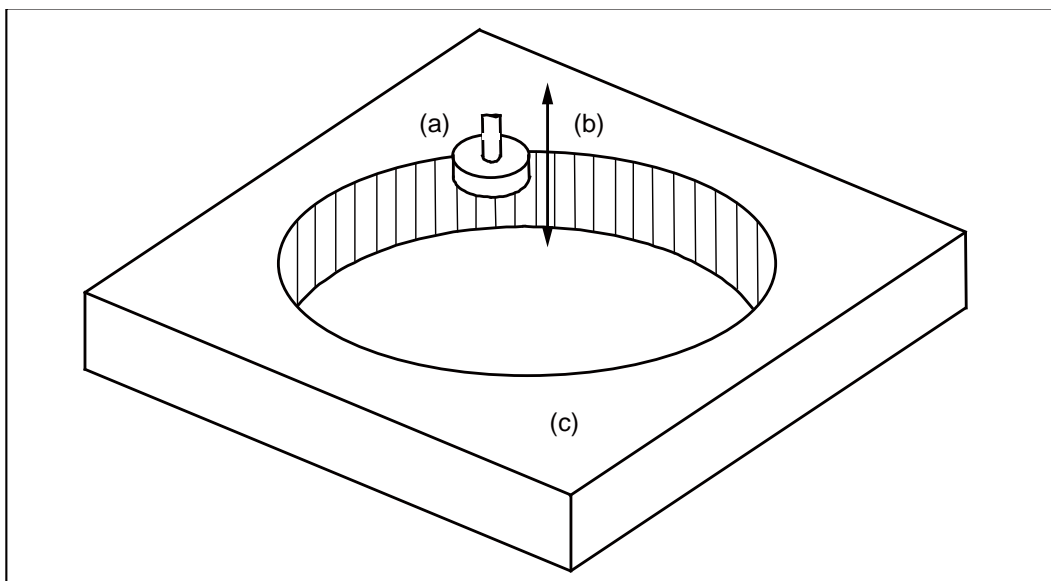
Q\_ : Command the distance between the upper dead point and the lower dead point with incremental value

F\_ : Command the feedrate during chopping (mm/min)

**G80 ; Cancelling the chopping operation**

This function continuously raises and lowers the chopping axis independently of program operation when workpiece contours are to be cut.

There are two types of commands for the chopping function: a command by the machining program and a command by a signal from the PLC. Use "#1323 chopsel (chopping command method)" to select which command to use for this function.



- (a) Grindstone
- (b) Chopping action
- (c) Workpiece

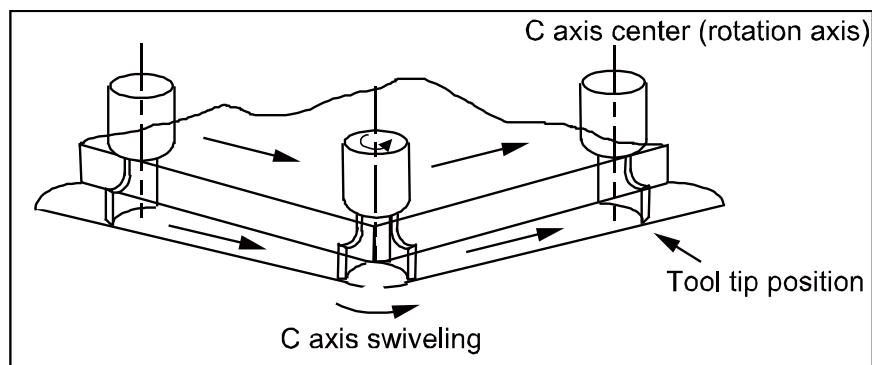
## 12.1.7.2 Normal line control

**M system :** Δ**L system :** -

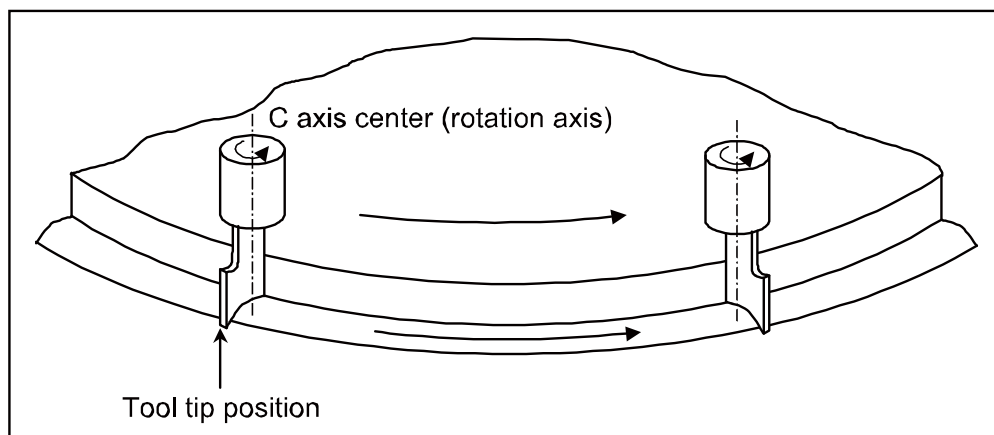
This function controls the swiveling of the C axis (rotary axis) so that the tool is always pointing in the normal line direction for movements of the axis which is selecting the plane during program operation.

| G code | Function                               |
|--------|--|
| G40.1  | Normal line direction control cancel   |
| G41.1  | Normal line direction control left ON  |
| G42.1  | Normal line direction control right ON |

At the block seams, the C axis turning is controlled so that the tool faces the normal line direction at the next block's start point.



During arc interpolation, the C axis turning is controlled in synchronization with the operation of arc interpolation.



12.1.7.3 Circular Cutting

M system : Δ

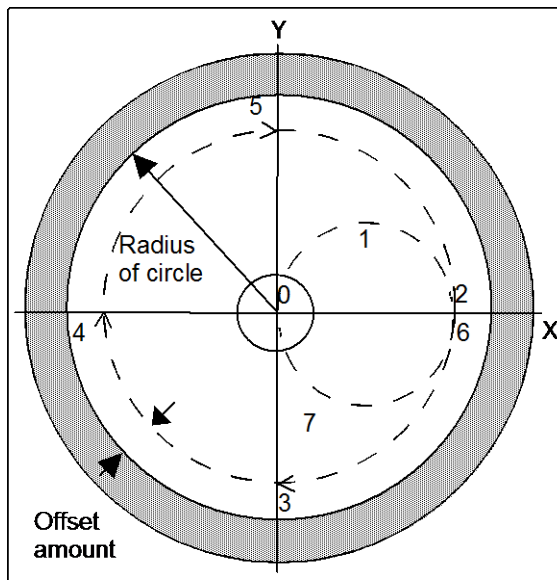
L system : -

A series of cuts is performed: first, the tool departs from the center of the circle, and by cutting along the inside circumference of the circle, it draws a complete circle, then it returns to the center of the circle. The position at which G12 or G13 has been programmed serves as the center of the circle.

| G code | Function               |
|--------|------------------------|
| G12    | CW (clockwise)         |
| G13    | CCW (counterclockwise) |

The program format is given below.

|               |           |                           |           |          |
|---------------|-----------|---------------------------|-----------|----------|
| <b>G12/13</b> | <b>li</b> | <b>Dd</b>                 | <b>Ff</b> | <b>;</b> |
| G12/13        | :         | Circular cutting command  |           |          |
| li            | :         | Radius of complete circle |           |          |
| Dd            | :         | Compensation number       |           |          |
| Ff            | :         | Feed rate                 |           |          |



When the G12 command is used  
(path of tool center)  
0 → 1 → 2 → 3 → 4 → 5 → 6 → 7 → 0  
When the G13 command is used  
(path of tool center)  
0 → 7 → 6 → 5 → 4 → 3 → 2 → 1 → 0

- (Notes)**
- Circular cutting is undertaken on the plane which has been currently selected (G17, G18 or G19).
  - The (+) and (-) signs for the compensation amount denote reduction and expansion respectively.

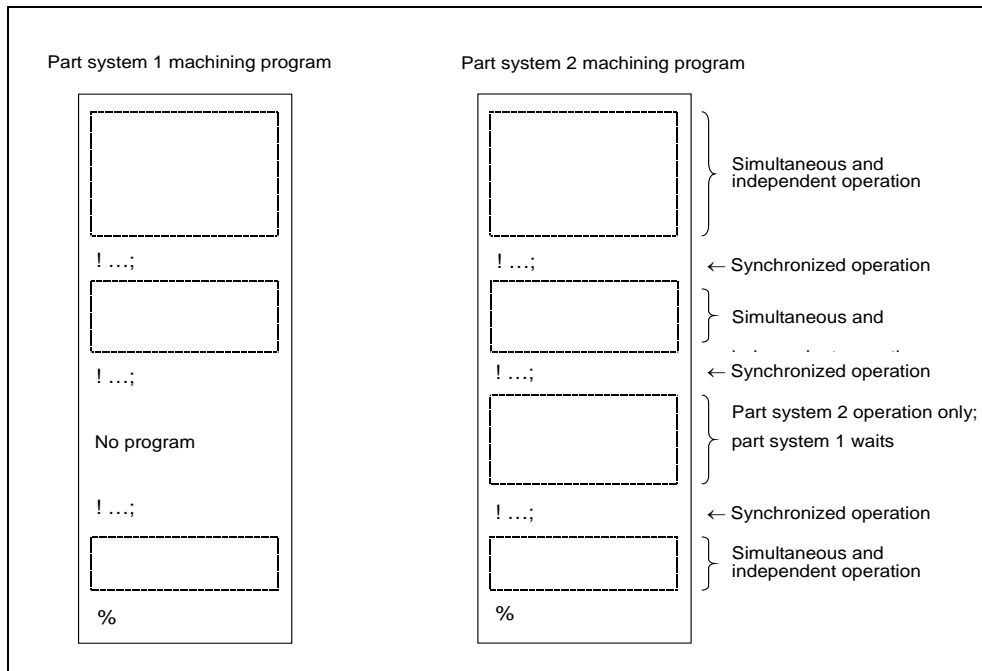
12.1.8 Multi-part System Control

12.1.8.1 Timing Synchronization Between Part Systems

M system : O

L system : O

The multi-axis, multi-part system compound control CNC system can simultaneously run multiple machining programs independently. This function is used in cases when, at some particular point during operation, the operations of different part systems are to be synchronized or in cases when the operation of only one part system is required.



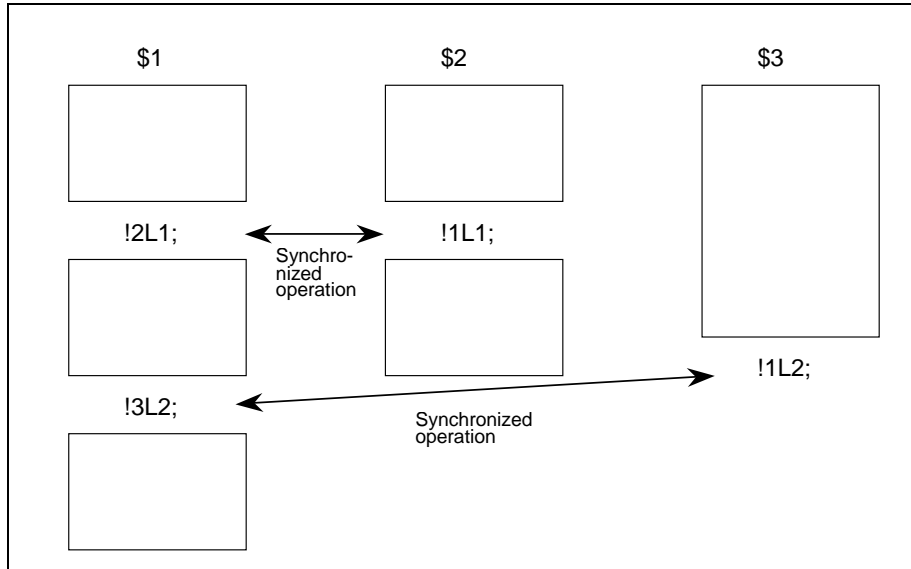
**Command format**

(1) Command for synchronizing with part system n

`!nL1 ;`

n : Part system number

1 : Synchronizing number 01 to 9999

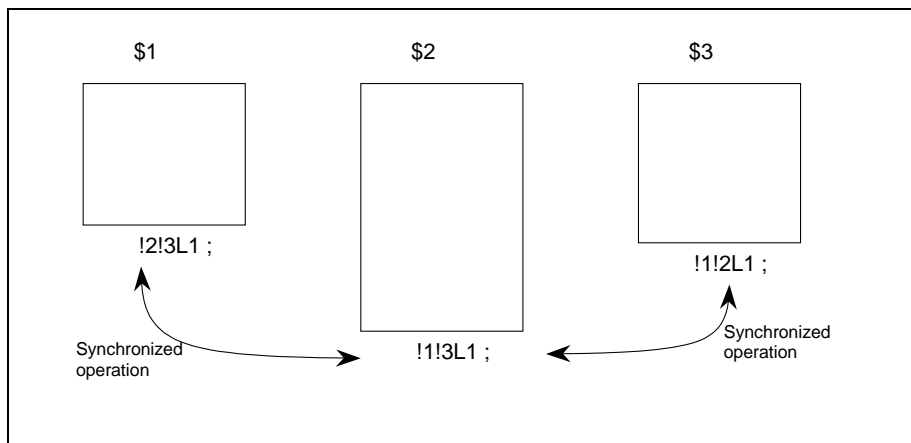


(2) Command for synchronizing among three part systems

`!n!m...L1 ;`

n, m : Part system number  $n \neq m$

1 : Synchronizing number 01 to 9999



12.1.8.2 Start Point Designation Timing Synchronization

M system : ○

L system : △

The synchronizing point can be placed in the middle of the block by designating the start point.

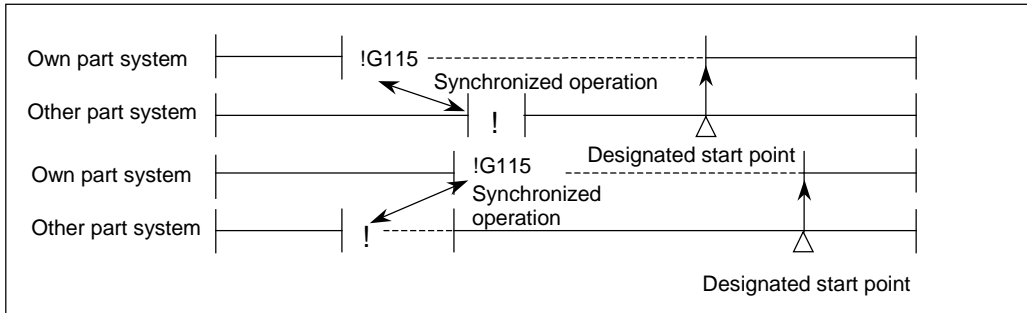
(1) Start point designation synchronization Type 1 (G115)

Command format

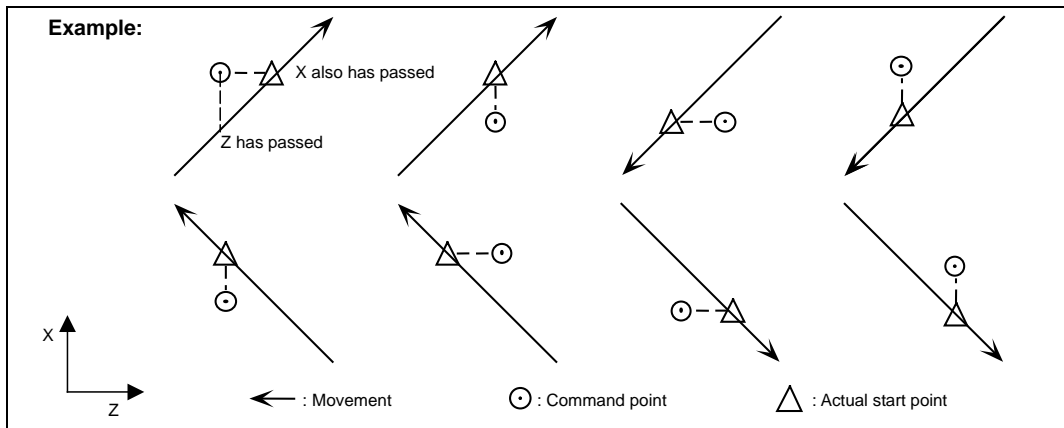
```

!LI G115 X_ Z_ ;
!LI      : Synchronizing command
G115    : G command
X_, Z_  : Own start point (designate other part system's coordinate value)
    
```

- (a) The other part system starts first when synchronizing is executed.
- (b) The own part system waits for the other part system to move and reach the designated start point, and then starts.



- (c) When the start point designated by G115 is not on the next block movement path of the other part system, the own part system starts once the other part system has reached all of the start point axis coordinates.





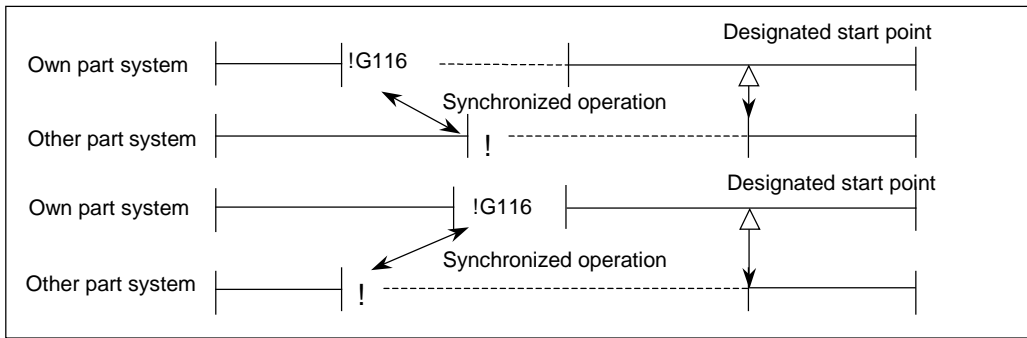
(2) Start point designation synchronization Type 2 (G116)

Command format

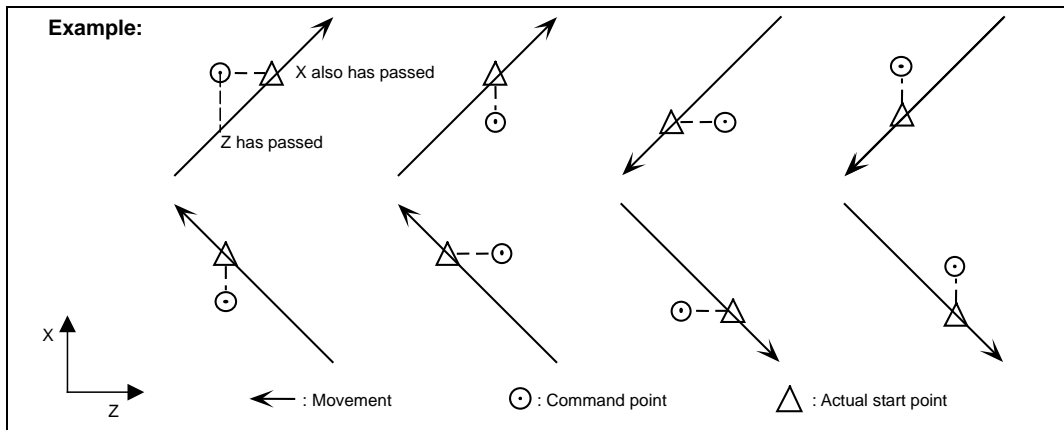
```

!LI G116 X_ Z_ ;
!LI      : Synchronizing command
G116    : G command
X_, Z_  : Other start point (designate own part system's coordinate value)
    
```

- (a) The own part system starts first when synchronizing is executed.
- (b) The other part system waits for the own part system to move and reach the designated start point, and then starts.



- (c) When the start point designated by G116 is not on the next block movement path of the own part system, the other part system starts once the own part system has reached all of the start point axis coordinates.

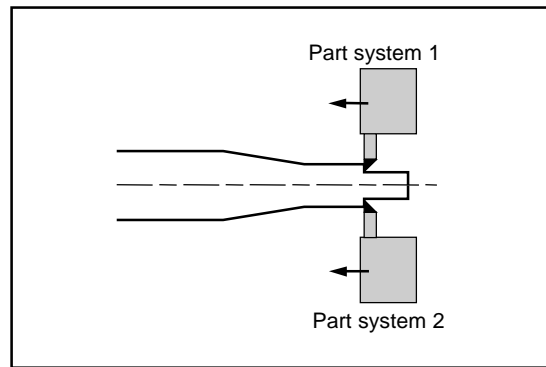


12.1.8.6 Balance Cut

M system : -

L system : O

When a workpiece that is relatively long and thin is machined on a lathe, deflection may result, making it impossible for the workpiece to be machined with any accuracy. In cases like this, the deflection can be minimized by holding tools simultaneously from both sides of the workpiece and using them in synchronization to machine the workpiece (balance cutting). This method has an additional advantage: since the workpiece is machined by two tools, the machining time is reduced. The balance cutting function enables the movements of the tool rests belonging to part system 1 and part system 2 to be synchronized (at the block start timing) so that this kind of machining can easily be accomplished.



The command format is given below.

|            |                                 |
|------------|---------------------------------|
| <b>G14</b> | Balance cut command OFF (modal) |
| <b>G15</b> | Balance cut command ON (modal)  |

G14 and G15 are modal commands. When the G15 command is assigned, the programmed operations of two part systems are synchronized (at the block start timing) for all blocks until the G14 command is assigned or until the modal information is cleared by the reset signal.

Part system 1 program      Part system 2 program

```
T0101;
G00 X_ Z_;
G15;
G01 Z_ F0.4;
⋮
```

```
T0102;
G00 X_ Z_;
G15;
G01 Z_ F0.4;
⋮
```

Whereas synchronization is possible only with the next block when using the code "!" of synchronization between part systems, the balance cutting function provides synchronization (at the block start timing) with multiple consecutive blocks.

12.1.8.8 2-part System Synchronous Thread Cutting

**M system : -**                      **L system : O**

The 2-part system synchronous thread cutting cycle is the function which performs synchronous thread cutting for the same spindle using the part systems 1 and 2.

The 2-part system synchronous thread cutting cycle is "2-part system synchronous thread cutting cycle I" (G76.1) for synchronous thread cutting of two screws or "2-part system synchronous thread cutting cycle II" (G76.2) for thread cutting of one screw.

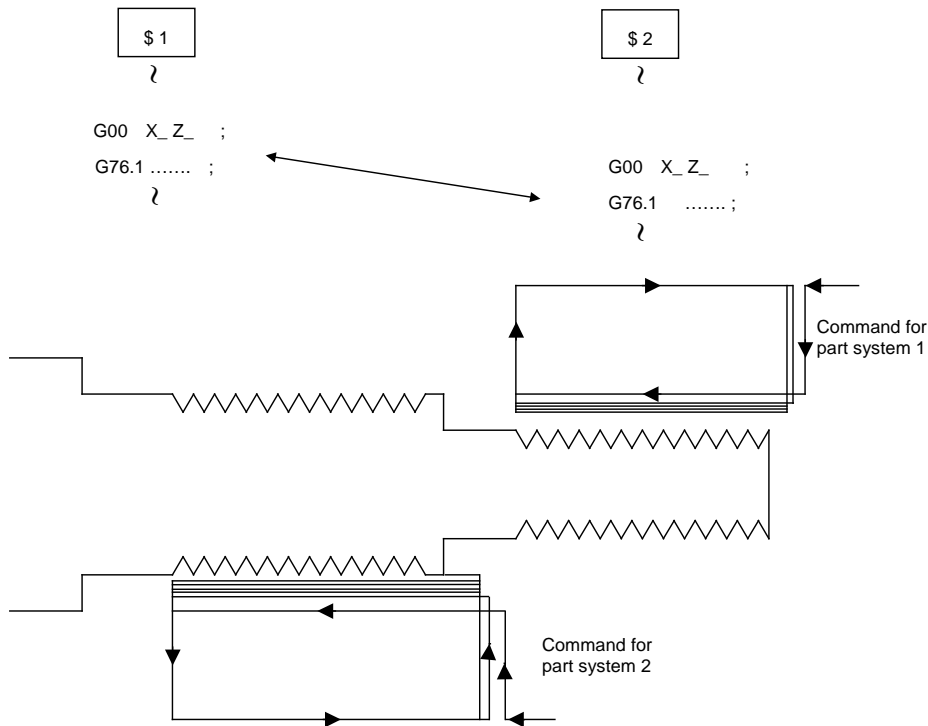
(1) 2-part system synchronous thread cutting cycle I

**Command format**

|                                       |   |
|---------------------------------------|---|
| <b>G76.1 X/U_ Z/W_ Ri Pk QΔd Fl ;</b> |   |
| X/U                                   | : X axis end point coordinate of screw .... Designate the X coordinate of the end point at screw in an absolute or incremental value. |
| Z/W                                   | : Z axis end point coordinate of screw .... Designate the Z coordinate of the end point at screw in an absolute or incremental value. |
| i                                     | : Height constituent of taper at screw (radius value) ... When i is 0, a straight screw is generated.                                 |
| k                                     | : Screw thread height .... Designate the thread height in a positive radius value.  |
| Δd                                    | : Cut depth .... Designate the first cut depth in a positive radius value.  |
| l                                     | : Thread lead   |

If G76.1 command is given in part system 1 or 2, a wait is made until G76.1 command is given in the other part system.

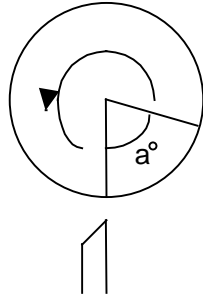
Once the G76.1 command exists in both part systems, the thread cutting cycle is started.



(2) 2-part system synchronous thread cutting cycle II

Command format

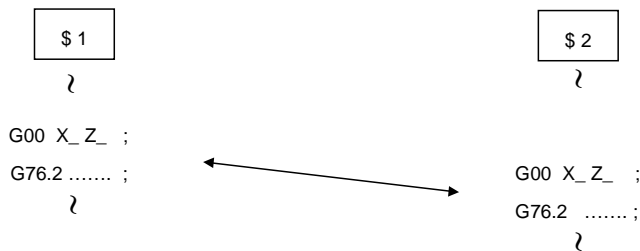
```
G76.2 X/U_ Z/W_ Ri Pk QΔd Aa FI ;
a : Thread cutting start shift angle
```



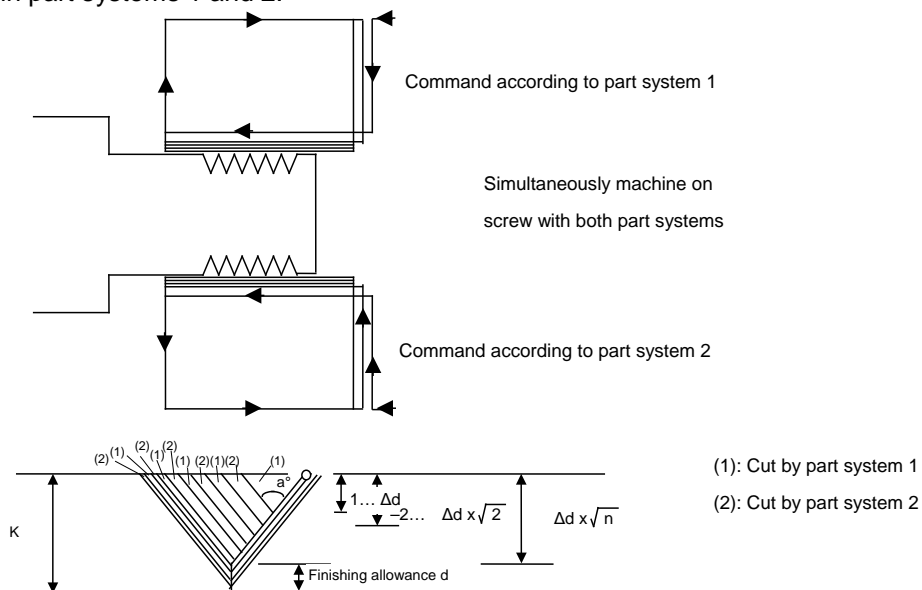
Thread cutting command waits for 1-revolution synchronizing signal of the spindle encoder and starts moving. The start point can be delayed by thread cutting start angle.

The address except A has the same meanings as those in 2-part system synchronous thread cutting cycle I.

If G76.2 command is given in part system 1 or 2, a wait is made until G76.2 command is given in the other part system. Once the G76.2 command exists in both part systems, the thread cutting cycle is started.



In the G76.2 cycle, the same screw is assumed to be cut, and it is cut deeply according to alternate cut in part systems 1 and 2.



## 12.1.9 Data Input by Program

## 12.1.9.1 Parameter Input by Program

M system : Δ

L system : Δ

The parameters set from the setting and display unit can be changed using the machining programs.  
The format used for the data setting is shown below.

**G10 L70; Data setting command**

|                 |                   |            |                     |                            |
|-----------------|-------------------|------------|---------------------|----------------------------|
| P parameter No. | S part system No. | A axis No. | H□ data ;           | Bit parameter              |
| P parameter No. | S part system No. | A axis No. | D data;             | Numerical value parameter  |
| P parameter No. | S part system No. | A axis No. | <character string>; | Character string parameter |
| P parameter No. | S part system No. | A axis No. | ,character string;  | Character string parameter |

**G11; ..... Data setting end command**

- (Note 1)** The sequence of addresses in a block must be as shown above.  
When the same address is commanded more than twice, the last command will be valid.
- (Note 2)** The part system No. is set in the following manner: "1" for 1st part system, "2" for 2nd part system, and so forth.  
If the address S is omitted, the part system of the executing program will be applied.  
As for the parameters common to part systems, the command of part system No. will be ignored.
- (Note 3)** The axis No. is set in the following manner: "1" for 1st axis, "2" for 2nd axis, and so forth.  
If the address A is omitted, the 1st axis will be applied.  
As for the parameters common to axes, the command of axis No. will be ignored.
- (Note 4)** Address H is commanded with the combination of the bit designation □ (0 to 7) and setting data (0 or 1).
- (Note 5)** Only the decimal number can be commanded with the address D.  
The value that is smaller than the setting/display unit (#1003 iunit) will be rounded off.
- (Note 6)** Designate the character string with "," or "<>".  
A program error (P33) will occur without either them.  
Up to 31 characters can be set.
- (Note 7)** Command G10L70, G11 in independent blocks. A program error (P33, P421) will occur if not commanded in independent blocks.
- (Note 8)** If data with decimal point is commanded without decimal point, it is considered as decimal point valid.

## 12.1.9.2 Compensation Data Input by Program

**M system : Δ****L system : Δ**

The value of the workpiece coordinate systems selected can be set or changed using program commands. The tool compensation amounts, that are set from the setting and display can be input by program commands.

## (1) Workpiece coordinate system offset input

The value of the workpiece coordinate systems selected by the G54 to G59 commands can be set or changed by program commands.

| G code |    |    | Function                                     |
|--------|----|----|--|
| G10    | L2 | P0 | External workpiece coordinate system setting |
| G10    | L2 | P1 | Workpiece coordinate system 1 setting (G54)  |
| G10    | L2 | P2 | Workpiece coordinate system 2 setting (G55)  |
| G10    | L2 | P3 | Workpiece coordinate system 3 setting (G56)  |
| G10    | L2 | P4 | Workpiece coordinate system 4 setting (G57)  |
| G10    | L2 | P5 | Workpiece coordinate system 5 setting (G58)  |
| G10    | L2 | P6 | Workpiece coordinate system 6 setting (G59)  |

The format for the workpiece coordinate system setting commands is shown below.

|                                   |
|-----------------------------------|
| <b>G10 L2 Pp1 Xx1 Yy1 Zz1 ;</b>   |
| G10 L2 : Parameter change command |
| Pp1 : Workpiece coordinate No.    |
| Xx1, Yy1, Zz1 : Settings          |

**(Note 1)** L2 can be omitted. Omitting Pp1 results in a program error. [M system]

## (2) Tool compensataion input

The tool compensataion amounts, which have been set from the setting and display unit, can be input by program commands.

The command format differs between the [M system] and the [L system]. The respective command format must be set by a parameter.

[M system]

| G code  | Function                               |
|---------|--|
| G10 L10 | Tool length shape compensataion amount |
| G10 L11 | Tool length wear compensataion amount  |
| G10 L12 | Tool radius shape compensataion amount |
| G10 L13 | Tool radius wear compensataion amount  |

The tool compensation input format is as follows.

|                                       |  |
|---------------------------------------|--|
| <b>G10 L10(L11/L12/L13) Pp1 Rr1 ;</b> |  |
| G10 L10(L11/L12/L13)                  | : Command for setting compensataion amount |
| Pp1                                   | : Compensataion No.                        |
| Rr1                                   | : Compensataion amount                     |

**(Note 1)** When L11(L12/L13) has been omitted, the tool length shape compensataion amount is set. Omitting Pp1 results in a program error.

[L system]

| G code  | Function                         |
|---------|----------------------------------|
| G10 L10 | Tool length compensataion amount |
| G10 L11 | Tool wear compensataion amount   |

The tool compensataion input format is as follows.

|   |  |
|---|--|
| <b>G10 L10(L11) Pp1 Xx1 Zz1 Rr1 Qq1 ;</b> |  |
| G10 L10(L11)                              | : Command for setting compensataion amount |
| Pp1                                       | : Compensataion No.                        |
| Xx1                                       | : X axis compensataion amount              |
| Zz1                                       | : Z axis compensataion amount              |
| Rr1                                       | : Nose R compensation amount               |
| Qq1                                       | : Hypothetical tool nose point             |

**12.1.10 Machining Modal****12.1.10.1 Tapping Mode****M system : O****L system : O**

When tapping mode commands are issued, the CNC system is set to the following internal control modes required for tapping.

- (1) Cutting override is fixed at 100%.
- (2) Deceleration commands at joints between blocks are invalid.
- (3) Feed hold is invalid.
- (4) Single block is invalid.
- (5) "In tapping mode" signal is output.

| <b>G code</b> | <b>Function</b> |
|---------------|-----------------|
| G63           | Tapping mode ON |

The tapping mode command will be canceled with the following commands:

- Exact stop check mode (G61)
- Automatic corner override (G62)
- Cutting mode (G64)
- High-accuracy control mode command (G61.1) [M system]

The machine is in the cutting mode status when its power is turned on.

**12.1.10.2 Cutting Mode****M system : O****L system : O**

When a cutting mode command is issued, the NC system is set to the cutting mode that enables smooth cutting surface to be achieved. In this mode, the next block is executed continuously without the machine having to decelerate and stop between the cutting feed blocks: this is the opposite of what happens in the exact stop check mode (G61).

| <b>G code</b> | <b>Function</b> |
|---------------|-----------------|
| G64           | Cutting mode ON |

The cutting mode command will be canceled with the following commands:

- Exact stop check mode (G61)
- Automatic corner override (G62)
- Tapping mode (G63)
- High-accuracy control mode command (G61.1) [M system]

The machine is in the cutting mode status when its power is turned on.



## 12.2 Machining Accuracy Support Functions

### 12.2.1 Automatic Corner Override

M system : ○

L system : ○

To prevent machining surface distortion due to the increase in the cutting load when cutting corners, this function automatically applies an override on the cutting feed rate so that the cutting amount is not increased for a set time at the corner.

Automatic corner override is valid only during tool radius compensation.

The automatic corner override mode is set to ON by the G62 command and it is canceled by any of the G commands below.

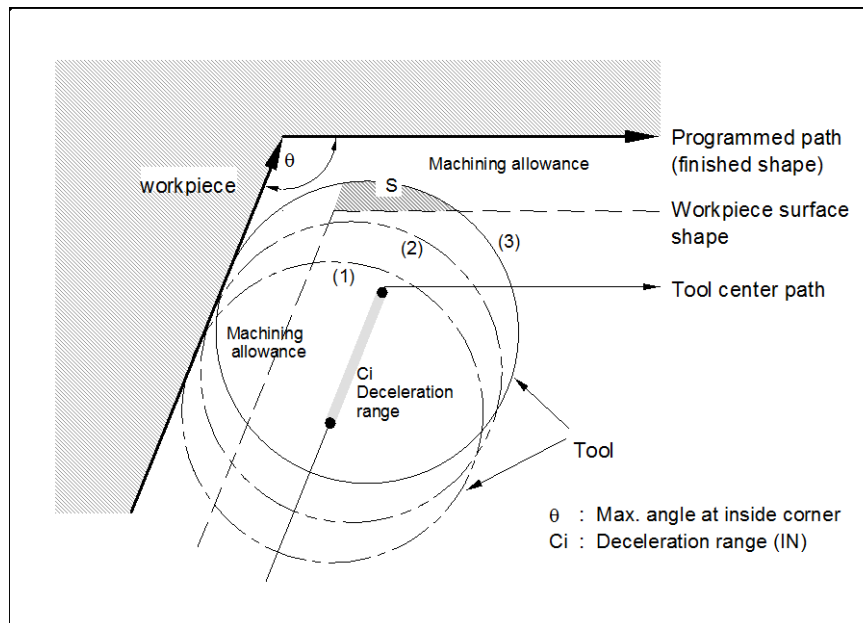
G40 Tool radius compensation cancel

G61 Exact stop check mode

G63 Tapping mode

G64 Cutting mode

G61.1 High-accuracy control mode [M system]



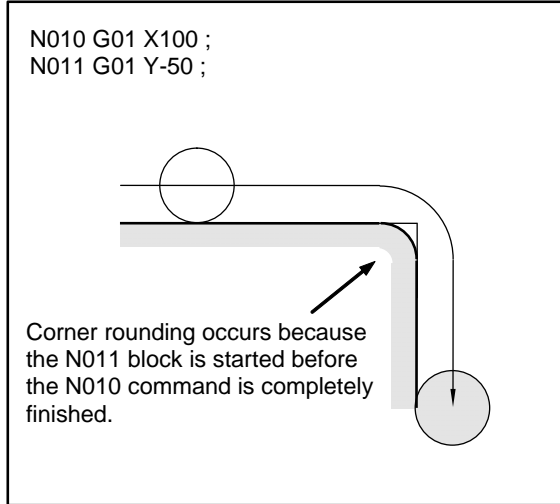
#### Operation

- (a) When automatic corner override is not to be applied :  
When the tool moves in the order of (1) → (2) → (3) in the figure above, the machining allowance at (3) is larger than that at (2) by an amount equivalent to the area of shaded section S and so the tool load increases.
- (b) When automatic corner override is to be applied :  
When the inside corner angle  $\theta$  in the figure above is less than the angle set in the parameter, the override set into the parameter is automatically applied in the deceleration range Ci.

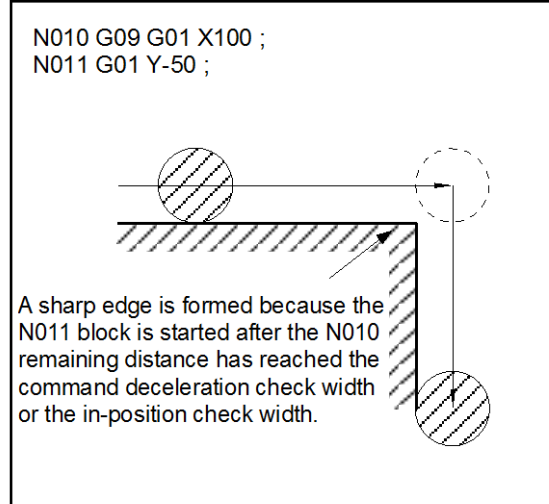
12.2.2 Deceleration Check

The deceleration check function leads the machine to decelerate and stop at the join between one block and another before executing the next block to alleviate the machine shock and to prevent the corner roundness that occurs when the feedrate of the control axis changes suddenly.

Without deceleration check

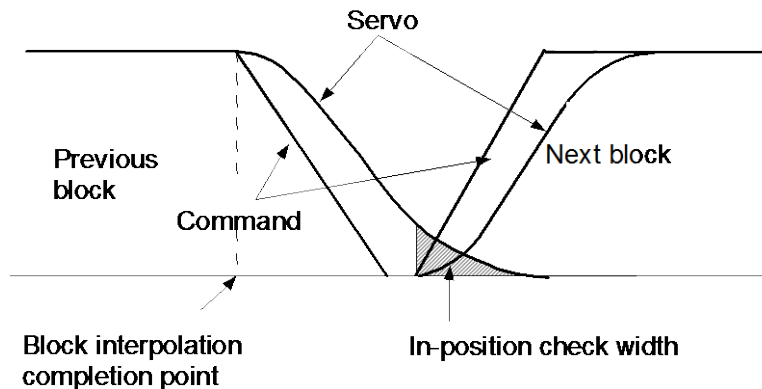


With deceleration check



The conditions for executing deceleration check are described below.

- (1) Deceleration check in the rapid traverse mode  
In the rapid traverse mode, the deceleration check is always performed when block movement is completed before executing the next block.
- (2) Deceleration check in the cutting feed mode  
In the cutting feed mode, the deceleration check is performed at the end of block when any of the conditions below is applicable before executing the next block.
  - (a) When G61 (exact stop check mode) is selected.
  - (b) When the G09 (exact stop check) is issued in the same block.
  - (c) when the error detect switch (external signal) is ON.
- (3) Deceleration check system  
Deceleration check is a system that executes the next block only after the command deceleration check is executed as shown below, and it has been confirmed that the position error amount, including the servo system, is less than the in-position check width (designated with parameter or with ",I" in same block).



**12.2.2.1 Exact Stop Check Mode****M system : ○****L system : ○**

A deceleration check is performed when the G61 (exact stop check mode) command has been selected. G61 is a modal command. The modal command is released by the following commands.

G62 Automatic corner override

G63 Tapping mode

G64 Cutting mode

G61.1 High-accuracy control mode [M system]

Refer to "12.2.2 Deceleration Check" for details on the deceleration check.

**12.2.2.2 Exact Stop Check****M system : ○****L system : ○**

A deceleration check is performed when the G09 (exact stop check) command has been designated in the same block.

The G09 command is issued in the same block as the cutting command. It is an unmodal command.

Refer to "12.2.2 Deceleration Check" for details on the deceleration check.

**12.2.2.3 Error Detection****M system : ○****L system : ○**

To prevent rounding of a corner during cutting feed, the operation can be changed by turning an external signal switch ON so that the axis decelerates and stops once at the end of the block and then the next block is executed.

The deceleration stop at the end of the cutting feed block can also be commanded with a G code. Refer to "12.2.2 Deceleration Check" for details on the deceleration check.

## 12.2.2.4 Programmable In-position Check

M system : ○

L system : ○

This command is used to designate the in-position width, which is valid when a linear interpolation command is assigned, from the machining program. The in-position width designated with a linear interpolation command is valid only in cases when the deceleration check is performed, such as:

- When the error detect switch is ON.
- When the G09 (exact stop check) command has been designated in the same block.
- When the G61 (exact stop check mode) command has been selected.

**G01 X\_ Z\_ F\_ ,I\_;**

X\_,Z\_ : Linear interpolation coordinates of axes

F\_ : Feed rate

,I\_ : In-position width

This command is used to designate the in-position width, which is valid when a positioning command is assigned, from the machining program.

**G00 X\_ Z\_ ,I\_;**

X\_,Z\_ : Positioning coordinates of axes

,I\_ : In-position width

**In-position check operation**

After it has been verified that the position error between the block in which the positioning command (G00: rapid traverse) is designated and the block in which the deceleration check is performed by the linear interpolation command (G01) is less than the in-position width of this command, the execution of the next block is commenced.

## 12.3 High-speed and High-accuracy Functions

### 12.3.5 High-Accuracy Control 1 (G61.1)

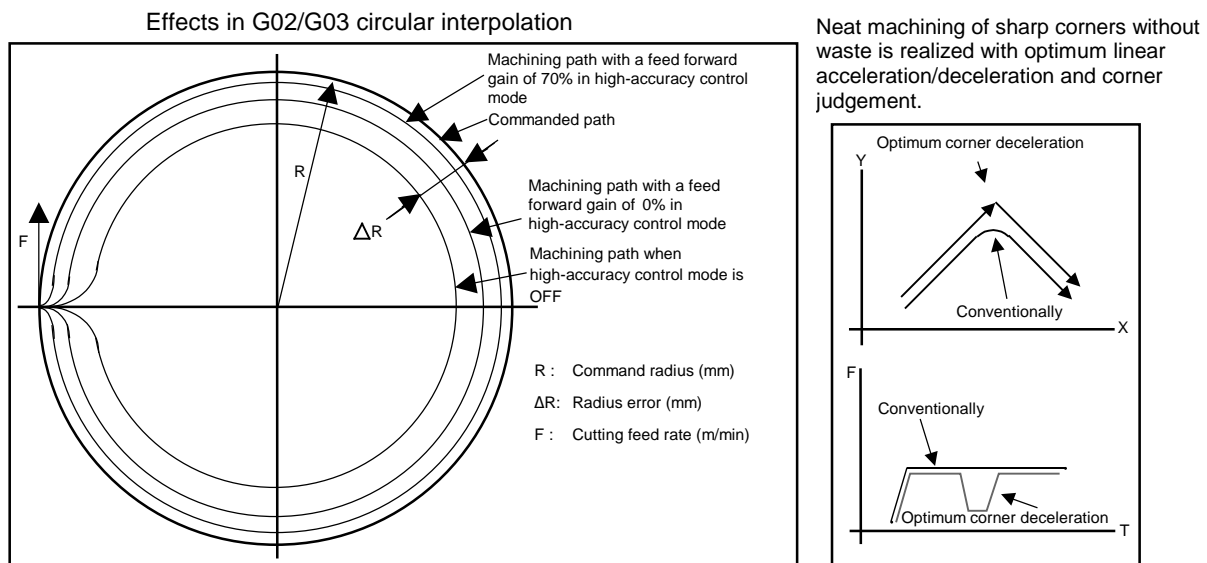
M system :  $\Delta$

L system :  $\Delta$

This function controls the operation so the lag will be eliminated in control systems and servo systems. With this function, improved machining accuracy can be realized, especially during high-speed machining, and machining time can be reduced.

The high-accuracy control is commanded with ;

**G61.1** High-accuracy control ON



#### (1) Acceleration / deceleration before interpolation

By accelerating /decelerating before interpolation, the machining shape error can be eliminated with smoothing, and a highly accurate path can be achieved.

With the arc commands, the radius reduction error can be significantly minimized.

Furthermore, since constant inclination acceleration/deceleration is performed, the time taken for positioning at microscopically small distances in the G00 command is reduced.

**(Note 1)** Whether acceleration/deceleration before interpolation in the rapid traverse command (G00) is to be performed always or not can be selected using a parameter setting independently from the high-accuracy control assignment.

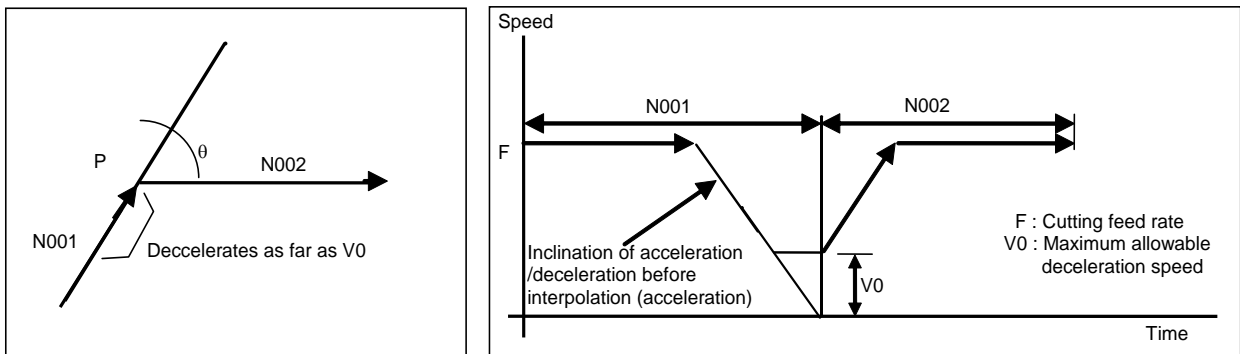
(2) Optimum corner deceleration

By determining the command vector in the machining program and thereby performing corner deceleration, it is possible to machine workpiece with a high-edge accuracy. The figure below shows the pattern of the deceleration speed at the corners.

(Optimum corner deceleration is a function of high-accuracy control mode.)

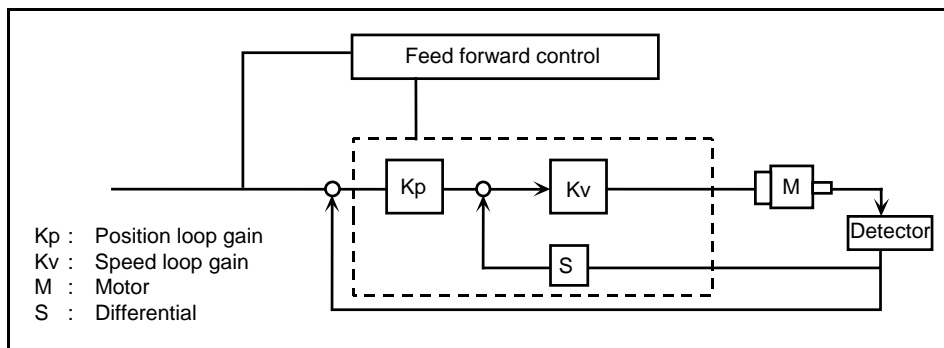
The speed change can be smoothed by the S-shape filter, the machine vibration can be suppressed, and the surface accuracy improved.

At the corner, the vector commanded in the machining program is automatically determined, and the speed is decelerated at the corner. A highly accurate edge can be machined by decelerating at the corner.



(3) Feed forward control

A stable servo control with an extremely small servo error can be realized using the feed forward control characteristic to this CNC system.



## 13. Machine Accuracy Compensation

### 13.1 Static Accuracy Compensation

#### 13.1.1 Backlash Compensation

**M system :** ○

**L system :** ○

This function compensates for the error (backlash) produced when the direction of the machine system is reversed.

The backlash compensation can be set in the cutting feed mode or rapid traverse mode.

The amount of backlash compensation can be set separately for each axis. It is set using a number of pulses in increments of one-half of the least input unit. The output follows the output unit system. The "output unit system" is the unit system of the machine system (ball screw unit system).

The amount of compensation for each axis ranges from 0 to  $\pm 9999$  (pulses).

#### 13.1.2 Memory-type Pitch Error Compensation

**M system :**  $\Delta$

**L system :**  $\Delta$

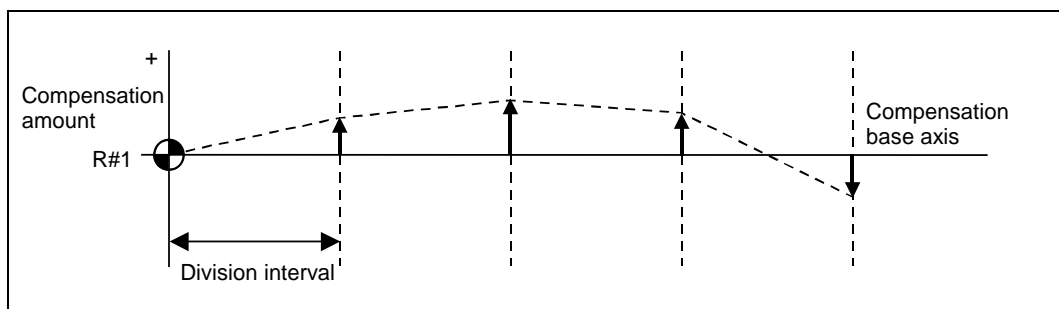
Machine accuracy can be improved by compensating for the errors in the screw pitch intervals among the mechanical errors (production errors, wear, etc.) of the feed screws.

The compensation positions and amounts are stored in the memory by setting them beforehand for each axis, and this means that there is no need to attach dogs to the machine.

The compensation points are divided into the desired equal intervals.

1. Division intervals of compensation points : 1 to 9999999 ( $\mu\text{m}$ )
2. Number of compensation points : 1024
3. Compensation amount : -128 to 127 (output unit)
4. No. of compensated axes : 10 axes (including number of axes for relative position error compensation)

- (1) The compensation position is set for the compensation axis whose reference point serves as the zero (0) point. Thus, memory-type pitch error compensation is not performed if return to reference point is not made for the compensation base axis or compensation execution axis after the controller power is turned ON and the servo is turned ON.
- (2) When the compensation base axis is a rotary axis, select the dividing intervals so that one rotation can be divided.



- (3) As shown in the figure above, highly individualized compensation control is exercised using the minimum output units with linear approximation for the compensation intervals between the compensation points.

**(Note 1)** Compensation points 1,024 is a total including the points for memory-type relative position error compensation.

**(Note 2)** A scale of 0 to 99-fold is applied on the compensation amount.

## 13.1.3 Memory-type Relative Position Error Compensation

M system :  $\Delta$ L system :  $\Delta$ 

Machine accuracy can be improved by compensating the relative error between machine axes, such as a production error or aging.

The compensation base axis and compensation execution axis are set by using parameters.

The compensation points are divided at any desired equal intervals.

- |  |  |
|--|--|
| 1. Compensation point dividing intervals | : 1 to 9999999 ( $\mu\text{m}$ )   |
| 2. Number of compensation points         | : 1024   |
| 3. Compensation amount                   | : -128 to 127 (output unit)  |
| 4. No. of compensated axe                | : 10 axes (including number of axes for memory type pitch error compensation.) |

- (1) The compensation position is set for the compensation axis whose reference point serves as the zero (0) point. Thus, memory-type relative position error compensation is not performed if return to reference point is not made for the compensation base axis or compensation execution axis after the controller power is turned ON and the servo is turned ON.
- (2) When the compensation base axis is a rotary axis, select the dividing intervals so that one rotation can be divided.
- (3) Since all coordinate systems of compensation execution axes are shifted or displaced by the compensation amount when the relative position error compensation is made, the stroke check point and machine coordinate system are also shifted or displaced.

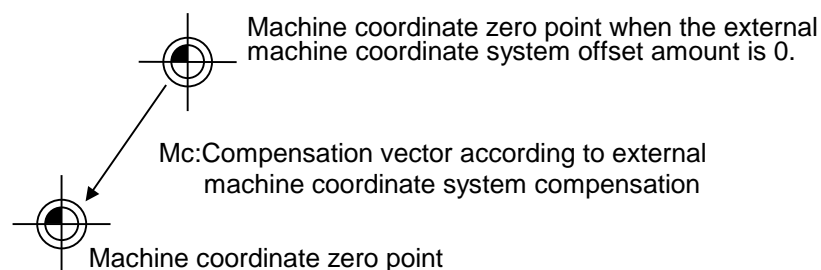
**(Note 1)** Compensation points 1024 is a total including the points for memory-type pitch error compensation.

**(Note 2)** A scale of 0 to 99-fold is applied on the compensation amount.

## 13.1.4 External Machine Coordinate System Compensation

M system :  $\Delta$ L system :  $\Delta$ 

The coordinate system can be shifted by inputting a compensation amount from the PLC. This compensation amount will not appear on the counters (all counters including machine position). If the machine's displacement value caused by heat is input for example, this can be used for thermal displacement compensation.





## 13.1.5 Circular Error Radius Compensation

M system :  $\Delta$ L system :  $\Delta$ 

With commands designated during arc cutting, this function compensates for movement toward the inside of the arcs caused by a factor such as servo delay.

## 13.1.6 Ball Screw Thermal Expansion Compensation

M system :  $\Delta$ L system :  $\Delta$ 

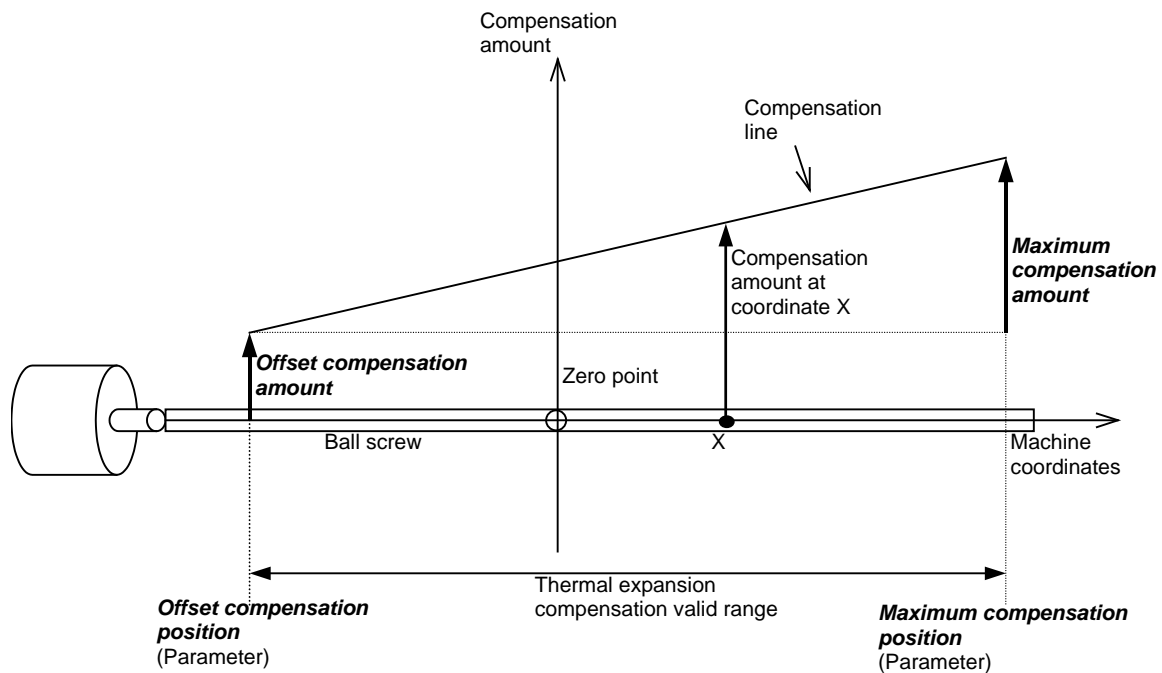
## (1) Outline

The feed error caused by the thermal expansion of the ball screw is set from the PLC, and compensated.

The compensation amount depends on the offset compensation amount and maximum compensation amount.

The compensation amount based on the offset compensation amount is set as the maximum compensation amount.

The offset compensation amount and maximum compensation amount are set beforehand in the parameters.



## (2) Compensation operation

The offset compensation position and maximum compensation position are connected with a straight line following the designated compensation amount, and the compensation amount to the current coordinates is obtained and compensated. The compensation amount changes immediately when the offset compensation amount or maximum compensation amount changes.

The thermal expansion compensation is valid only between the offset compensation amount and maximum compensation position, and is "0" outside of this range.

The compensation amount is not included in the coordinate value display.

13.2 Dynamic Accuracy Compensation

13.2.1 Smooth High-gain (SHG) Control

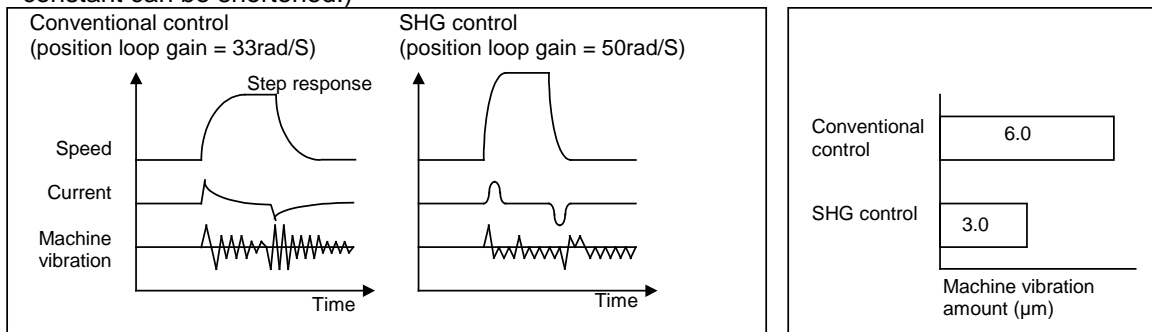
M system : ○

L system : ○

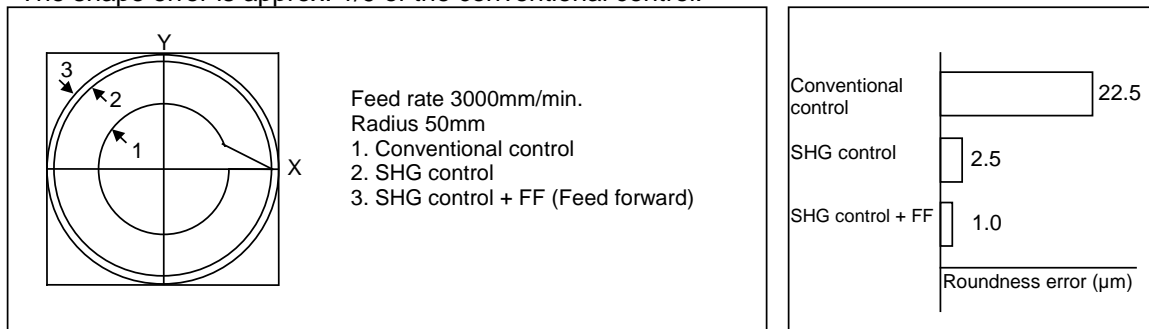
This is a high-response and stable position control method using the servo system (MDS-□-V□/SVJ3). This SHG control realizes an approximately three-fold position loop gain compared to the conventional control method.

The features of the SHG control are as follows.

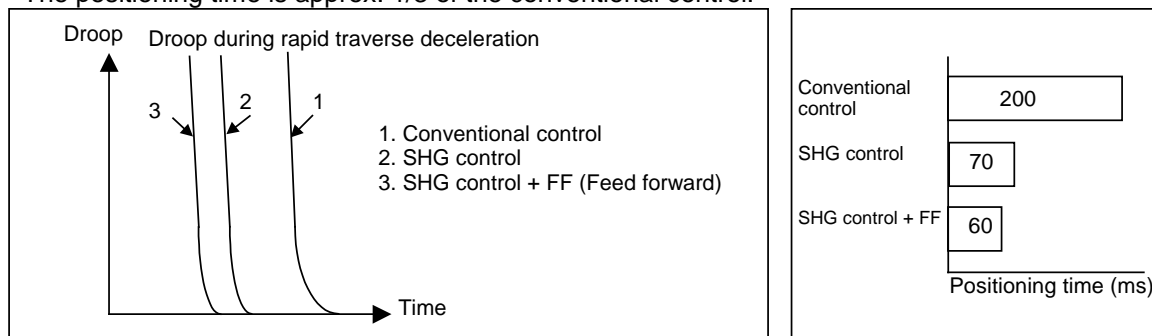
- (1) The acceleration/deceleration becomes smoother, and the mechanical vibration can be suppressed (approx. 1/2) during acceleration/deceleration. (In other words, the acceleration/ deceleration time constant can be shortened.)



- (2) The shape error is approx. 1/9 of the conventional control.



- (3) The positioning time is approx. 1/3 of the conventional control.

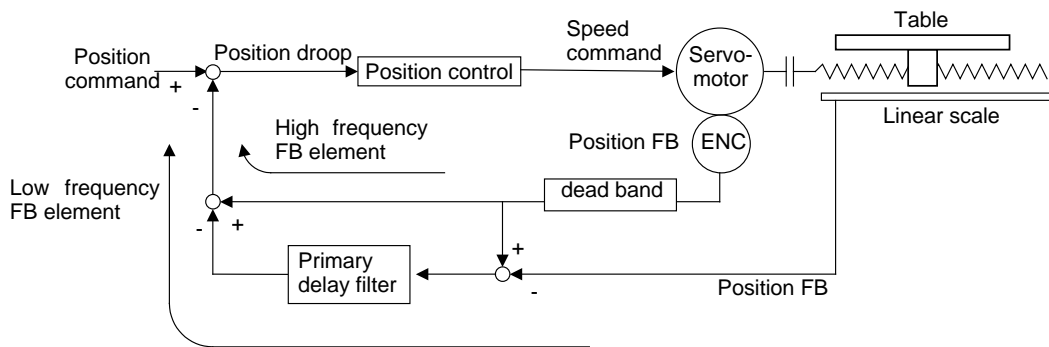


13.2.2 Dual Feedback

M system : ○

L system : ○

If the motor and machine coupling or machine system's rigidity is low (ex. large machine, etc.) when using a closed loop system, the response during acceleration/deceleration will vibrate and cause overshooting. This can cause the position loop gain from increasing. The dual feedback function is effective in this case. To validate the dual feedback function, use position feedback with a motor side detector in ranges with high acceleration to enable stable control. In ranges with low acceleration, use position feedback with the machine side detector (scale). This will make it possible to increase the position loop gain. A machine side detector (scale) is separately required.



Dual feedback control

The state will approach the semi-closed loop system as the primary delay filter's time constant increases, so the position loop gain limit will increase. Note that the limit of the position loop gain increased with the dual feedback function is the same as the position loop gain limit for a semi-closed system that does not use a machine side detector (scale, etc.). In addition, the positioning time will increase as the primary delay filter time constant increases.

13.2.3 Lost Motion Compensation

M system : ○

L system : ○

This function compensates the error in protrusion shapes caused by lost motion at the arc quadrant changeover section during circular cutting.

## 14. Automation Support Functions

### 14.1 Measurement

#### 14.1.1 Skip

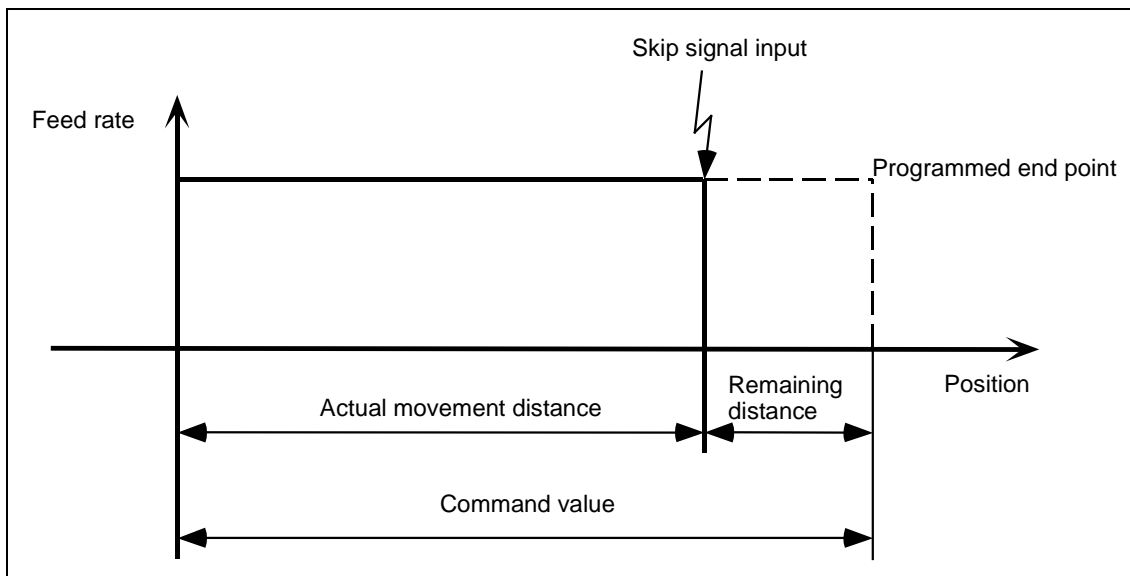
##### 14.1.1.1 Skip

**M system** : Δ

**L system** : Δ

When the external skip signal is input during linear interpolation using the G31 command, the machine feed is stopped immediately, the remaining distance is discarded and the commands in the next block are executed.

|               |                          |
|---------------|--------------------------|
| <b>G31</b>    | <b>Xx1 Yy1 Zz1 Ff1 ;</b> |
| G31           | : Measurement command    |
| Xx1, Yy1, Zz1 | : Command values         |
| Ff1           | : Feed rate              |



When the G31 command is issued, acceleration/deceleration is accomplished in steps (time constant = 0).

There are two types of skip feed rate.

- (1) Feed rate based on program command when F command is present in program
- (2) Feed rate based on parameter setting when F command is not present in program

**(Note 1)** The approximate coasting distance up to feed stop based on the detection delay in the skip signal input is calculated as below.

$$\delta \approx \frac{F}{60} \times (T_p + t)$$

$\delta$  : Coasting distance (mm)  
 $F$  : G31 rate (mm/min)  
 $T_p$  : Position loop time constant (s) = (position loop gain)<sup>-1</sup>  
 $T$  : Response delay time of 0.0035 (s)

**(Note 2)** Skipping during machine lock is not valid.

14.1.1.2 Multiple-step Skip

**M system : Δ**

**L system : Δ**

This function realizes skipping by designating a combination of skip signals for each skip command.

(1) G31.n method

This function realizes skipping by designating a combination of skip signals for each skip command (G31.1, G31.2, G31.3).

The combination of the skip signals 1, 2, 3 and 4 are designated with parameters for each G code (G31.1, 31.2, 31.3), and the skip operation is executed when all signals in the combination are input.

|               |  |            |            |            |   |
|---------------|--|------------|------------|------------|---|
| <b>G31.n</b>  | <b>Xx1</b>   | <b>Yy1</b> | <b>Zz1</b> | <b>Ff1</b> | ; |
| G31.n         | : Skip command (n=1, 2, 3)                                   |            |            |            |   |
| Xx1, Yy1, Zz1 | : Command format axis coordinate word and target coordinates |            |            |            |   |
| Ff1           | : Feed rate (mm/min)   |            |            |            |   |

(2) G31Pn method

As with the G31.n method, the valid skip signal is designated and skip is executed. However, the method of designating the valid skip signal differs.

The skip signals that can be used are 1 to 4. Which is to be used is designated with P in the program. Refer to Table 1 for the relation of the P values and valid signals.

Skip can be executed on dwell, allowing the remaining dwell time to be canceled and the next block executed under the skip conditions (to distinguish external skip signals 1 to 4) set with the parameters during the dwell command (G04).

|               |  |            |            |            |            |   |
|---------------|--|------------|------------|------------|------------|---|
| <b>G31</b>    | <b>Xx1</b>   | <b>Yy1</b> | <b>Zz1</b> | <b>Pp1</b> | <b>Ff1</b> | ; |
| G31           | : Skip command   |            |            |            |            |   |
| Xx1, Yy1, Zz1 | : Command format axis coordinate word and target coordinates |            |            |            |            |   |
| Pp1           | : Skip signal command  |            |            |            |            |   |
| Ff1           | : Feed rate (mm/min)   |            |            |            |            |   |

- (a) Specify the skip rate in command feedrate F. However, F modal is not updated.
- (b) Specify skip signal command in skip signal command P. Specify the P value in the range of 1 to 15. If it exceeds the specified range, a program error occurs.
- (c) When the skip signals are commanded in combination, the skip operation takes place with OR result of those signals.

Table 1 Valid skip signals

| Skip signal command P | Valid skip signal |   |   |   |
|-----------------------|-------------------|---|---|---|
|                       | 4                 | 3 | 2 | 1 |
| 1                     |                   |   |   | ○ |
| 2                     |                   |   | ○ |   |
| 3                     |                   |   | ○ | ○ |
| 4                     |                   | ○ |   |   |
| 5                     |                   | ○ |   | ○ |
| 6                     |                   | ○ | ○ |   |
| 7                     |                   | ○ | ○ | ○ |
| 8                     | ○                 |   |   |   |
| :                     | :                 | : | : | : |
| 13                    | ○                 | ○ |   | ○ |
| 14                    | ○                 | ○ | ○ |   |
| 15                    | ○                 | ○ | ○ | ○ |

#### 14.1.1.4 PLC Skip

**M system :  $\Delta$**

**L system :  $\Delta$**

This function enables skip operations to be performed by signals which are input from the sequence program.

## 14.1.2 Automatic Tool Length Measurement

This function moves the tool in the direction of the tool measurement position by the commanded value between the measurement start position and measurement position. It stops the tool as soon as it contacts the sensor and calculates the difference between the coordinates when the tool has stopped and the command coordinates. It registers this difference as the tool length offset amount for that tool.

**M system :  $\Delta$**

**L system :  $\Delta$**

## (1) Automatic Tool Length Measurement (M system)

This function moves the tool in the direction of the tool measurement position by the commanded value between the measurement start position to the measurement position, it stops the tool as soon as it contacts the sensor and calculates the difference between the coordinates when the tool has stopped and commanded coordinates. It registers this difference as the tool length offset amount for that tool. If compensation has already been applied to the tool, it is moved in the direction of the measurement position with the compensation still applied, and when the measurement and calculation results are such that a further compensation amount is to be provided, the current compensation amount is further corrected.

If the compensation amount at this time is one type, the compensation amount is automatically corrected; if there is a distinction between the tool length compensation amount and wear compensation amount, the wear amount is automatically corrected.

**G37 Z\_R\_D\_F\_ ;**

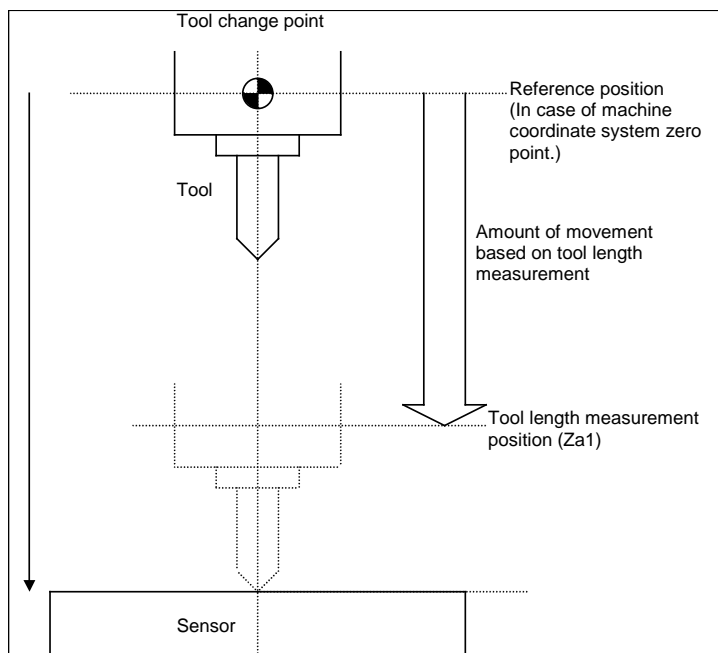
**Z** : Measurement axis address and measurement position coordinate. ... X, Y, Z,  $\alpha$   
(where  $\alpha$  is an optional axis)

**R** : The distance between the point at which tool movement is to start at the measurement speed and the measurement position.

**D** : The range in which the tool is to stop.

**F** : The measurement rate.

When R\_, D\_ and F\_ have been omitted, the values set in the parameters are used.



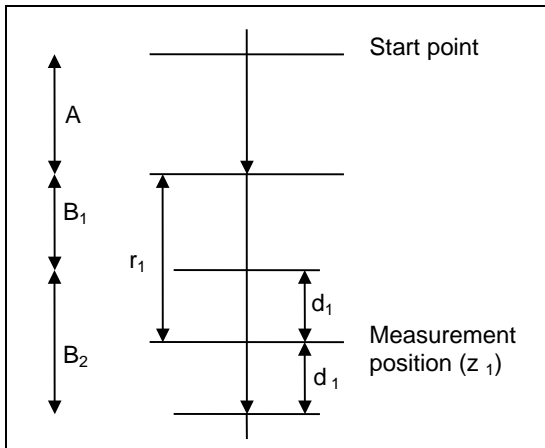
At this time, the tool length offset amount has a minus ("-") value.

**Example of program**

```
G28 Z0 ;
T01 ;
M06 T02 ;
G43 G00 Z0 H01 ;
G37 Z-300. R10.D2.F10 ;
```

In this case, the distance ( $H01 = Z_{a1} - z_0$ ) from the tool T01 tip to the top of the measurement sensor is calculated as the tool length offset amount which is then registered in the tool offset table.

**(Note 1)** The measurement position arrival signal (sensor signal) is also used as the skip signal.



Area A : Moves with rapid traverse feed rate.

Areas B1, B2 : Moves with the measurement speed ( $f_1$  or parameter setting)

If a sensor signal is input in area B<sub>1</sub>, an error will occur.

If a sensor signal is not input in the area B<sub>2</sub>, an error will occur.



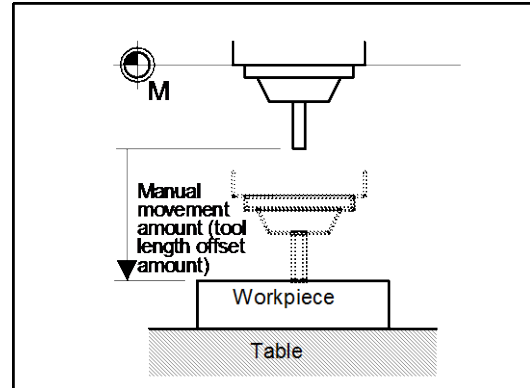


## 14.1.3 Manual Tool Length Measurement 1

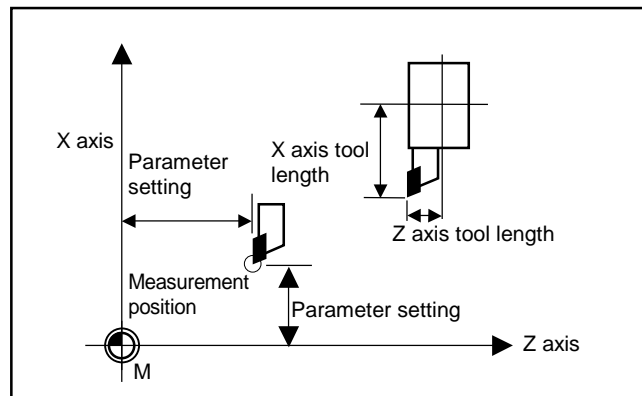
M system :  $\Delta$ L system :  $\Delta$ 

Simple measurement of the tool length is done without a sensor.

- (1) Manual tool length measurement I  
[M system]  
When the tool is at the reference point, this function enables the distance from the tool tip to the measurement position (top of workpiece) to be measured and registered as the tool length offset amount.



- (2) Manual tool length measurement I  
[L system]  
A measurement position (machine coordinates) to match the tool nose on the machine is preset and the tool nose is set to the measurement position by manual feed, then the operation key is pressed, thereby automatically calculating the tool length offset amount and setting it as the tool length offset amount.

**Measurement method**

- Preset the machine coordinates of the measurement position in a given parameter as the measurement basic value.
- Select a tool whose tool length offset amount is to be measured.
- Set the tool nose to the measurement position by manual feed.
- Press the input key. The tool length offset amount is calculated and displayed on the setting area.  
Tool length offset amount = machine coordinates - measurement basic value
- Again press the input key to store the value in the memory as the tool length offset amount of the tool.

## 14.2 Tool Life Management

### 14.2.1 Tool Life Management

#### 14.2.1.1 Tool Life Management I

**M system : Δ**

**L system : Δ**

(1) M system

For the tool mounted on the spindle, that tool's usage time (0 to 4000 hours) or frequency of use (0 to 65000 times) is accumulated, and the tool usage state is monitored. The life of up to 100 tools can be managed.

(2) L system

Tool life management is performed using the amount of time and frequency of use of a tool. The life for up to 80 tools (tool numbers 1 to 80) can be managed.

(a) Management by the time of use

The cutting time after specification of a tool selection (T) command (G01, G02, and G33) is added to the tool use time for the specified tool.

If the use time reaches the life time when a tool selection command is specified, an alarm is given.

(b) Management by the frequency of use

The tool use counter corresponding to the specified tool No. is incremented each time a tool selection (T) command is specified for the tool.

If the counter reaches the limit number when a tool selection command is specified, an alarm is given.

#### 14.2.1.2 Tool Life Management II

**M system : Δ**

**L system : Δ**

(1) M system

A spare tool change function is added to "Tool life management I". This function selects a usable tool out of the spare tools of the group determined by a tool selection (T) command, then outputs data of such usable spare tool. The spare tool can be selected in two ways: the tools are selected in order they were registered in the group or the tool whose remaining life is the longest of all in the group is selected.

- No. of groups: Max. 100 sets

- No. of tools in group: 100 tools (no limitation)

(2) L system

The life of each tool (time and frequency) is controlled, and when the life is reached, a spare tool that is the same type is selected from the group where the tool belongs and used.

- No. of groups: Max. 40 sets (each part system)/ For 1 part system: 80 sets

- No. of tools in group: Max. 16 tools

**14.2.2 Number of Tool Life Management Sets**

The number of tools that can be managed for their lives are shown below. (These are fixed by the No. of part systems according to the model.)

**14.2.2.1 80 Sets**

**M system : -**                      **L system :  $\Delta$**

Maximum of 80 tools for one part system and maximum of 40 tools for two or more part systems.

**14.2.2.2 100 Sets**

**M system :  $\Delta$**                       **L system : -**

Up to 100 tools regardless of the number of part systems.

## 14.3 Others

### 14.3.1 Programmable Current Limitation

**M system** : ○

**L system** : ○

This function allows the current limit value of the servo axis to be changed to the desired value in the program, and is used for the workpiece stopper, etc.

The commanded current limit value is designated with a ratio of the limit current to the rated current. The current limit value can also be set from the window function and setting and display unit.

The validity of the current limit can be selected with the external signal input.

However, the current limit value of the PLC axis cannot be rewritten.

**G10 L14 X dn ;**  
 L14 : Current limit value setting (+ side/- side)  
 X : Axis address  
 dn : Current limit value 1% to 300%

- (1) If the current limit is reached when the current limit is valid, the current limit reached signal is output.
- (2) The following two modes can be used with external signals as the operation after the current limit is reached.
  - Normal mode
    - The movement command is executed in the current state.
    - During automatic operation, the movement command is executed to the end, and then the next block is moved to with the droops still accumulated.
  - Interlock mode
    - The movement command is blocked (internal interlock).
    - During automatic operation, the operation stops at the corresponding block, and the next block is not moved to.
    - During manual operation, the following same direction commands are ignored.
- (3) During the current limit, the droop generated by the current limit can be canceled with external signals. (Note that the axis must not be moving.)
- (4) The setting range of the current limit value is 1% to 300%. Commands that exceed this range will cause a program error.  
"P35 CMD VALUE OVER" will be displayed.
- (5) If a decimal point is designated with the G10 command, only the integer will be valid.  
**(Example)** G10 L14 X10.123 ; The current limit value will be set to 10%.
- (6) For the axis name "C", the current limit value cannot be set from the program (G10 command). To set from the program, set the axis address with an incremental axis name, or set the axis name to one other than "C".

#### 14.3.101 PLC Axis Current Limit

**M system** : ○

**L system** : ○

A current limit is available for the PLC axis as well as for the NC axis. This function can be used for actions such as stopper operation.

## 15. Safety and Maintenance

### 15.1 Safety Switches

#### 15.1.1 Emergency Stop

**M system** : ○

**L system** : ○

All operations are stopped by the emergency stop signal input, and at the same time, the drive section is shutoff to stop movement of the machine.

The servo ready signal is turned OFF.

#### 15.1.2 Data Protection Key

**M system** : ○

**L system** : ○

With the input from the user PLC, it is possible to prohibit the setting and deletion of parameters and the editing of programs from the setting and display unit.

Data protection is divided into the following groups.

Group 1: For protecting the tool data and protecting the coordinate system presettings as based on origin setting (zero)

Group 2: For protecting the user parameters, common variables, CNC ladder, R register data, C register data and T register data

Group 3: For protecting the machining programs

## 15.2 Display for Ensuring Safety

### 15.2.1 NC Warning

**M system** : ○

**L system** : ○

The warnings which are output by the CNC system are listed below.

When one of these warnings has occurred, a warning number is output to the PLC and a description of the warning appears on the screen. Operation can be continued without taking further action.

| Type of warning           | Description  |
|---------------------------|--|
| Servo warning             | The servo warning is displayed.  |
| Spindle warning           | The spindle warning is displayed.  |
| System warning            | The system warning is displayed. (State such as temperature rise, battery voltage low, etc.) |
| Absolute position warning | A warning in the absolute position detection system is displayed.                            |

### 15.2.2 NC Alarm

**M system** : ○

**L system** : ○

The alarms which are output by the CNC system are listed below. When one of these alarms has occurred, an alarm number is output to the PLC, and a description of the alarm appears on the screen. Operation cannot be continued without taking remedial action.

| Type of warning                          | Description  |
|--|--|
| Operation alarm                          | This alarm occurs due to incorrect operation by the operator or by machine trouble during NC operation.  |
| Servo alarm                              | This alarm describes errors in the servo system such as the servo drive unit, motor and encoder.   |
| Spindle alarm                            | This alarm describes errors in the spindle system such as the spindle drive unit, motor and encoder.   |
| MCP alarm                                | An error has occurred in the drive unit and other interfaces.  |
| System alarm                             | This alarm is displayed with the register at the time when the error occurred on the screen if the system stops due to a system error.   |
| Absolute position detection system alarm | An alarm in the absolute position detection system is displayed.   |
| Program error                            | This alarm occur during automatic operation, and the cause of this alarm is mainly program errors which occur, for instance, when mistakes have been made in the preparation of the machining programs or when programs which conform to the specification have not been prepared. |

### 15.2.3 Operation Stop Cause

**M system** : ○                      **L system** : ○

The stop cause of automatic operation is shown on the display.

### 15.2.4 Emergency Stop Cause

**M system** : ○                      **L system** : ○

When the "EMG" (emergency stop) message is displayed in the operation status area of the setting and display unit, the cause of the emergency stop can be confirmed.

### 15.2.5 Thermal Detection

**M system** : ○                      **L system** : ○

When overheating is detected in the control unit or the CNC CPU module, an alarm is displayed and the "temperature rise" signal is output at the same time. If the system is in auto run at the time, run is continued, but it cannot be started after reset or M02/M30 run ends. (It can be started after block stop or feed hold.)  
When the temperature falls below the specified temperature, the alarm is released and the temperature rise signal is turned OFF.

### 15.2.6 Battery Alarm/Warning

**M system** : ○                      **L system** : ○

When it is time for changing batteries, an alarm and warning are displayed.  
When a warning is displayed, immediately backup all the necessary data and change batteries.  
When an alarm is displayed, there is a possibility that memory has been lost.

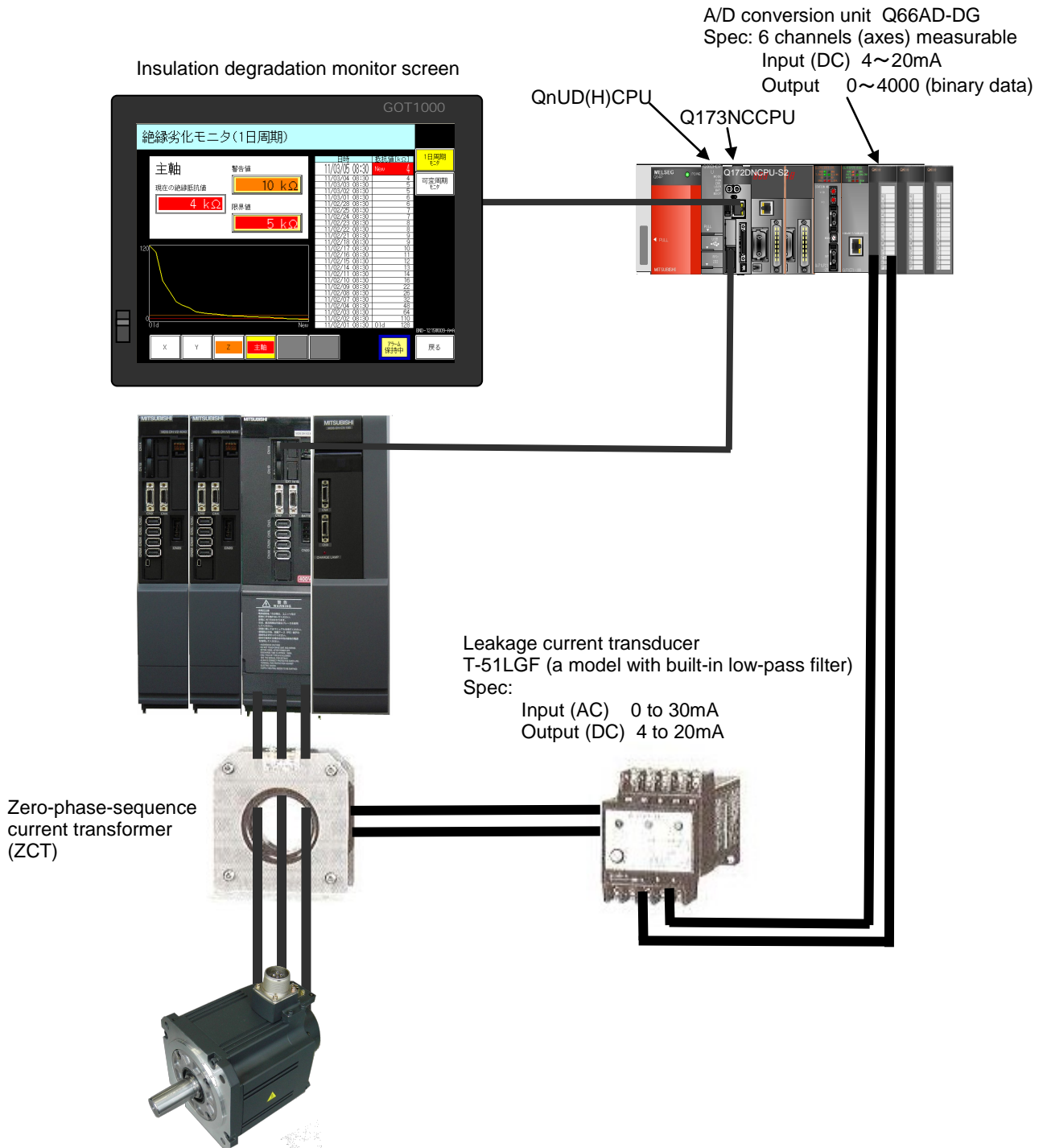


15.2.101 Insulation Degradation Monitor

M system : Δ

L system : Δ

Insulation degradation monitor function monitors insulation degradation by insulation resistance value calculated from leakage current values of servo motors and spindle motors that are measured with a zero-phase-sequence current transformer (ZCT) (user-prepared), a leakage transducer (user-prepared), and an analog/digital conversion unit (Q66AD-DG) to assist machine breakdown prevention. NCCPU monitors the resistance value and an alarm/warning occurs when the value becomes less than the preset alarm/limit value. Users can utilize it by PLC processing or combining with an insulation degradation monitor screen for GOT, a Japanese sample of which is available (not available in other languages).



## 15.3 Protection

### 15.3.1 Stroke End (Over Travel)

**M system** : ○

**L system** : ○

Limit switches and dogs are attached to the machine, and when a limit switch has kicked a dog, the movement of the machine is stopped by the signal input from the limit switch.

At the same time, the alarm output is sent to the machine.

The stroke end state is maintained and the alarm state is released by feeding the machine in the reverse direction in the manual mode to disengage the dog.

### 15.3.2 Stored Stroke Limit

This function sets the prohibited area for the tool to enter.

The stored stroke limits I, II, IIB, IB and IC are handled as follows.

| Type | Prohibited range | Explanation   |
|------|------------------|---|
| I    | Outside          | <ul style="list-style-type: none"> <li>• Set by the machine tool builder.</li> <li>• When used with II, the narrow range designated by the two types becomes the movement valid range.</li> <li>• Can be rewritten with window function.</li> </ul>                   |
| II   | Outside          | <ul style="list-style-type: none"> <li>• Set by the user.</li> <li>• The change or function of parameter can be turned OFF/ON with the program command.</li> <li>• Select II or IIB with the parameters.</li> <li>• Can be rewritten with window function.</li> </ul> |
| IIB  | Inside           |   |
| IB   | Inside           | <ul style="list-style-type: none"> <li>• Set by the machine tool builder.</li> </ul>  |
| IC   | Outside          | <ul style="list-style-type: none"> <li>• Set by the machine tool builder.</li> <li>• Can be rewritten with window function.</li> </ul>  |

15.3.2.1 Stored Stroke Limit I/II

M system : ○

L system : ○

(1) Stored Stroke Limit I

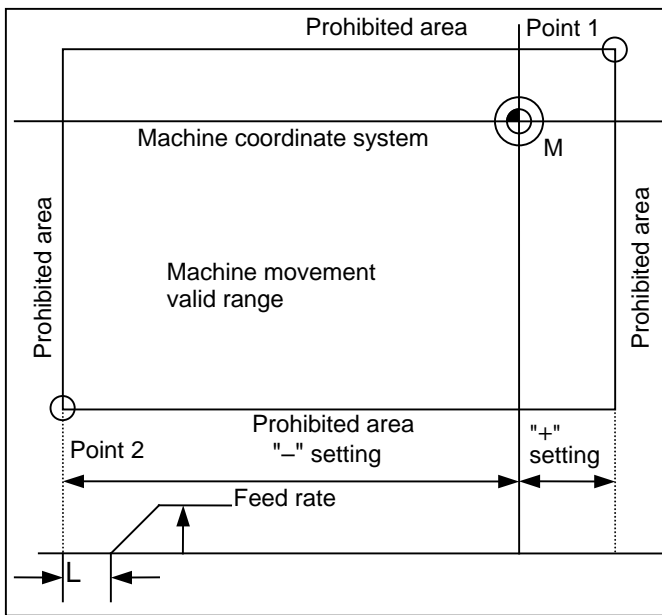
This is the stroke limit function used by the machine maker, and the area outside the set limits is the entrance prohibited area.

The maximum and minimum values for each axis can be set by parameters. The function itself is used together with the stored stroke limit II function described in the following section, and the tolerable area of both functions is the movement valid range.

The setting range is -99999.999 to +99999.999mm.

The stored stroke limit I function is made valid not immediately after the controller power is turned ON but after reference point return.

The stored stroke limit I function will be invalidated if the maximum and minimum values are set to the same data.



The values of points 1 and 2 are set using the coordinate values in the machine coordinate system.

All axes will decelerate and stop if an alarm occurs even for a single axis during automatic operation. Only the axis for which the alarm occurs will decelerate and stop during manual operation. The stop position must be before the prohibited area.

The value of distance "L" between the stop position and prohibited area differs according to the feed rate and other factors.

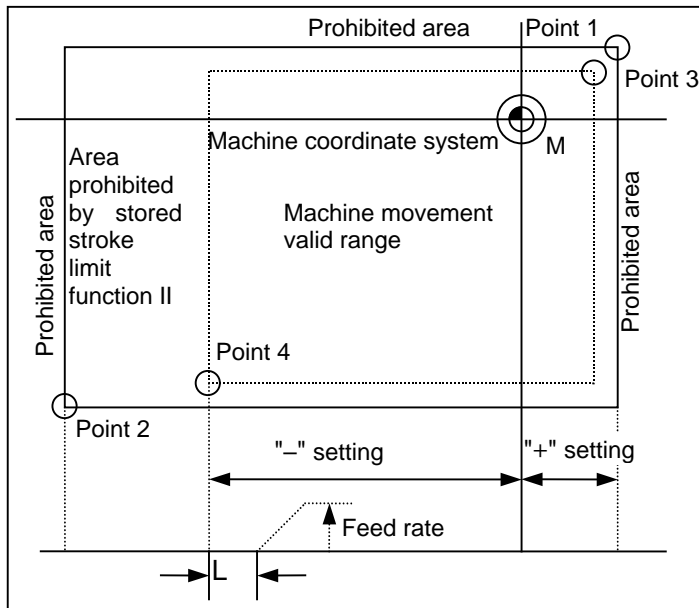
## (2) Stored Stroke Limit II

This is the stroke limit function which can be set by the user, and the area outside the set limits is the prohibited area.

The maximum and minimum values for each axis can be set by parameters. The function itself is used together with the stored stroke limit I function described in the foregoing section, and the tolerable area of both functions is the movement valid range.

The setting range is  $-99999.999$  to  $+99999.999$ mm.

The stored stroke limit II function will be invalidated if the maximum and minimum parameter values are set to the same data.



The values of points 3 and 4 are set with the coordinate values in the machine coordinate system.

The area determined by points 1 and 2 is the prohibited area set with stored stroke limit I.

All axes will decelerate and stop if an alarm occurs even for a single axis during automatic operation. Only the axis for which the alarm occurs will decelerate and stop during manual operation. The stop position must be before the prohibited area.

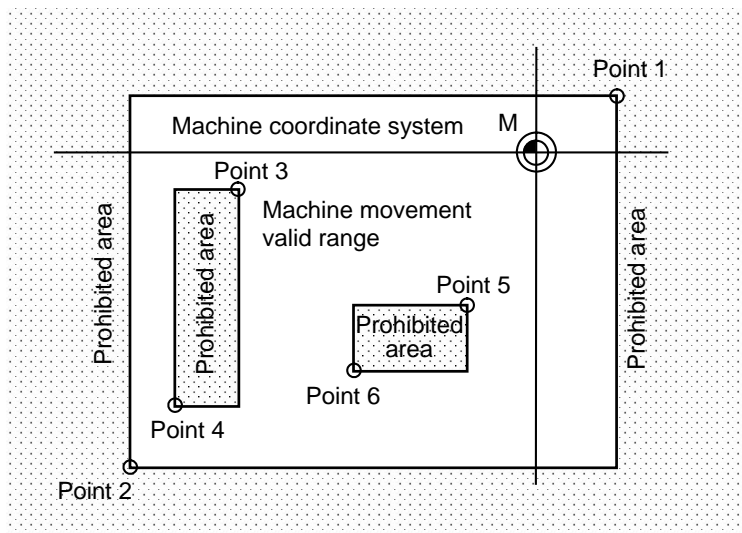
The value of distance "L" between the stop position and prohibited area differs according to the feed rate and other factors.

The stored stroke limit II function can also be invalidated with the parameter settings.

## 15.3.2.2 Stored Stroke Limit IB

M system :  $\Delta$ L system :  $\Delta$ 

Three areas where tool entry is prohibited can be set using the stored stroke limit I, stored stroke limit II, IIB and stored stroke limit IB functions.



The area determined by points 1 and 2 is the prohibited area set with stored stroke limit I.

The area determined by points 3 and 4 is the prohibited area set with stored stroke limit IIB.

The area determined by points 5 and 6 is the prohibited area set with stored stroke limit IB.

When an attempt is made to move the tool beyond the set range, an alarm is displayed, and the tool decelerates and stops. If the tool has entered into the prohibited area and an alarm has occurred, it is possible to move the tool only in the opposite direction to the direction in which the tool has just moved. This function is an option.

**Precautions**

- Bear in mind that the following will occur if the same data is set for the maximum and minimum value of the tool entry prohibited area:
  - (1) When zero has been set for the maximum and minimum values, tool entry will be prohibited in the whole area.
  - (2) If a value other than zero has been set for both the maximum and minimum values, it will be possible for the tool to move in the whole area.

## 15.3.2.3 Stored Stroke Limit IIB

M system :  $\Delta$ L system :  $\Delta$ 

A parameter is used to switch between this function and stored stroke limit II. With stored stroke limit IIB, the range inside the boundaries which have been set serves as the tool entry prohibited area.

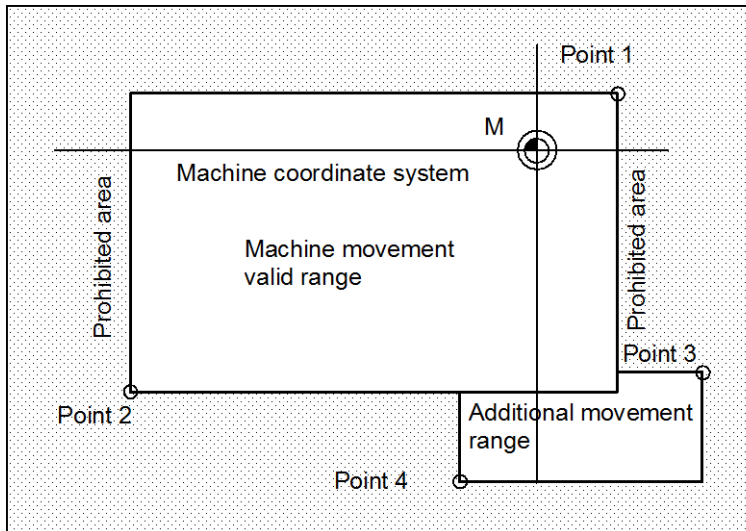
15.3.2.4 Stored Stroke Limit IC

M system :  $\Delta$

L system :  $\Delta$

The boundary is set for each axis with the parameters. The inside of the set boundary is the additional movement range.

This cannot be used with soft limit IB.



The position of points 3 and 4 are set with the machine coordinate.

The area determined by points 1 and 2 is the prohibited area set with stored stroke limit I.

## 15.3.4 Chuck/Tailstock Barrier Check

M system : -

L system : O

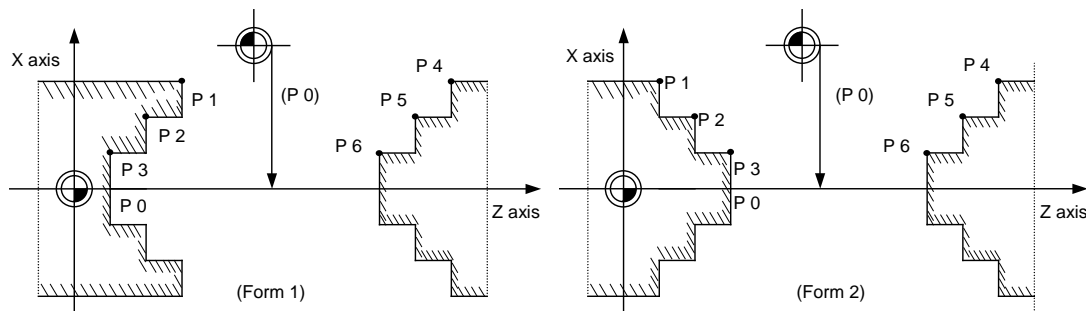
By limiting the tool nose point movement range, this function prevents the tool from colliding with the chuck or tail stock because of a programming error.

When a move command exceeding the area set in a given parameter is programmed, the tool is stopped at the barrier boundaries.

## Program format

|  |
|--|
| <b>G22 ; ..... Barrier ON</b><br><b>G23 ; ..... Barrier OFF (cancel)</b> |
|--|

- (1) When the machine is about to exceed the area, the machine is stopped and an alarm is displayed. To cancel the alarm, execute reset.
- (2) The function is also effective when the machine is locked.
- (3) This function is valid when all axes for which a barrier has been set have completed reference point return.
- (4) The chuck barrier/tail stock barrier can be set independently for part system 1 and part system 2.
- (5) Chuck barrier/tail stock barrier setting



The chuck barrier and tail stock barrier are both set with the machine coordinate by inputting one set of three-point data in the parameter. Points P1, P2 and P3 are the chuck barrier, and points P4, P5 and P6 are the tail stock barrier. The X axis is set with the coordinate value (radius value) from the workpiece center, and the Z axis is set with the basic machine coordinate system coordinate.

Point P0 is the chuck barrier and tail stock barrier's basic X coordinates, and the workpiece center coordinate in the basic machine coordinate system is set.

The barrier area is assumed to be symmetrical for the Z axis, and if the X axis coordinate of barrier point P\_ is minus, the sign is inverted to plus and the coordinate is converted for a check.

Set the absolute values of the X axis coordinates of the barrier points as shown below:

$P1 \geq P2 \geq P3, P4 \geq P5 \geq P6$

(However, this need not apply to the Z axis coordinates.)

### 15.3.5 Interlock

**M system** : ○

**L system** : ○

The machine movement will decelerate and stop as soon as the interlock signal, serving as the external input, is turned ON.

When the interlock signal is turned OFF, the machine starts moving again.

- (1) In the manual mode, only that axis for which the interlock signal is input will stop.
- (2) In the automatic mode, all axes will stop when the interlock signal is input to even one axis which coincides with the moving axis.
- (3) Block start interlock  
While the block start interlock signal (\*BSL) is OFF (valid), the execution of the next block during automatic operation will not be started. The block whose execution has already commenced is executed until its end. Automatic operation is not suspended. The commands in the next block are placed on standby, and their execution is started as soon as the signal is turned ON.  
**(Note 1)** This signal is valid for all blocks including internal operation blocks such as fixed cycles.
- (4) Cutting start interlock  
While the cutting start interlock signal (\*CSL) is OFF (valid), the execution of all movement command blocks except positioning during automatic operation will not be started. The block whose execution has already commenced is executed until its end. Automatic operation is not suspended. The commands in the next block are placed on standby, and their execution is started as soon as the signal is turned ON.  
**(Note 1)** The signal is valid for all blocks including internal operation block such as fixed cycles.

### 15.3.6 External Deceleration

**M system** : ○

**L system** : ○

This function reduces the feed rate to the deceleration speed set by the parameter when the external deceleration input signal has been set to ON. External deceleration input signals are provided for each axis and for each movement direction ("+" and "-"), and a signal is valid when the signal in the direction coinciding with the direction of the current movement has been input. External deceleration speed can be set commonly for axes of each part system, or it can be set for each axis. The choice of which setting to use can be set with a parameter. When an axis is to be returned in the opposite direction, its speed is returned immediately to the regular speed assigned by the command.

When non-interpolation positioning is performed during manual operation or automatic operation, only the axis for which the signal that coincides with the direction of the current movement has been input will decelerate.

However, with interpolation during automatic operation, the feed rate of the axis will be reduced to the deceleration rate if there is even one axis for which the signal that coincides with the direction of current movement has been input.



### 15.3.9 Door Interlock

#### 15.3.9.1 Door Interlock I

**M system** : ○

**L system** : ○

##### Outline of function

Under the CE marking scheme of the European safety standards (machine directive), the opening of any protective doors while a machine is actually moving is prohibited.

When the door open signal is input from the PLC, this function first decelerates, stops all the control axes, establishes the ready OFF status, and then shuts off the drive power inside the servo drive units so that the motors are no longer driven.

When the door open signal has been input during automatic operation, the suspended machining can be resumed by first closing the door concerned and then initiating cycle start again.

##### Description of operation

When a door is open

The NC system operates as follows when the door open signal is input:

- (1) It stops operations.
  1. When automatic operation was underway
    - The machine is set to the feed hold mode, and all the axes decelerate and stop.
    - The spindle also stops.
  2. When manual operation was underway
    - All the axes decelerate and stop immediately.
    - The spindle also stops.
- (2) The complete standby status is established.
- (3) After all the servo axes and the spindle have stopped, the ready OFF status is established.
- (4) The door open enable signal is output.
  - Release the door lock using this signals at the PLC.

When a door is closed

After the PLC has confirmed that the door has been closed and locked, the NC system operates as follows when the door open signal is set to OFF.

- (5) All the axes are set to ready ON.
- (6) The door open enable signal is set to OFF.

Resuming operation

- (7) When automatic operation was underway
  - Press the AUTO START button.
  - Operation now resumes from the block in which machining was suspended when the door open signal was input.
- (8) When manual operation was underway
  - Axis movement is commenced when the axis movement signals are input again.
- (9) Spindle rotation
  - Restore the spindle rotation by inputting the forward rotation or reverse rotation signal again.

## 15.3.9.2 Door Interlock II

M system : ○

L system : ○

**Outline of function**

Under the CE marking scheme of the European safety standards (machine directive), the opening of any protective doors while a machine is actually moving is prohibited.

When the door open signal is input from the PLC, this function first decelerates, stops all the control axes, establishes the ready OFF status, and then shuts off the drive power inside the servo drive units so that the motors are no longer driven.

With the door interlock function established by the door open II signal, cycle start can be enabled even when the door open signal has been input. However, the axes will be set to the interlock status.

**Description of operation**

When a door is open

The NC system operates as follows when the door open II signal is input:

- (1) It stops operations.  
All the axes decelerate and stop.  
The spindle also stops.
- (2) The complete standby status is established.
- (3) After all the servo axes and the spindle have stopped, the ready OFF status is established.  
However, the servo ready finish signal (SA) is not set to OFF.

When a door is closed

After the PLC has confirmed that the door has been closed and locked, the NC system operates as follows when the door open signal is set to OFF.

- (4) All the axes are set to ready ON.
- (5) The door open enable signal is set to OFF.

Resuming operation

- (6) When automatic operation was underway  
The door open signal is set to OFF, and after the ready ON status has been established for all the axes, operation is resumed.
- (7) When manual operation was underway  
Axis movement is commenced when the axis movement signals are input again.
- (8) Spindle rotation  
Restore the spindle rotation by inputting the forward rotation or reverse rotation signal again

**(Note 1)** Concerning the handling of an analog spindle

The signals described in this section are valid in a system with serial connections for the NC control unit and drive units. When an analog spindle is connected, the NC system cannot verify that the spindle has come to a complete stop. This means that the door should be opened after the PLC has verified that the spindle has come to a complete stop. Since the spindle may resume its rotation immediately after the door has been closed, set the forward and reverse rotation signals to OFF when opening the door so as to ensure safety.

**Differences from door interlock I**

- (1) The method used to stop the machine during automatic operation is the same as with the axis interlock function.
- (2) The servo ready finish signal (SE) is not set to OFF.
- (3) Cycle start is valid during door interlock. However, the interlock takes effect for the axis movements.
- (4) When this door interlock function (door open signal ON) is initiated during axis movement, the axes decelerate and stop.
- (5) When this door interlock function (door open signal) is set to OFF, the axis movement resumes.

## 15.3.10 Parameter Lock

M system : ○

L system : ○

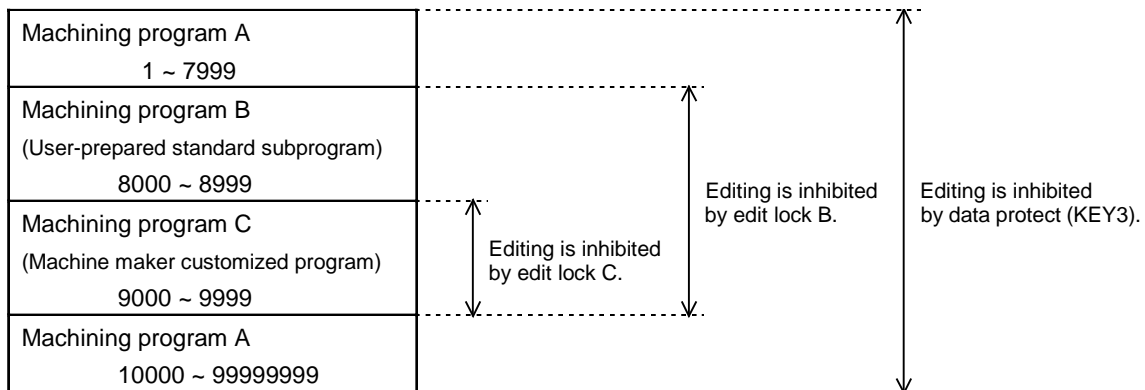
This function is used to prohibit changing the set-up parameter.

## 15.3.11 Program Protection (Edit Lock B, C)

M system : ○

L system : ○

The edit lock function B or C inhibits machining program B or C (group with machining program numbers) from being edited or erased when these programs require protection.



## 15.3.12 Program Display Lock

M system : ○

L system : ○

This function allows the display of only a target program (label address 9000) to be invalidated for the program display in the monitor screen, etc.

The operation search of a target program can also be invalidated.

The validity of the display is selected with the parameters. The setting will be handled as follows according to the value.

0: Display and search are possible.

1: Display of the program details is prohibited.

2: Display and operation search of the program details are prohibited.

The program details are not displayed in the prohibited state, but the program number and sequence number will be displayed.

### 15.3.13 Safety Observation

**M system : Δ**

**L system : Δ**

This function is composed of the following functions.

[Dual safety circuit function]

PLC CPU and CNC CPU separately control the Input/Output signal of the dual signal unit.

The state of the disagreement of the Input/Output signal of each CPU is observed by the dual-signal comparison. When an error is detected during observation, the main power for the drive is shut.

[Dual emergency stop function]

PLC CPU, CNC CPU and drive CPU separately observe the input of emergency stop.

The main power for the drive can be shut by controlling the contactor from PLC, CNC CPU, and drive CPU respectively when the emergency stops.

[Dual speed monitor function]

CNC CPU and drive CPU separately observe the following.

- Observe the open and close state signal of the safety door detected with a different circuit
- Observe that the command speed should not exceed the speed set by the parameter (safety speed).
- Observe that the motor rotation speed should not exceed the rotation speed set by parameter (safety rotation speed).

When an error is detected during observation, the main power for the drive is shut.

[Safe brake control]

This feature controls OFF/ON of the brake control output signals through the safety signal compare process.

This can also perform a brake test by issuing a travel command from CNC to a motor with the motor brake put on.

## 15.4 Maintenance and Troubleshooting

### 15.4.1 Operation history

**M system** : ○

**L system** : ○

This is a maintenance function which is useful for tracing the history and CNC operation information, and analyzing trouble, etc. This information can be output as screen displays or as files.

(1) Screen display showing operation history and event occurrence times

The times/dates (year/month/day and hour/minute/second) and messages are displayed as the operation history data. The key histories, alarm histories and input/output signal change histories are displayed as the messages.

The part system information is displayed as the alarm histories.

For instance, "\$1" denotes the first part system, and "\$2" the second part system.

The history data containing the most recent operation history and event occurrence times (2,068 sets) are displayed on the "Operation history" screen. The most recent history data appears at the top of the screen, and the older data is displayed in sequence below.

(2) Outputting the data in the operation history memory

Information on the alarms occurring during NC operation and stop codes, signal information on the changes in the PLC interface input signals and the key histories can be output.

### 15.4.2 Data Sampling

**M system** : ○

**L system** : ○

The data sampling function can sample the CNC internal data (speed output from the CNC to the drive unit and feedback data from the drive unit, etc.) and output it as text data.

### 15.4.3 NC Data Backup

**M system** : ○

**L system** : ○

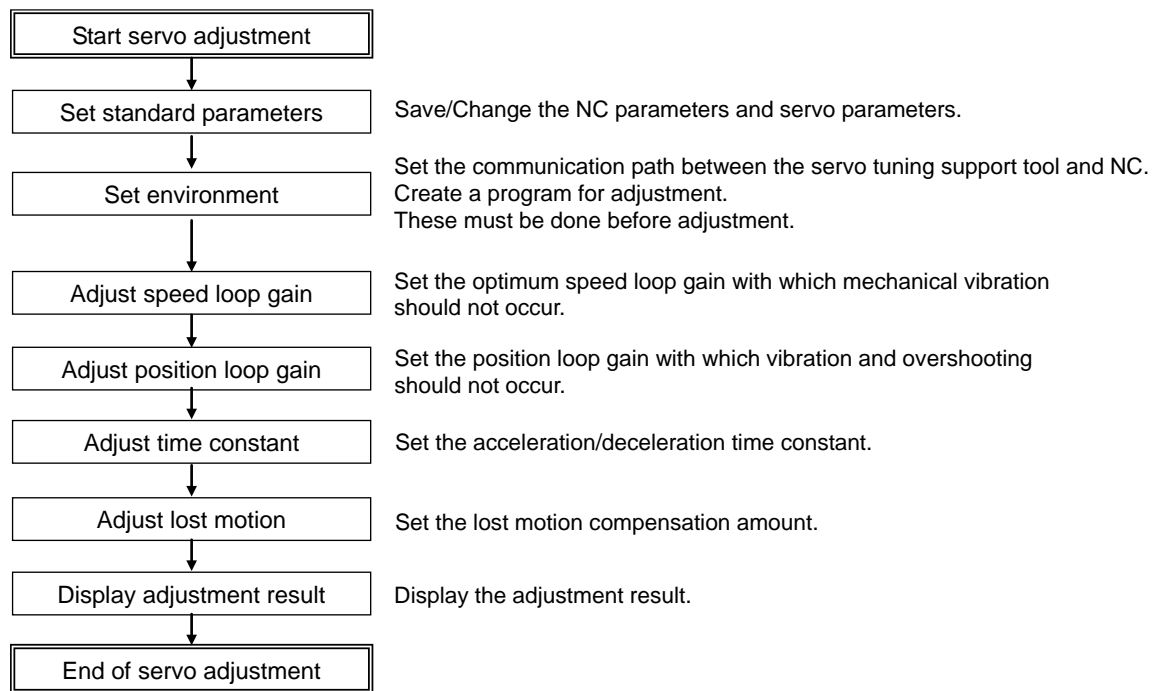
This function serves to back-up the parameters and other data of the CNC control unit. The data can also be restored.

### 15.4.5 Servo Tuning Support Tools

The servo parameters can be automatically adjusted by connecting the CNC and a servo tuning support tool, which is an application designed to be used on a regular personal computer.

The servo tuning support tool measures and analyzes the machine characteristics to automatically adjust the servo parameters while having the motor run by test NC programs or vibration signals.

The currently available servo tuning support tool is MS Configurator.  
The servo adjustment process flow is shown below.



**15.4.5.1 MS Configurator (Need to prepare separate S/W)****M system : ○****L system : ○**

With MS Configurator, the servo system's bode diagram can be measured by activating the motor with vibration signals and measuring/analyzing the machine characteristics. And the servo waveform measurement function is supported, too.

(Note) This tool is free of charge. Please contact us.

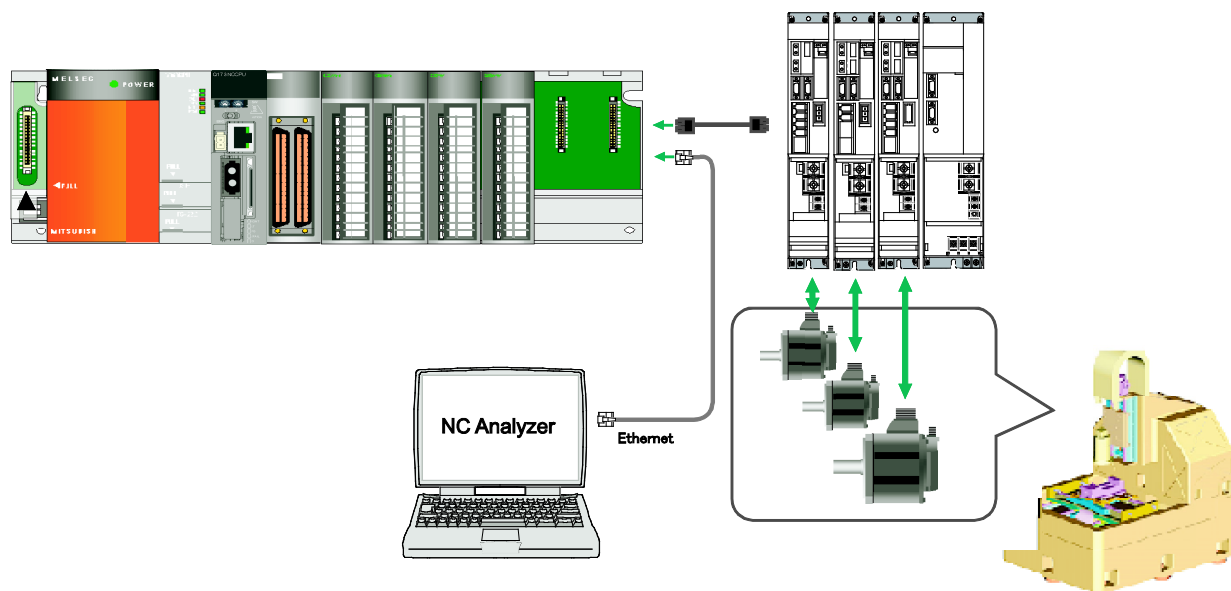
## 15.4.5.2 NC Analyzer

M system : ○

L system : ○

With NC Analyzer, the attribute of the servo motor system is measured and the bode diagram is output by activating the motor with vibration signals and measuring/analyzing the machine characteristics. And the servo waveform measurement function is supported, too.

(Note) Please contact us to purchase this tool.



## &lt;Function&gt;

**Waveform measurement function**

- |   |   |  |
|---|---|--|
| Frequency response measurement                        | : | Measures the frequency response (speed command - speed FB) of speed loop for the designated axis. The result will be presented as Bode diagram.      |
| Frequency response measurement of machine             | : | Measures the frequency response (torque command - speed FB) of machine system for the designated axis. The result will be presented as Bode diagram. |
| Measurement function (with program creation function) | : | Measures the Time-series data measurement, Circular error measurement, Synchronous tapping error measurement, Arbitrary path measurement.            |

**Automatic adjustment function**

- |                               |   |   |
|-------------------------------|---|---|
| Program creation              | : | Creates machining programs for adjustment.  |
| Initial notch filter setup    | : | Automatically adjusts the notch filter when the initial resonance is large.                             |
| Velocity loop gain adjustment | : | Automatically adjusts the notch filter and the speed loop gain.   |
| Time constant adjustment      | : | Automatically adjusts the acceleration/deceleration time constant.                                      |
| Position loop gain adjustment | : | Automatically adjusts the position loop gain.   |
| Lostmotion adjustment         | : | Automatically adjusts the quadrant protrusion amount of the designated axis.                            |
| Lostmotion 3 adjustment       | : | Automatically adjusts the lost motion type 3 for the quadrant protrusion amount of the designated axis. |

**Environment setup**

- |                          |   |  |
|--------------------------|---|--|
| Communication path setup | : | Sets the path to communicate with NC. The model of connected NC is selected. |
| Parameter setup          | : | Saves/changes the servo parameters.  |



**15.4.13 Parameter Setting Tool****15.4.13.1 NC Configurator2****M system : ○****L system : ○**

The NC data file necessary for NC control and machine operation (such as parameters, tool data and common variables) can be edited on a personal computer.

Please contact us to purchase a full function version. A limited function version is also available free of charge.

**15.4.102 Backup****M system : ○****L system : ○**

This function saves (backs up) the screen data and each controller (PLC, CNC) data to a memory card or a USB memory. It also reloads (restores) that data to each device.

If this function is used, the backup is unnecessary for the MONITOR screen and each controller, and work improves.

## **16. Drive System**

CNC dedicated products are used as drive units, spindle motors, and servo motors.  
Refer to "C70 Series Specifications List II" in the contents.

Refer to the following manuals for details on the servo and spindle system.

DRIVE SYSTEM DATA BOOK(IB-1500273)

MDS-D/DH Series Specifications Manual(IB-1500875)

MDS-D-SVJ3/SPJ3 Series Specifications Manual(IB-1500158)

MDS-DM Series Specifications Manual(IB-1500891)

DRIVE SYSTEM DATA BOOK(IB-1501142)

MDS-D2/DH2 Series Specifications Manual(IB-1501124)

MDS-DJ Series Specifications Manual(IB-1501130)

MDS-DM2 Series Specifications Manual(IB-1501136)

## 17. Machine Support Functions

### 17.1 PLC

#### 17.1.2 PLC Functions

##### 17.1.2.1 Built-in PLC Basic Function

**M system : Δ (MELSEC)      L system : Δ (MELSEC)**

As the PLC function of MITSUBISHI CNC C70, the PLC CPU of MITSUBISHI Programmable Controller MELSEC is used.

Select a PLC suitable for the control scale and the performance from several kinds of PLCs and use it. Refer to the material of MITSUBISHI Programmable Controller MELSEC which can be used with MITSUBISHI CNC C70 for details.

17.1.2.2 NC Exclusive Instruction

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

NC exclusive instructions are not MELSEC standard instructions. They are directly related to the memory in the CNC, and convenient for using a CNC. They can be programmed with the MELSEC programming tool GX Developer as other standard instructions.

NC exclusive instructions include:

(1) ATC exclusive instruction (D(P).ATC)

This is an instruction to function ATC, or magazine index control, tool exchange with arm, etc. ATC exclusive instructions are as follows.

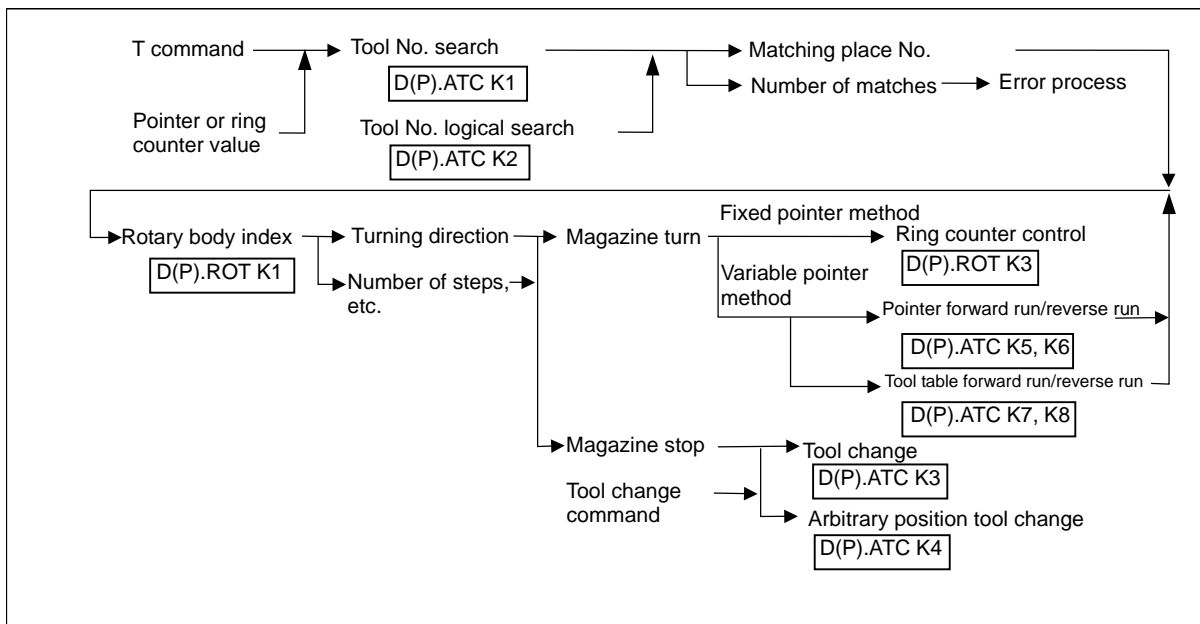
- Tool No. search
- Tool change
- Tool table forward/reverse run
- Pointer (which indicates magazine index position) forward/reverse run
- Tool data read/write

(2) Rotary body control instruction (D(P).ROT)

This is an instruction to determine the rotary body's target position or rotation direction, or to function as a ring counter. This is used when calculating the rotation direction or number of index steps of the magazine or turret based on the output data figured from ATC exclusive instruction tool No. search processing, or when controlling the rotary body position.

**Using the ATC and ROT instructions**

The order for using the D(P).ATC and D(P).ROT instructions when T is commanded or tool exchange is commanded is shown below.



17.1.2.101 Built-in PLC Processing Mode

**M system : ○                      L system : ○**

This function is used when executing safety observation of significant signals using a dual signal module. Refer to the documents of safety observation function for details.

### 17.1.3 PLC Support Functions

#### 17.1.3.6 Multi-ladder Program Register and Execution

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Two or more PLC programs can be stored and executed.

#### 17.1.3.7 Ladder Program Writing during RUN

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Ladder program can be written while CPU unit is running.

#### 17.1.3.8 PLC Protection

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Read and writing of PLC program and device comments can be prohibited.

### 17.1.4 Built-in PLC Capacity

**M system : □ 30k/40k/60k/130k/260k    L system : □ 30k/40k/60k/130k/260k**

Parameters, intelligent function unit parameters, programs, device comments, and system area set by user can be stored in a program memory.

### 17.1.5 Machine Contact Input/Output I/F

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

The device is selected from the I/O unit of MITSUBISHI Programmable Controller MELSEC Q Series. Follow the manual of the I/O unit about the method of handling.

### 17.1.6 Ladder Monitor

**M system : ○                    L system : ○**

This function enables the operating status of the sequence circuit to be checked on a MITSUBISHI Graphic Operation Terminal (GOT).

The monitor functions include the following.

- (1) Circuit monitoring
- (2) Batch monitor
- (3) Entry monitoring

**17.1.7 PLC Development****17.1.7.101 MELSEC Development Tool (GX Developer)**

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

This function enables the data of the MELSEC CPU PLC programs to be developed and debugged using GX Developer installed in a personal computer with Windows.

Many and varied functions of the GX Developer make it possible to reduce the PLC data development and debugging time.

**17.1.9 GOT Connection**

For connecting a MITSUBISHI Graphic Operation Terminal (GOT), refer to the GOT materials.

Only when GOT has been bus-connected with the DISPLAY interface of NC CPU or the basic base unit, the CNC exclusive use screen (CNC monitor function) can be displayed.

The size of GOT corresponds to SVGA and XGA.

## 17.2 Machine Construction

### 17.2.1 Servo OFF

**M system** : ○

**L system** : ○

When the servo OFF signal (per axis) is input, the corresponding axis is set in the servo OFF state.

When the moving axis is mechanically clamped, this function is designed to prevent the servomotor from being overloaded by the clamping force.

Even if the motor shaft should move because of some reason in the servo OFF state, the movement amount will be compensated in the next servo ON state by one of the following two methods. (You can select the compensation method using a parameter.)

- (1) The counter is corrected according to the movement amount (follow up function).
- (2) The motor is moved according to the counter and compensated.

When follow up function is designated, the movement amount will be compensated even in the emergency stop state.

The axis is simultaneously set to servo OFF state and the interlock state.

#### **Mechanical handle**

Even if the servo OFF axis is moved with the mechanical handle with the application of the servo OFF function and follow up function, the position data can be constantly read in and the machine position updated. Thus, even if the axis is moved with the mechanical handle, the coordinate position display will not deviate.

17.2.2 Axis Detachment

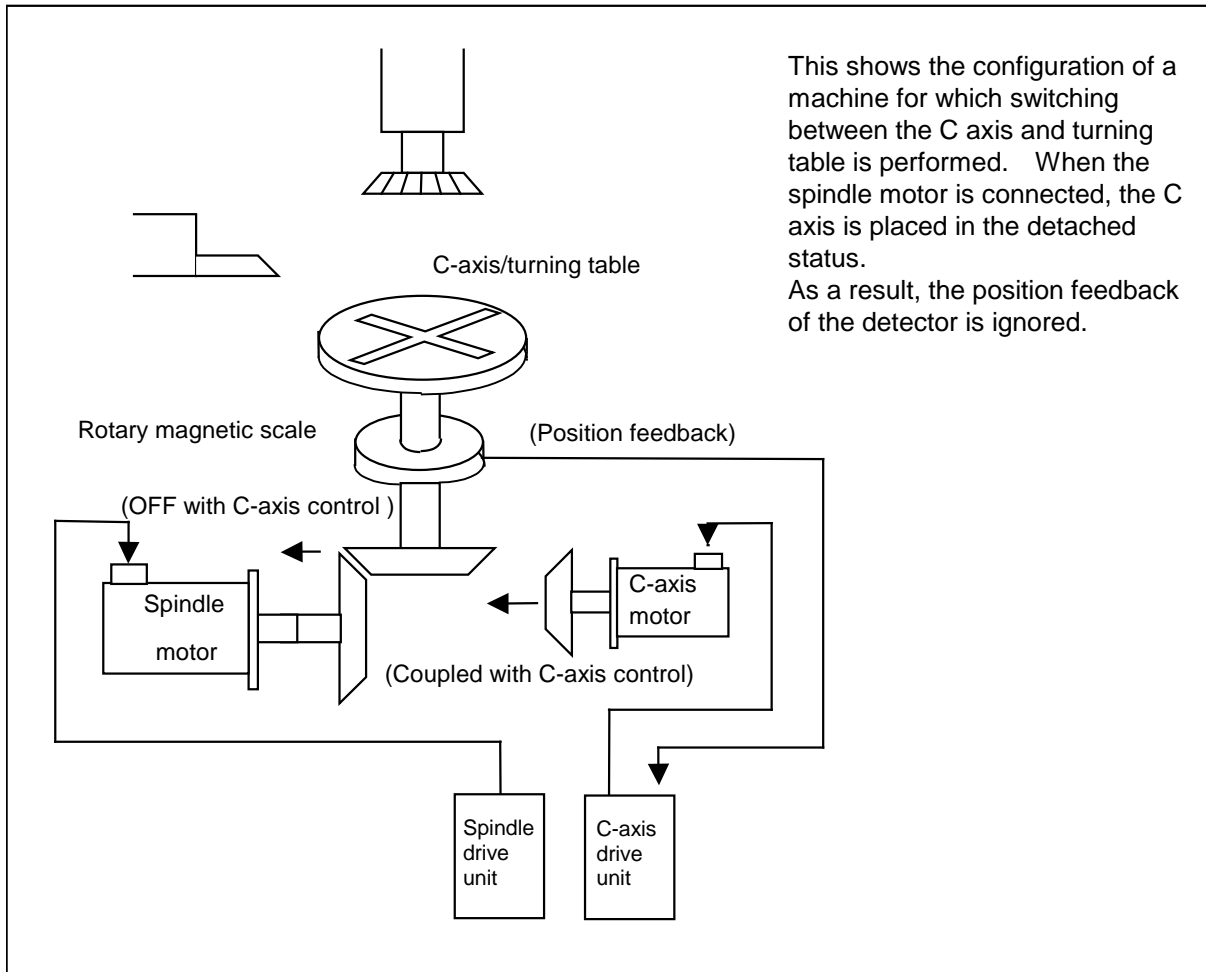
M system : Δ

L system : Δ

This function enables the control axis to be released from control. Conversely, an axis which has been freed from control can be returned to the control status.

This function enables the rotary table or attachments to be removed and replaced.

Automatic operation is disabled until the axis for which the axis detach command has been released completes its dog-type reference position return.



| POSITION |                  |
|----------|------------------|
| X        | 1 2 3 . 4 5 6    |
| Z        | 0 . 0 0 0 #1     |
| C        | 3 4 5 . 6 7 8 >< |

The detached status > < is indicated on the right of the POSITION display on the POSITION screen and at the same time the servo ready for the controller output signal is set to OFF. The POSITION counter retains the value applying when detach was assigned.

**(Note)** Axis detach can be executed even for the absolute position detection specifications axis, but when the axis is reinstalled, the zero point must be set.



## 17.2.3 Synchronous Control

M system :  $\Delta$ 

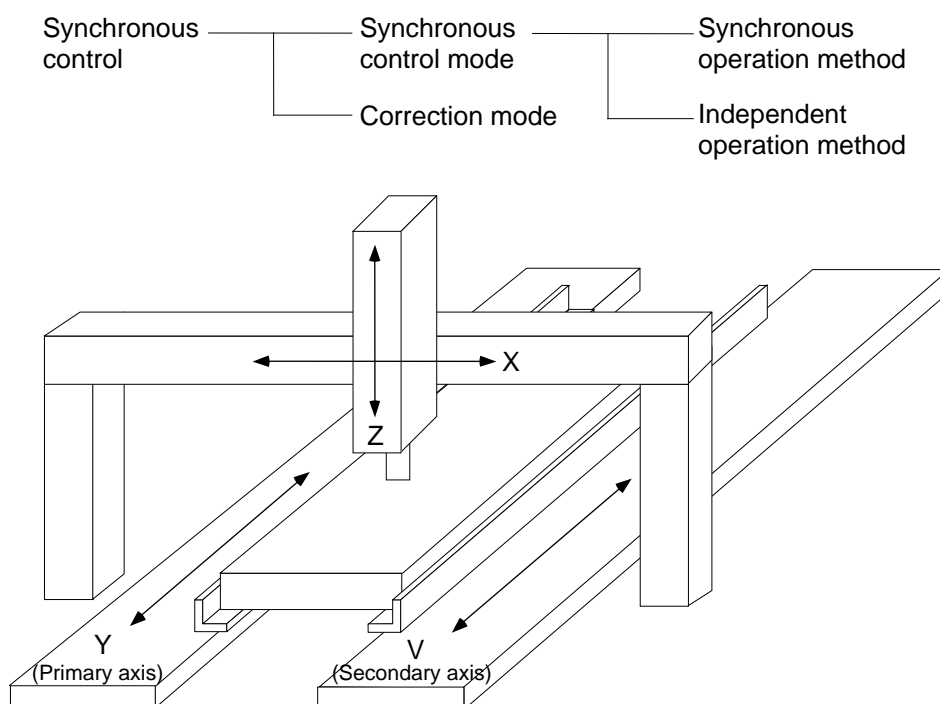
L system : -

The synchronous control is a control method that both primary and secondary axes are controlled with the same movement command designating the movement command for the primary axis also to the secondary axis. This function is assumed to be used in large machine tools, etc. which drive one axis with two servo motors.

The axis for the base of the synchronization is called the primary axis, and the axis according to the primary axis is called the secondary axis.

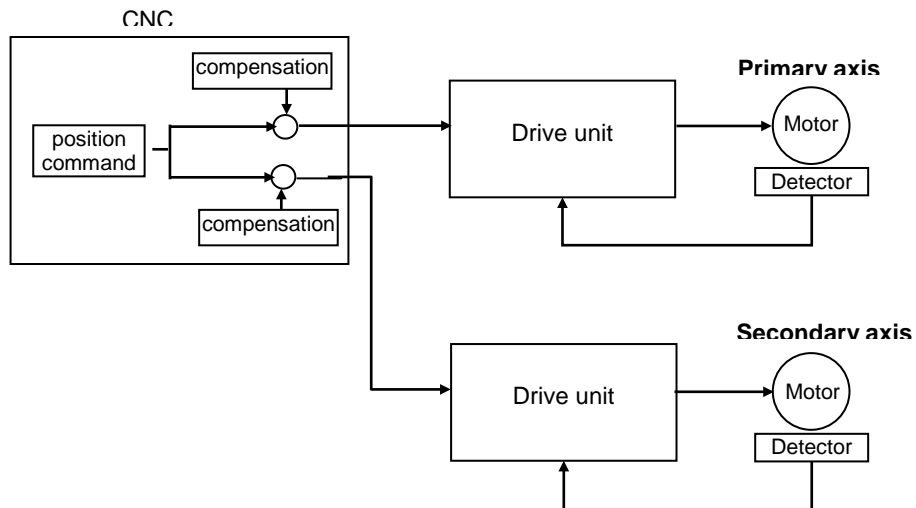
The axis detach function cannot be added to the axes used in the synchronous control.

- The secondary axis is controlled with the movement command for the primary axis.
- One secondary axis can be set to one primary axis.
- Up to 3 sets of primary axis / secondary axis can be set in total for all the part systems.

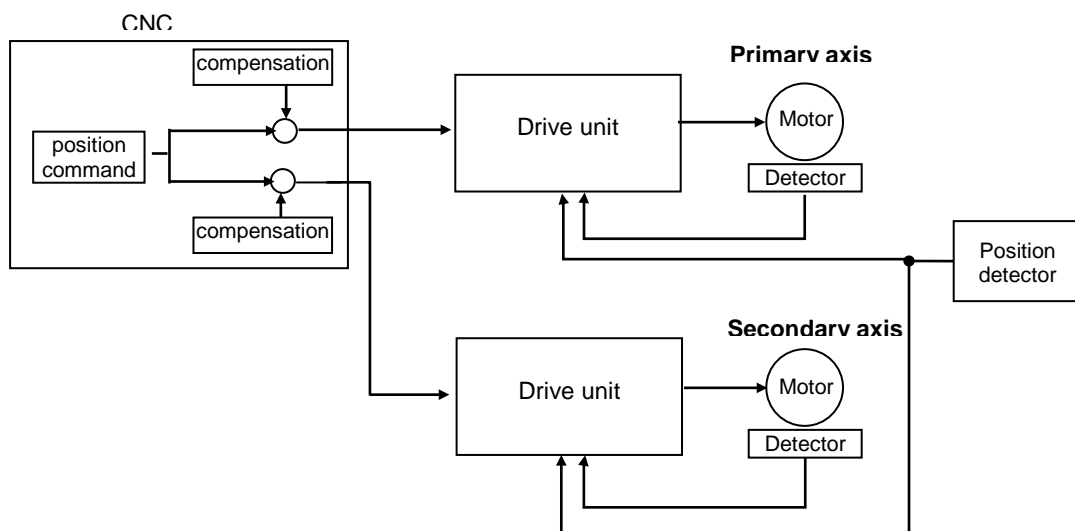


(1) Synchronous control  
 There are three ways of synchronous control:

- (a) Position command synchronous control  
 This is intended for a machine with low stiffness.  
 NC outputs matched position commands to the both axes so that the two travel in synchronization.



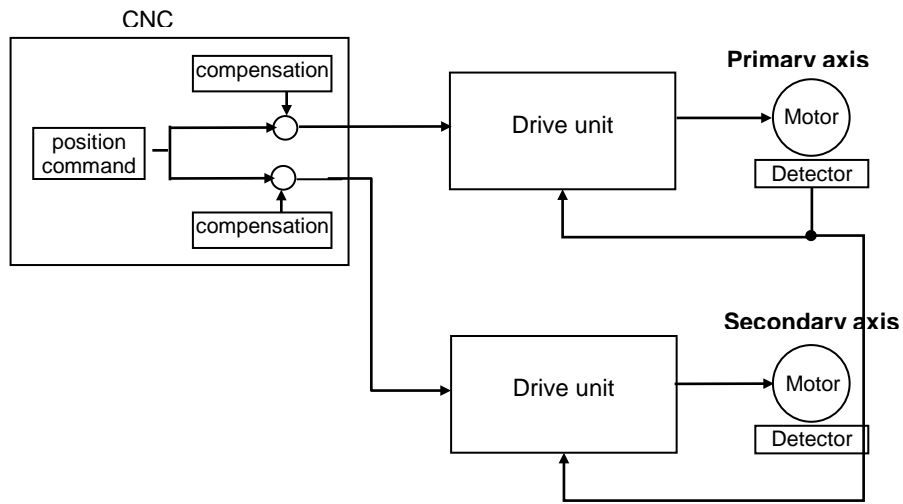
- (b) Speed command synchronous control  
 Choose this when the scale of the full-closed system is set rather small, or to avoid a mechanical conflict that would otherwise be caused because of machine stiffness, etc.  
 By using position feedbacks from the same position detector, the primary and secondary axes move in synchronization.



(c) Current command synchronous control

This is intended for a machine with high stiffness.

The secondary axis refers to detector feedbacks of the primary axis to synchronize its motion to the primary.

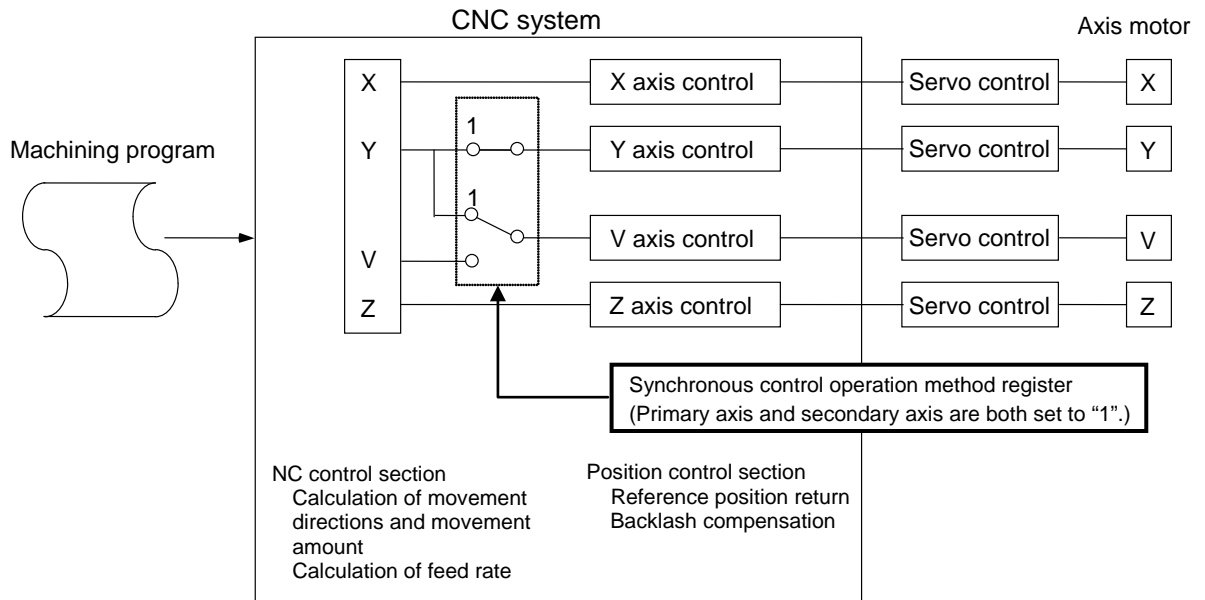


## (2) Synchronous control mode

The following two operation methods are available in the synchronous control mode.

## (a) Synchronous operation

This is a method that both primary and secondary axes are moved simultaneously with the movement command for the primary axis.

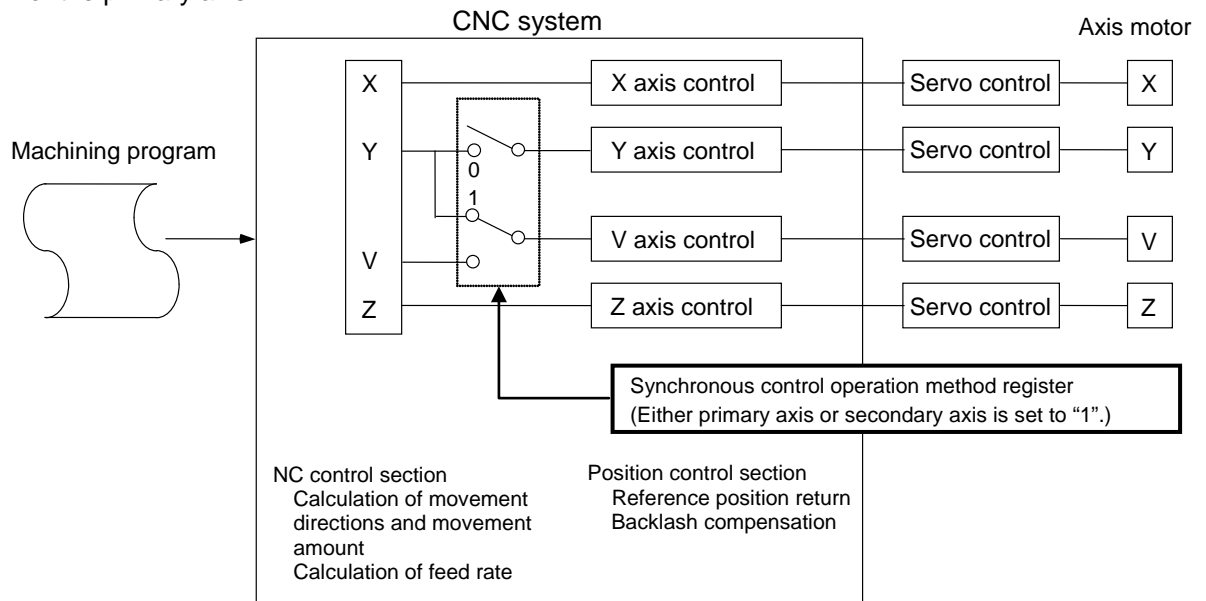


There is a function that checks the correlation between the positions of the primary axis and secondary axis at all times while the synchronous operation method is selected to stop the feed as alarm when the error between the positions exceeds the allowable synchronization error value set in the parameter. However, when the zero point is not established, the synchronous error is not checked.

Even during synchronous operation, pitch error compensation, backlash compensation and external machine coordinate compensation are performed independently for each primary axis and secondary axis. Designation/cancellation of synchronous operation is executed at "all axes in-position".

## (b) Independent operation

This is a method that either the primary or secondary axis is moved with the movement command for the primary axis.



Even during independent operation, pitch error compensation, backlash compensation and external machine coordinate compensation are performed independently for each primary axis and secondary axis. Designation/cancellation of independent operation is executed at "all axes in position".

## (3) Correction mode

The synchronization is temporarily canceled to adjust the balance of the primary and secondary axes during the synchronous control mode in the machine adjustment. Each axis can be moved separately with the manual handle feed or the arbitrary feed in manual mode. If the operation mode other than the manual handle feed and arbitrary feed in manual mode is applied during the correction mode, the operation error will occur.

17.2.4 Inclined Axis Control

M system : -

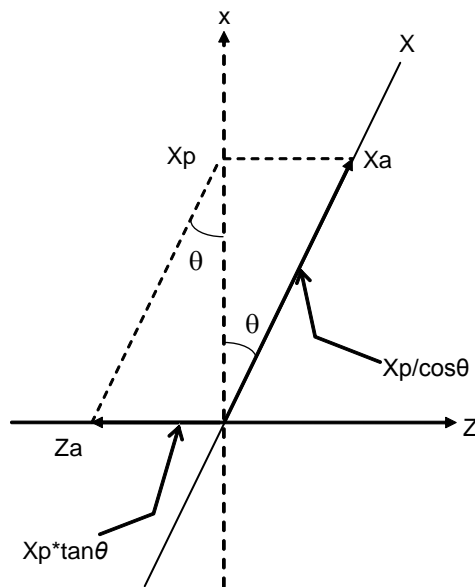
L system : Δ

Even when the control axes configuring that machine are mounted at an angle other than 90 degrees, this function enables to control by the same program as an orthogonal axis.

The inclination angle is set using a parameter, and axes are controlled using the movement amounts of the axes which are obtained through conversion and compensation using this angle.

Note that the inclined axis is fixed to the 1st axis of the part system and the basic axis is fixed to the 2nd axis of the part system.

<Example of use> When the X axis serves as the inclined axis and the Z axis serves as the basic axis



X: Actual X axis  
 Z: Actual Z axis  
 x: Programmed X axis  
 θ: Inclination angle

Xp, the X-axis position on the programmed coordinates (on the orthogonal coordinates), is the position of Za and Xa which are produced by synthesis of Z axis and X axis.

Therefore, the X-axis (inclined axis) movement amount is expressed by the following formula:

$$X_a = X_p / \cos\theta \dots\dots\dots(1)$$

The Z-axis (basic axis) movement amount is compensated by the inclined movement of the X axis, and it is expressed as follows:

$$Z_a = Z_p - X_p \times \tan\theta \dots\dots\dots(2)$$

The X-axis (inclined axis) speed is as follows:

$$F_a = F_p / \cos\theta$$

Xa, Za and Fa are the actual movement amounts and speed.  
 Xp, Zp and Fp are the movement amounts and speed on the program coordinates.

17.2.5 Position Switch

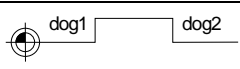
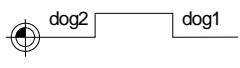
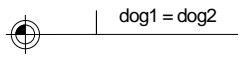
**M system :** ○ (24 for each part system,  
16 for PLC axis)

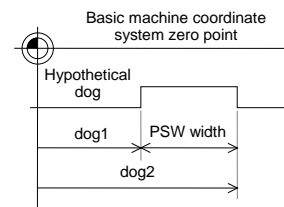
**L system :** ○ (24 for each part system,  
16 for PLC axis)

Instead of a dog switch on a machine's axis, a hypothetical dog switch is established using a parameter to set a coordinate position to show the axis name and the hypothetical dog position. When the machine reaches the position, a signal is output to the PLC interface. The hypothetical dog switches are known as position switches (PSW).

The coordinate position indicating the hypothetical dog positions (dog1, dog2) on the coordinate axes whose names were set by parameters ahead of time in place of the dog switches provided on the machine axes are set using position switches (PSW1 to PSW16). When the machine has reached the hypothetical dog positions, a signal is output to the device supported by the PLC interface.

**Example of dog1, dog2 settings and execution**

| dog1, dog2 settings | dog1, dog2 positions   | Description                                  |
|---------------------|--|--|
| dog1 < dog2         |   | Signal is output between dog1 and dog2       |
| dog1 > dog2         |   | Signal is output between dog2 and dog1       |
| dog1 = dog2         |  | Signal is output at the dog1 (dog2) position |



## 17.2.101 Multi-secondary-axis Synchronous Control

M system :  $\Delta$ 

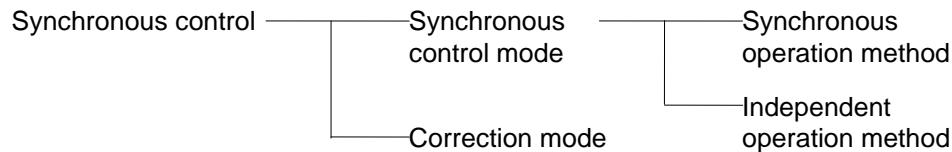
L system : -

Multi-secondary-axis synchronous control function serves to drive 2 or more secondary axes in synchronization with travel commands for the primary axis.

It can be used in instances such as when operating a machine that has a normal-line control axis as its primary axis and multiple normal-line axes in parallel to the primary axis.

Up to 3 groups of axes, including standard synchronously-controlled axes, can be simultaneously operated at one time.

The number of secondary axes is subject to the maximum number of axes allowed for each part system.



## (1) Synchronous control mode

The following two operation methods are available in the synchronous control mode.

## (a) Synchronous operation

Designated axes among the primary axis and secondary axes will move in synchronization with commands for the primary axis. Either all axes or a one given axis can be designated. (Primary axis must always be designated.)

## (b) Independent operation

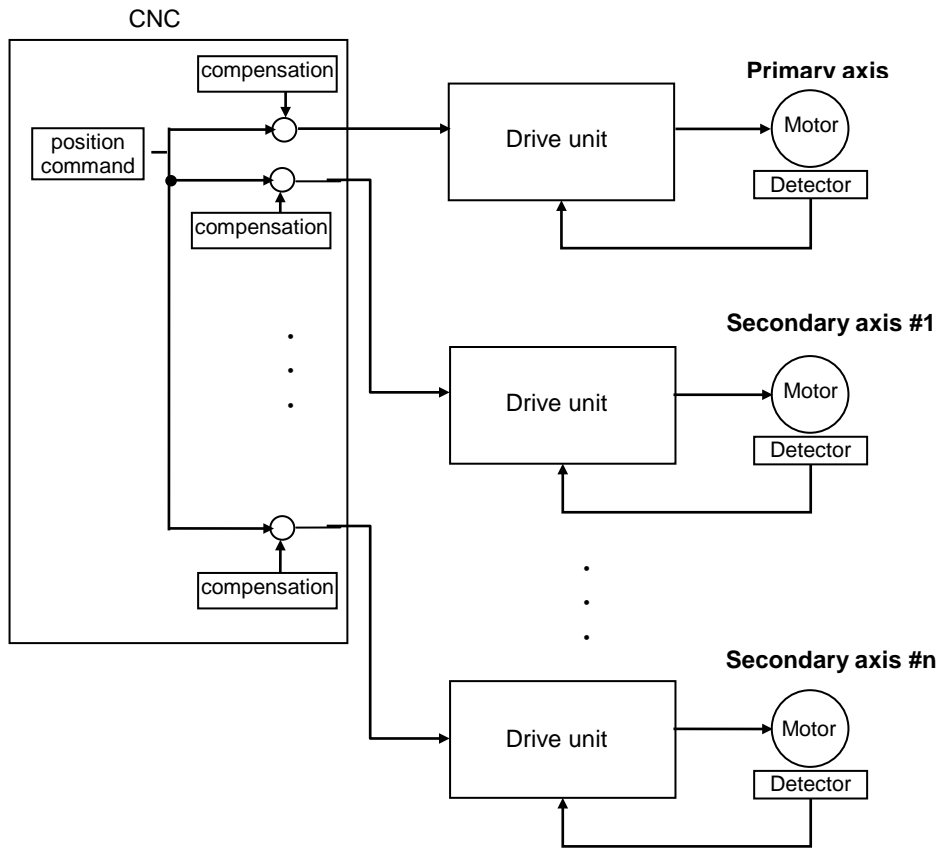
Axes that are not designated for synchronous operation will independently move with their own travel commands. If no axes are designated, the primary axis only will move.

## (2) Correction mode

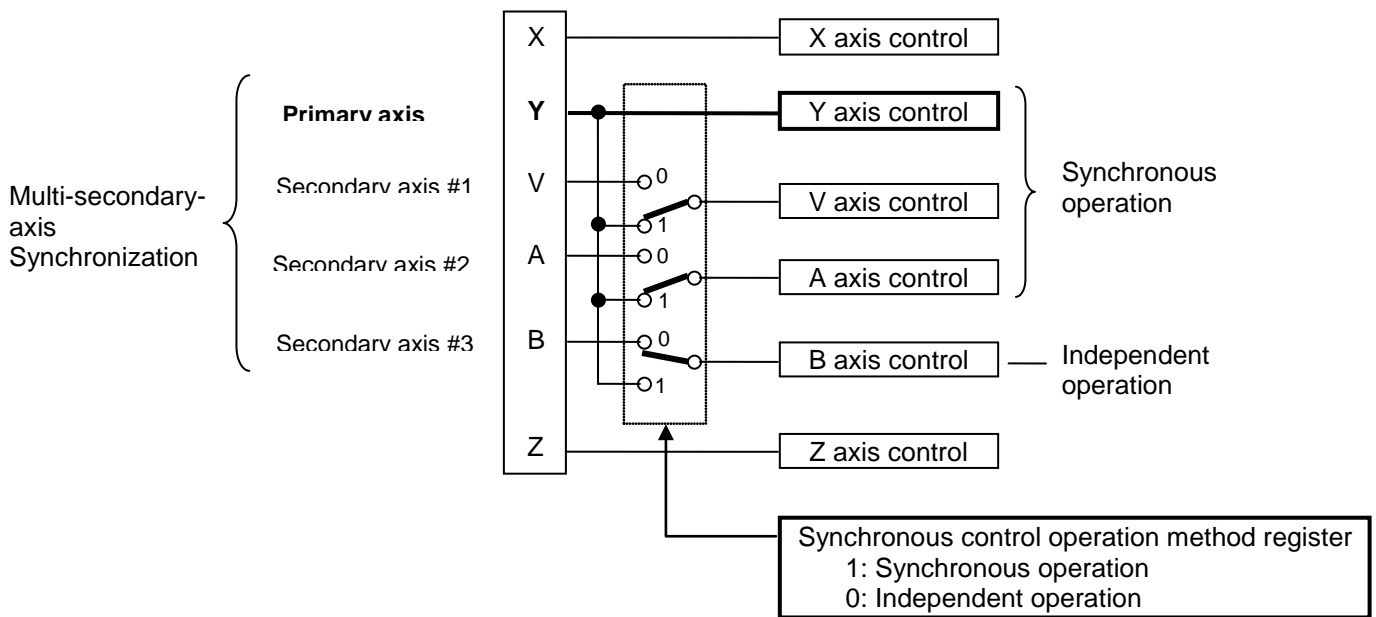
The synchronization is temporarily canceled to adjust the balance of the primary and secondary axes during the synchronous control mode in the machine adjustment. Each axis can be moved separately with the manual handle feed or the arbitrary feed in manual mode. If the operation mode other than the manual handle feed and arbitrary feed in manual mode is applied during the correction mode, the operation error will occur.



Configuration example of multi-secondary-axis synchronous control:



Block chart of synchronous operation method:



## 17.3 PLC Operation

### 17.3.1 Arbitrary Feed in Manual Mode

**M system** : ○

**L system** : ○

This function enables the feed directions and feed rates of the control axes to be controlled using commands from the user PLC.

The arbitrary feed function controls the movement of the axes at the specified rates while the start signal is output from the PLC to the NC system.

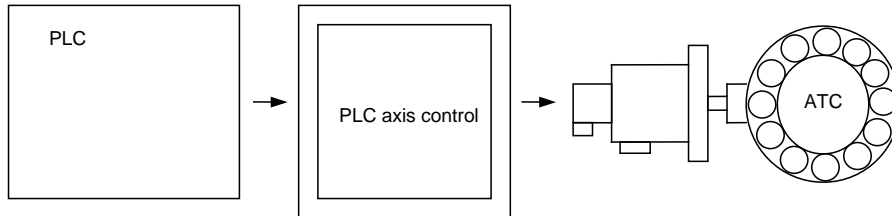
PLC operations can be performed even during manual operation or automatic operation, but they cannot be performed when an axis for which arbitrary feed has been assigned is executing a command from the NC system (that is, while the axis is moving).

17.3.3 PLC Axis Control

M system : Δ

L system : Δ

Over and above the NC control axes, this function enables axes to be controlled independently by commands from the PLC.



| Item                           | Details  |
|--------------------------------|--|
| No. of control axes            | Max. 8 axes  |
| Simultaneous control axes      | The PLC control axis is controlled independently of the CNC control axis. Simultaneous start of multiple PLC axes is possible.   |
| Command unit                   | Min. command unit                    0.001mm (0.0001 inch)<br>0.0001mm (0.00001 inch)  |
| Feedrate                       | 0 to 1000000mm/min (0 to 100000inch/min)<br>(The feedrate is fixed regardless of the unit system.)   |
| Movement commands              | Incremental value commands from the current position.<br>Absolute value commands of the machine coordinate system.<br>0 to ±99999999   |
| Operation modes                | Rapid traverse, cutting feed<br>Jog feed (+), (-)<br>Reference position return feed (+), (-)<br>Handle feed  |
| Backlash compensation          | Provided   |
| Stroke end                     | Not provided   |
| Soft limit                     | Provided   |
| Rotation axis commands         | Provided<br>Absolute value commands..... Rotation amount within one rotation. (Rotates the remainder divided by rotational axis division count.)<br>The axis rotates in shortcut direction by the setting of a parameter "#8213 Rotation axis type".<br>Incremental commands..... Rotates the commanded rotation amount. |
| Inch/mm changeover             | Not provided<br>Command to match the feedback unit.  |
| PLC axis automatic initial set | When zero point initialization to start up the absolute position detection system uses the stopper method, the automatic initial setting operation can be selected.  |

17.3.5 PLC Axis Indexing

M system : Δ

L system : Δ

PLC axis indexing is used to move the PLC axis to the positioning destination or an arbitrary coordinate position.

This function is applied to tool exchange and magazine control.

[Positioning command methods]

(1) Station method

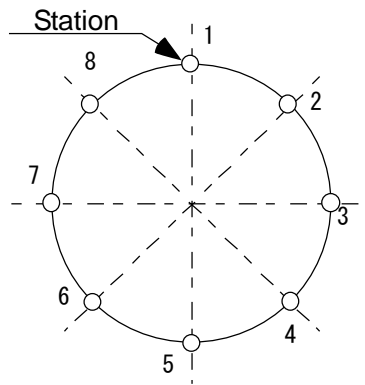
The axis will be positioned to the destination (station) that has been decided.

There are two assigning methods: Uniform assignment and arbitrary coordinate assignment.

- Uniform assignment

One rotation (360°) of the rotary axis will be equally divided to determine the stations.

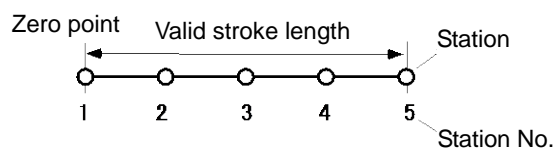
(Maximum number of divisions: 360)



[Setting 8 stations (8 divisions)]

[For linear axis]

A valid stroke will be equally divided to determine the station. (Maximum number of divisions: 359)



[Setting 5 stations]

- Arbitrary coordinate assignment

A station will be assigned to an arbitrary coordinate set in each table.

(2) Arbitrary coordinate designation method

An arbitrary coordinate will be directly designated in PLC program for positioning.

## [Operation functions]

- Automatic mode  
Stations will be determined automatically.
- Manual mode  
Stations will be determined manually.  
While the start signal is ON, the axis will be rotated at a constant speed. When the start signal is OFF, the axis will be positioned at the nearest station.
- JOG mode  
The axis will be rotated at constant speed.
- Incremental feed  
The axis will be moved by the designed amount.
- Manual handle feed  
The axis will be moved by the manual pulse generator.
- Reference position return  
The axis will be positioned at the reference position.  
Reference position return is not possible by a dog switch.

## [Feed functions]

- Feed rate selection  
Automatic mode and manual mode can have each four different feed rates to be designated in the PLC program.
- Acceleration/deceleration method  
Four different combination can be set from the acceleration/deceleration patterns (linear or S-pattern acceleration/deceleration) and the acceleration/deceleration time constants. The combination will be selected in the PLC program.  
Select acceleration/deceleration type with parameter: the acceleration/deceleration with constant time or the one with a constant angle of inclination.
- Short-cut control  
A least movement distance is automatically judged when a rotary axis is rotated.

**17.3.101 NC Axis/PLC Axis Changeover****M system : Δ****L system : Δ**

This function enables one control axis to be dynamically switched to be used as NC axis or PLC axis. If the PLC axis is set as indexing axis, changeover is available between the NC axis and the indexing axis.

## 17.4 PLC Interface

### 17.4.1 CNC Control Signal

**M system** : ○

**L system** : ○

Control commands to the CNC system are assigned from the PLC. Input signals with skip inputs that respond at high speed can also be used.

(1) Control signals

- Control signals for operations in automatic operation mode
- Control signals for operations in manual operation mode
- Control signals for program execution
- Control signals for interrupt operations
- Control signals for servo
- Control signals for spindle
- Control signals for mode selection
- Control signals for axis selection
- Control signals for feed rates

(2) Skip signals

When signals are input to the skip input interface, they are processed by interrupt processing. This enables functions requiring a high response speed to be implemented. (Maximum 4 points)

For further details, refer to the PLC Interface Manual.

## 17.4.2 CNC Status Signal

**M system** : ○**L system** : ○

The status signals are output from the CNC system. They can be utilized by referencing them from the PLC.

**Status output functions**

- (1) Controller operation ready  
When the controller power is turned ON and the controller enters the operation ready status, the "Ready" signal is output to the machine.  
Refer to the PLC Interface Manual for details of the sequences from when the controller power is supplied to when the controller ready status is entered.
- (2) Servo operation ready  
When the controller power is turned ON and the servo system enters the operation ready status, the "Servo ready" signal is output to the machine.  
Refer to the PLC Interface Manual for details of the sequences from when the power is supplied to when the "Servo ready" signal is turned ON.
- (3) In automatic operation "run"  
Generally, if the "cycle start" switch is turned ON in the automatic operation mode (memory, MDI), this signal is output until the reset state or emergency stop state is entered by the M02, M30 execution or the reset & rewind input to the controller using the reset button.
- (4) In automatic operation "start"  
The signal that denotes that the controller is operating in the automatic mode is output from the time when the cycle start button is pressed in the memory or MDI mode and the cycle start status has been entered until the time when the automatic operation is terminated in the automatic operation pause status entered by the "feed hold" function, block completion stop entered by the block stop function or resetting.
- (5) In automatic operation "pause"  
An automatic operation pause occurs and this signal is output during automatic operation from when the automatic pause switch is pressed ON until the cycle start switch is pressed ON, or during automatic operation when the mode select switch is changed from the automatic mode to the manual mode.
- (6) In rapid traverse  
The "In rapid traverse" signal is output when the command now being executed is moving an axis by rapid traverse during automatic operation.
- (7) In cutting feed  
The "In cutting feed" signal is output when the command now being executed is moving an axis by cutting feed during automatic operation.
- (8) In tapping  
The "In tapping" signal is output when the command now being executed is in a tapping modal which means that one of the statuses below is entered during automatic operation.
  - (a) G84, G88 (fixed cycle: tapping cycle)
  - (b) G84.1, G88.1 (fixed cycle: reverse tapping cycle)
  - (c) G63 (tapping mode)

- (9) In thread cutting  
The "In thread cutting" signal is output when the command now being executed is moving an axis by thread cutting feed during automatic operation.
- (10) In rewinding  
The "In rewinding" signal is output when the reset & rewind signal is input by M02/M30, etc., during memory operation and the program currently being executed is being indexed.  
The rewinding time is short, so there may be cases when it cannot be confirmed with the sequence program (ladder).
- (11) Axis selection output  
The "Axis selection output" signal for each axis is output to the machine during machine axis movement.
- (a) Automatic mode  
The signal is output in the movement command of each axis. It is output until the machine stops during stop based on feed hold or block stop.
  - (b) Manual mode (including incremental feed)  
The signal is output while the axis is moving from the time when the jog feed signal is turned ON until the time when it is turned OFF and the machine feed stops.
  - (c) Handle feed mode  
The signal is output at all times when the axis selection input is on.
- (12) Axis movement direction  
This output signal denotes the direction of the axis now moving, and for each axis a "+" (plus) signal and a "-" (minus) signal are output respectively.
- (13) Alarm  
This signal indicates the various alarm statuses that arise during controller operation. It is divided into the following types and output.
- (a) System errors
  - (b) Servo alarms
  - (c) Program errors
  - (d) Operation errors
- (14) In resetting  
This signal is output when the controller is reset processing.  
This signal will also be output when the reset & rewind command is input to the controller, when the controller READY status is OFF, when the Emergency stop signal is input or when a servo alarm is occurring, etc.
- (15) Movement command finish  
In the memory or MDI automatic operation, the "Movement command finish" signal is output when the command block in the machining program features a movement command and when that block command has been completed.  
When the movement command and M, S, T or B command have been assigned in the same block, then the movement command signal can be used as a sync signal for either executing the processing of the M, S, T or B command at the same time as the command or executing it upon completion of the movement command.



17.4.3 PLC Window

M system : Δ

L system : Δ

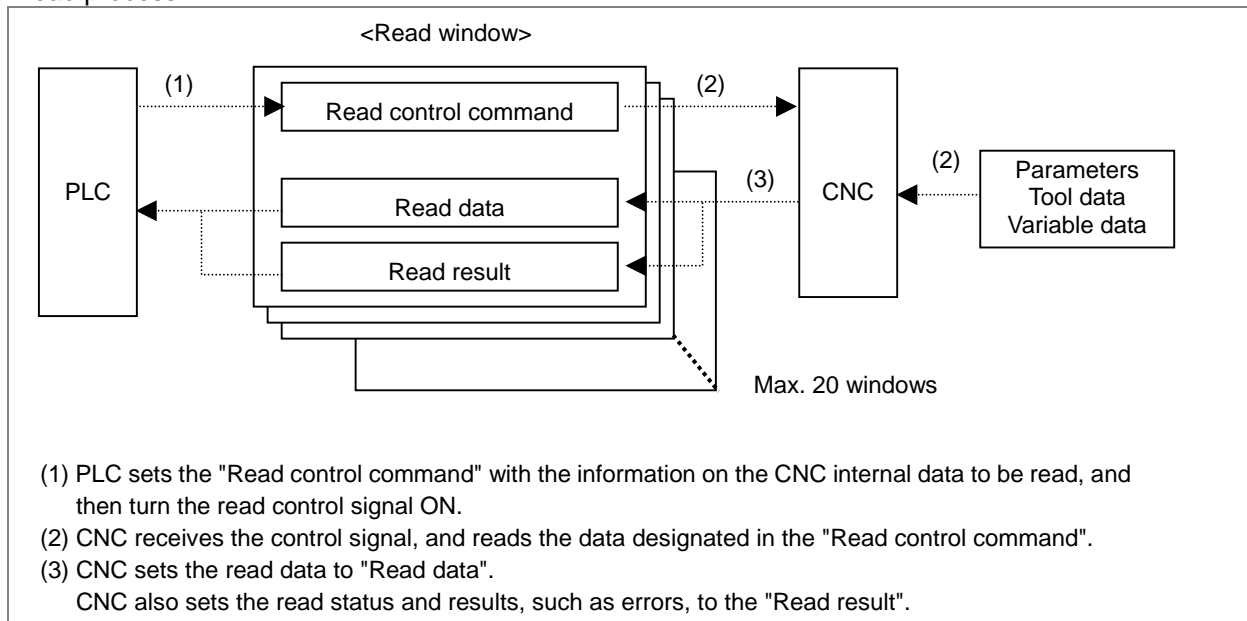
PLC window is used to read/write the operation state, axis information, parameters and tool data of the CNC through a cyclic transmission area in the CPU shared memory.

In the interface between CNC CPU for PLC window and PLC CPU, "Read control command", "Read data" and "Read result" are all called "Read window". "Write control command", "Write data" and "Write result" are all called "Write window".

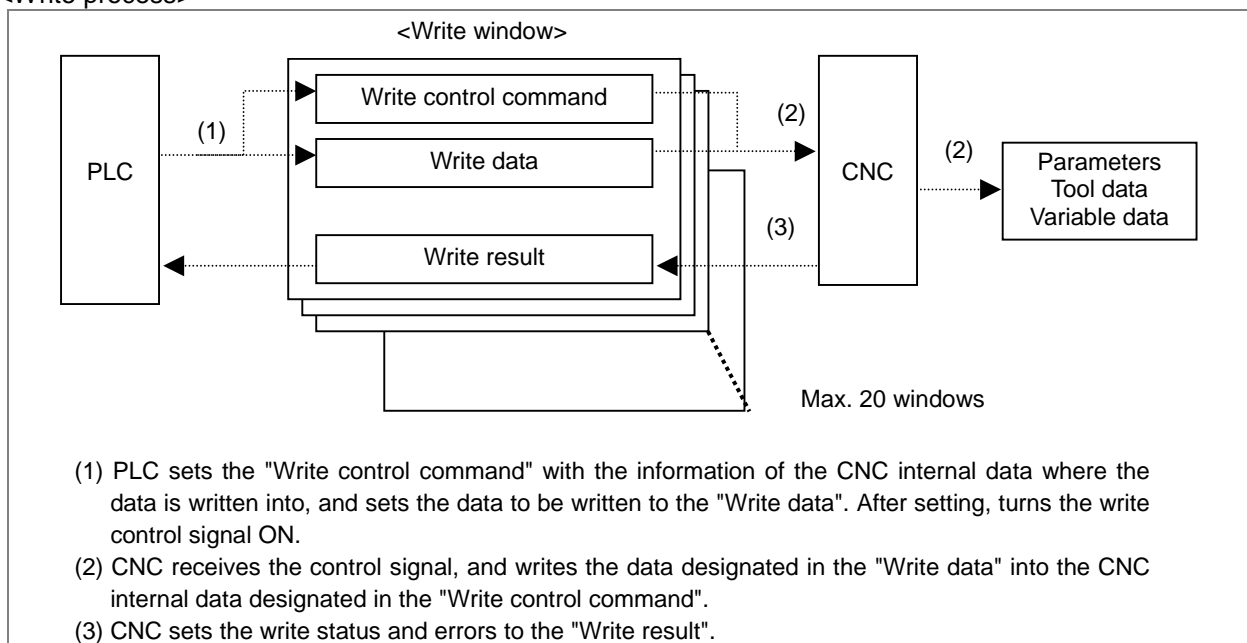
These windows are used for the read and write operations. 40 units of windows, 20 units for each, are provided for "Read window" and "Write window".

Outlines of read and write processes are shown below.

<Read process>



<Write process>



**17.4.4 External Search****M system : Δ****L system : Δ**

This function enables searching of the program to automatically start from the PLC. The program No., block No. and sequence No. can be designated. In addition, the currently searched details can be read.

## 17.6 External PLC Link

### 17.6.3 CC-Link (Master/Slave)

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.4 PROFIBUS-DP (Master)

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.5 DeviceNet (Master)

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.6 FL-net

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.7 CC-Link/LT

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.8 CC-Link IE

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

### 17.6.101 ASi

**M system : Δ (MELSEC)    L system : Δ (MELSEC)**

Refer to manuals of MITSUBISHI Programmable Controller "MELSEC Q series" for information on the function and the performance.

## 17.7 Installing S/W for Machine Tools

### 17.7.3 EZSocket I/F (Need to purchase separate S/W)

**M system :** ○

**L system :** ○

This middleware makes it easy to develop applications having a Windows interface. The various functions of the NC unit can be used from a Windows application using VC++ language, VB language and VBA macro language.

### 17.7.4 APLC release (Need to purchase separate S/W)

**M system :** Δ

**L system :** Δ

APLC (Advanced Programmable Logic Controller) release is a function that allows the user-generated C language module to be called from NC. Control operations that are difficult to express in a sequence program can be created with C language.

APLC release is activated between NC processings so that the processing frequency is not guaranteed.

[Hardware configuration]

This function will be activated by installing C language module into a built-in FROM. The installation requires the Remote Monitor Tool.

[Software configuration]

The names of directory, file and initialize function, where C language modules are stored, are fixed.

## 17.8 Others

### 17.8.2 CNC Remote Operation Tool

#### 17.8.2.101 Remote Monitor Tool

**M system :** ○

**L system :** ○

CNC remote operation tool is a PC compatible software tool that monitors information in NC unit connected with the Ethernet. (Downloadable from the Factory Automation Systems section of MITSUBISHI ELECTRIC's website.)

### 17.8.3 Automatic Operation Lock

**M system :** Δ

**L system :** Δ

Automatic operation lock function prevents falsification of a C language module (herein after "APLC") by a third party. If an illegal APLC is installed, automatic operation will be prohibited by requiring authentication with the APLC authentication password which has been registered to the NC unit beforehand using this function. Refer to "17.7.4 APLC Release" for details on the APLC.



## Revision History

| Date of revision | Manual No.      | Revision details   |
|------------------|-----------------|--|
| Dec. 2006        | IB(NA)1500259-A | First edition created.   |
| Jan. 2007        | IB(NA)1500259-B | Mistakes were corrected.   |
| May 2007         | IB(NA)1500259-C | <p>The following sections are added.</p> <ul style="list-style-type: none"> <li>• 16. Drive System</li> <li>• 17. Machine Support Functions</li> </ul> <p>Other contents were added/revised/deleted according to specification.</p>  |
| Sep. 2010        | IB(NA)1500259-D | <p>Added/Changed the following chapters in order to support C70 software B2version.</p> <p>Following contents were revised.</p> <ul style="list-style-type: none"> <li>- Updated the contents of "I. GENERAL SPECIFICATIONS".</li> <li>- Following chapters were added to "II. FUNCTIONAL SPECIFICATIONS".</li> </ul> <ul style="list-style-type: none"> <li>3.2.101 Hypothetical Linear Axis Control</li> <li>4.5.8 High-speed Synchronous Tapping (OMR-DD)</li> <li>6.1.2 Color Display(GOT)</li> <li>6.2.3 Single-NC and Multi-display Unit Switch</li> <li>6.2.4 Multi-NC and Common-display Unit</li> <li>6.2.10 Screen Saver, Backlight OFF</li> <li>6.2.15 Screen Capture</li> <li>8.1.1.2 Spindle Analog I/F</li> <li>11.1.2 Optional Block Skip Addition</li> <li>12.1.2.102 Macro Interface Extension (1200 sets)</li> <li>12.1.7.1 Chopping</li> <li>12.3.1 High-speed Machining Mode I (G5P1)[kBPM]</li> <li>16.1.1.4 MDS-DM-V3/SPV2/SPV3 (200V)</li> <li>17.1.2.3 Built-in PLC Processing Mode</li> <li>17.1.3.6 Multi-ladder Program Register and Execution</li> <li>17.1.3.7 Ladder Program Writing during RUN</li> <li>17.1.3.8 PLC Protection</li> <li>17.1.7.3 MELSEC Development Tool (GX Simulator)</li> <li>17.1.9.1 CPU Direct Connection (RS-422/RS-232C)</li> <li>17.1.9.2 CC-Link Connection (Remote device)</li> <li>17.1.9.3 CC-Link Connection (Intelligent terminal)</li> <li>17.5 Machine Contact Input/output I/F</li> <li>17.5.1 Additional DI/DO (DI:32/DO:32)</li> <li>17.6.4 PROFIBUS-DP(Master)</li> <li>17.6.8 CC-Link IE</li> <li>17.8.2.1 Remote monitor tool</li> <li>17.8.3 Cycle Monitor (Waveform Display)</li> </ul> <ul style="list-style-type: none"> <li>- Following chapter were deleted from "II. FUNCTIONAL SPECIFICATIONS".</li> <li>17.1.1 Built-in PLC Processing Mode</li> </ul> |

| Date of revision | Manual No.      | Revision details   |
|------------------|-----------------|--|
| Dec. 2010        | IB(NA)1500259-E | <p>Revised contents in order to support C70 software C5 version.</p> <ul style="list-style-type: none"> <li>- Added the Specifications list.</li> <li>- Updated the contents of "I. GENERAL SPECIFICATIONS".</li> <li>- Following chapters were added to "II. FUNCTIONAL SPECIFICATIONS". <ul style="list-style-type: none"> <li>1.1.4 Max. number of PLC indexing axes</li> <li>1.3.102 High-speed program server mode</li> <li>5.1.1.7 1000kB[2560m] (1000 programs)</li> <li>5.1.1.8 2000kB[5120m] (1000 programs)</li> <li>5.2.4 Word editing</li> <li>8.1.7 Spindle position control (Spindle/C axis control)</li> <li>17.3.5 PLC axis indexing</li> <li>17.7.4 APLC release (Need separate PC S/W)</li> </ul> </li> <li>- Following chapters were deleted from "II. FUNCTIONAL SPECIFICATIONS". <ul style="list-style-type: none"> <li>17.5 Machine contact input/output</li> <li>17.6.102 MELSEC multiple CPU system</li> </ul> </li> <li>- Following chapter Nos. were changed. <ul style="list-style-type: none"> <li>17.8.2.101 Remote monitor tool (17.8.2.1 in the former version.)</li> <li>17.8.102.200 Cycle Monitor (Waveform Display)(17.8.3 in the former version.)</li> </ul> </li> </ul> |
| Jan. 2012        | IB(NA)1500259-F | <ul style="list-style-type: none"> <li>- Added "Handling of our product"</li> <li>- Mistakes were corrected.</li> </ul>  |
| Jun. 2012        | IB(NA)1500259-G | <p>Revised contents in order to support C70 software D4 version.</p> <ul style="list-style-type: none"> <li>- "Precautions for Safety" was updated.</li> <li>- The Specifications list was updated.</li> <li>- "I. GENERAL SPECIFICATIONS" was updated.</li> <li>- "4.5.8 High-speed synchronous tapping (OMR-DD)" of "II. FUNCTIONAL SPECIFICATIONS" was rewritten.</li> <li>- Following sections were added to "II. FUNCTIONAL SPECIFICATIONS". <ul style="list-style-type: none"> <li>8.1.12 External Spindle Speed Clamp</li> <li>11.3.4 Program Restart</li> <li>12.1.7.2 Normal Line Control</li> <li>14.1.1.4 PLC Skip</li> <li>14.3.101 PLC Axis Current Limit</li> <li>15.2.101 Insulation Degradation Monitor</li> <li>17.2.101 Multi-secondary-axis Synchronous Control</li> <li>17.3.101 NC Axis/PLC Axis Changeover</li> <li>17.8.3 Automatic Operation Lock</li> </ul> </li> <li>- Following sections were deleted from "II. FUNCTIONAL SPECIFICATIONS". <ul style="list-style-type: none"> <li>12.3.1 High-speed Machining Mode I (G05P1)</li> <li>17.1.7.3 MELSEC Development Tool (GX Simulator)</li> <li>17.8.102.200 Cycle Monitor (Waveform display)</li> </ul> </li> </ul>              |

(Continued on the following page)

| Date of revision | Manual No.      | Revision details   |
|------------------|-----------------|--|
|                  |                 | <p style="text-align: right;">(Continued from the previous page)</p> <ul style="list-style-type: none"> <li>- Following sections were re-numbered.               <ul style="list-style-type: none"> <li>15.4.5.1 MS Configurator (formerly "15.4.5 Servo Automatic Tuning (MS Configurator)")</li> <li>17.1.2.101 Built-in PLC Processing Mode (formerly 17.1.2.3)</li> <li>17.1.7.101 MELSEC Development Tool (GX Developer) (formerly 17.1.7.2)</li> </ul> </li> <li>- Minor errors were corrected.</li> </ul>   |
| Sep. 2014        | IB(NA)1500259-H | <ul style="list-style-type: none"> <li>Added "Treatment of waste" and "WARRANTY".</li> <li>Revised contents in order to support C70 software DD version.</li> <li>- The Specifications list was updated.</li> <li>- "I GENERAL SPECIFICATIONS" was updated.</li> <li>- Following sections were added to "II FUNCTIONAL SPECIFICATIONS".               <ul style="list-style-type: none"> <li>3.2.5 Cylindrical Interpolation</li> <li>3.2.6 Polar Coordinate Interpolation</li> <li>4.5.3.102 Multiple-spindle Synchronous Tapping</li> <li>6.2.101 Machining Program Editing</li> <li>6.3.8.3 German</li> <li>6.3.8.4 Italian</li> <li>6.3.8.5 French</li> <li>12.1.2.2 Machine Tool Builder Macro</li> <li>15.4.5.2 NC Analyzer</li> <li>15.4.13 Parameter Setting Tool</li> </ul> </li> <li>- Following sections were deleted from "II FUNCTIONAL SPECIFICATIONS".               <ul style="list-style-type: none"> <li>9.3.1.4 Tool Offset Amount 100 sets</li> </ul> </li> <li>- Following sections in "II. FUNCTIONAL SPECIFICATIONS" are rewritten.               <ul style="list-style-type: none"> <li>11.4.4 Thread Cutting Cycle Retract</li> <li>15.3.13 Safety Observation</li> <li>15.4.5.1 MS Configurator</li> <li>16. Drive System</li> <li>17.2.5 Position Switch</li> </ul> </li> <li>- Following sections were re-numbered.               <ul style="list-style-type: none"> <li>9.3.1.4 Tool Offset Amount 200 Sets (formerly 9.3.1.5)</li> </ul> </li> <li>- Minor errors were corrected.</li> </ul> |
|                  |                 |  |



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## **Notice**

Every effort has been made to keep up with software and hardware revisions in the contents described in this manual. However, please understand that in some unavoidable cases simultaneous revision is not possible.

Please contact your Mitsubishi Electric dealer with any questions or comments regarding the use of this product.

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MITSUBISHI CNC

## MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE : TOKYO BLDG.,2-7-3 MARUNOUCHI,CHIYODA-KU,TOKYO 100-8310,JAPAN

|            |            |
|------------|------------|
| MODEL      | C70        |
| MODEL CODE | 100-009    |
| Manual No. | IB-1500259 |