# MITSUBISHI ELECTRIC

Programmable Controller

## MELSEC iQ-R series

MELSEC iQ-R Motion Controller
Programming Manual
(Advanced Synchronous Control)

-R16MTCPU
-R32MTCPU
-R64MTCPU

# SAFETY PRECAUTIONS

(Read these precautions before using this product.)

Before using this product, please read this manual and the relevant manuals carefully and pay full attention to safety to handle the product correctly.

The precautions given in this manual are concerned with this product only. Refer to MELSEC iQ-R Module Configuration Manual for a description of the PLC system safety precautions.

In this manual, the safety precautions are classified into two levels: " ⚠ WARNING" and " ⚠ CAUTION".

| ⚠ **WARNING** | Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury. |
| ⚠ **CAUTION** | Indicates that incorrect handling may cause hazardous conditions, resulting in minor or moderate injury or property damage. |

Under some circumstances, failure to observe the precautions given under " ⚠ CAUTION" may lead to serious consequences.

Observe the precautions of both levels because they are important for personal and system safety.

Make sure that the end users read this manual and then keep the manual in a safe place for future reference.

## [Design Precautions]

### ⚠ WARNING

- Configure safety circuits external to the programmable controller to ensure that the entire system operates safely even when a fault occurs in the external power supply or the programmable controller. Failure to do so may result in an accident due to an incorrect output or malfunction.

  (1) Emergency stop circuits, protection circuits, and protective interlock circuits for conflicting operations (such as forward/reverse rotations or upper/lower limit positioning) must be configured external to the programmable controller.

  (2) When the programmable controller detects an abnormal condition, it stops the operation and all outputs are:
    • Turned off if the overcurrent or overvoltage protection of the power supply module is activated.
    • Held or turned off according to the parameter setting if the self-diagnostic function of the CPU module detects an error such as a watchdog timer error.

  (3) All outputs may be turned on if an error occurs in a part, such as an I/O control part, where the CPU module cannot detect any error. To ensure safety operation in such a case, provide a safety mechanism or a fail-safe circuit external to the programmable controller. For a fail-safe circuit example, refer to "General Safety Requirements" in the MELSEC iQ-R Module Configuration Manual.

  (4) Outputs may remain on or off due to a failure of a component such as a relay and transistor in an output circuit. Configure an external circuit for monitoring output signals that could cause a serious accident.

- In an output circuit, when a load current exceeding the rated current or an overcurrent caused by a load short-circuit flows for a long time, it may cause smoke and fire. To prevent this, configure an external safety circuit, such as a fuse.

- Configure a circuit so that the programmable controller is turned on first and then the external power supply. If the external power supply is turned on first, an accident may occur due to an incorrect output or malfunction.

# [Design Precautions]

## ⚠ WARNING

- Configure a circuit so that the external power supply is turned off first and then the programmable controller. If the programmable controller is turned off first, an accident may occur due to an incorrect output or malfunction.

- For the operating status of each station after a communication failure, refer to manuals for the network used. For the manuals, please consult your local Mitsubishi representative. Incorrect output or malfunction due to a communication failure may result in an accident.

- When connecting an external device with a CPU module or intelligent function module to modify data of a running programmable controller, configure an interlock circuit in the program to ensure that the entire system will always operate safely. For other forms of control (such as program modification, parameter change, forced output, or operating status change) of a running programmable controller, read the relevant manuals carefully and ensure that the operation is safe before proceeding. Improper operation may damage machines or cause accidents. When a Safety CPU is used, data cannot be modified while the Safety CPU is in SAFETY MODE.

- Especially, when a remote programmable controller is controlled by an external device, immediate action cannot be taken if a problem occurs in the programmable controller due to a communication failure. To prevent this, configure an interlock circuit in the program, and determine corrective actions to be taken between the external device and CPU module in case of a communication failure.

- Do not write any data to the "system area" and "write-protect area" of the buffer memory in the module. Also, do not use any "use prohibited" signals as an output signal from the CPU module to each module. Doing so may cause malfunction of the programmable controller system. For the "system area", "write-protect area", and the "use prohibited" signals, refer to the user's manual for the module used. For areas used for safety communications, they are protected from being written by users, and thus safety communications failure caused by data writing does not occur.

- If a communication cable is disconnected, the network may be unstable, resulting in a communication failure of multiple stations. Configure an interlock circuit in the program to ensure that the entire system will always operate safely even if communications fail. Failure to do so may result in an accident due to an incorrect output or malfunction. When safety communications are used, an interlock by the safety station interlock function protects the system from an incorrect output or malfunction.

- Configure safety circuits external to the programmable controller to ensure that the entire system operates safely even when a fault occurs in the external power supply or the programmable controller. Failure to do so may result in an accident due to an incorrect output or malfunction.

- If safety standards (ex., robot safety rules, etc.,) apply to the system using the module, servo amplifier and servo motor, make sure that the safety standards are satisfied.

- Construct a safety circuit externally of the module or servo amplifier if the abnormal operation of the module or servo amplifier differs from the safety directive operation in the system.

- Do not remove the SSCNETⅢ cable while turning on the control circuit power supply of modules and servo amplifier. Do not see directly the light generated from SSCNETⅢ connector of the module or servo amplifier and the end of SSCNETⅢ cable. When the light gets into eyes, you may feel something wrong with eyes. (The light source of SSCNETⅢ complies with class 1 defined in JISC6802 or IEC60825-1.)

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# [Design Precautions]

## ⚠ CAUTION

● Do not install the control lines or communication cables together with the main circuit lines or power cables. Doing so may result in malfunction due to electromagnetic interference. Keep a distance of 100mm or more between those cables.

● During control of an inductive load such as a lamp, heater, or solenoid valve, a large current (approximately ten times greater than normal) may flow when the output is turned from off to on. Therefore, use a module that has a sufficient current rating.

● After the CPU module is powered on or is reset, the time taken to enter the RUN status varies depending on the system configuration, parameter settings, and/or program size. Design circuits so that the entire system will always operate safely, regardless of the time.

● Do not power off the programmable controller or reset the CPU module while the settings are being written. Doing so will make the data in the flash ROM and SD memory card undefined. The values need to be set in the buffer memory and written to the flash ROM and SD memory card again. Doing so also may cause malfunction or failure of the module.

● When changing the operating status of the CPU module from external devices (such as the remote RUN/STOP functions), select "Do Not Open by Program" for "Opening Method" of "Module Parameter". If "Open by Program" is selected, an execution of the remote STOP function causes the communication line to close. Consequently, the CPU module cannot reopen the line, and external devices cannot execute the remote RUN function.

# [Security Precautions]

## ⚠ WARNING

● To maintain the security (confidentiality, integrity, and availability) of the programmable controller and the system against unauthorized access, denial-of-service (DoS) attacks, computer viruses, and other cyberattacks from external devices via the network, take appropriate measures such as firewalls, virtual private networks (VPNs), and antivirus solutions.

# [Installation Precautions]

## ⚠ WARNING

● Shut off the external power supply (all phases) used in the system before mounting or removing the module. Failure to do so may result in electric shock or cause the module to fail or malfunction.

# [Installation Precautions]

## ⚠CAUTION

- Use the programmable controller in an environment that meets the general specifications in the Safety Guidelines (IB-0800525). Failure to do so may result in electric shock, fire, malfunction, or damage to or deterioration of the product.
- To mount a module, place the concave part(s) located at the bottom onto the guide(s) of the base unit, and push in the module until the hook(s) located at the top snaps into place. Incorrect interconnection may cause malfunction, failure, or drop of the module.
- To mount a module with no module fixing hook, place the concave part(s) located at the bottom onto the guide(s) of the base unit, push in the module, and fix it with screw(s). Incorrect interconnection may cause malfunction, failure, or drop of the module.
- When using the programmable controller in an environment of frequent vibrations, fix the module with a screw.
- Tighten the screws within the specified torque range. Undertightening can cause drop of the component or wire, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction. For the specified torque range, refer to the MELSEC iQ-R Module Configuration Manual.
- When using an extension cable, connect it to the extension cable connector of the base unit securely. Check the connection for looseness. Poor contact may cause malfunction.
- When using an SD memory card, fully insert it into the SD memory card slot. Check that it is inserted completely. Poor contact may cause malfunction.
- Securely insert an extended SRAM cassette or a battery-less option cassette into the cassette connector of the CPU module. After insertion, close the cassette cover and check that the cassette is inserted completely. Poor contact may cause malfunction.
- Beware that the module could be very hot while power is on and immediately after power-off.
- Do not directly touch any conductive parts and electronic components of the module, SD memory card, extended SRAM cassette, battery-less option cassette, or connector. Doing so can cause malfunction or failure of the module.

# [Wiring Precautions]

## ⚠WARNING

- Shut off the external power supply (all phases) used in the system before installation and wiring. Failure to do so may result in electric shock or cause the module to fail or malfunction.
- After installation and wiring, attach a blank cover module (RG60) to each empty slot before powering on the system for operation. Also, attach an extension connector protective cover[1] to each unused extension cable connector as necessary. Directly touching any conductive parts of the connectors while power is on may result in electric shock.
  
  *1 For details, please consult your local Mitsubishi Electric representative.

# [Wiring Precautions]

## ⚠ CAUTION

- Individually ground the FG and LG terminals of the programmable controller with a ground resistance of 100 ohms or less. Failure to do so may result in electric shock or malfunction.
- Use applicable solderless terminals and tighten them within the specified torque range. If any spade solderless terminal is used, it may be disconnected when the terminal screw comes loose, resulting in failure.
- Check the rated voltage and signal layout before wiring to the module, and connect the cables correctly. Connecting a power supply with a different voltage rating or incorrect wiring may cause fire or failure.
- Connectors for external devices must be crimped or pressed with the tool specified by the manufacturer, or must be correctly soldered. Incomplete connections may cause short circuit, fire, or malfunction.
- Securely connect the connector to the module. Poor contact may cause malfunction.
- Do not install the control lines or communication cables together with the main circuit lines or power cables. Doing so may result in malfunction due to noise. Keep a distance of 100mm or more between those cables.
- Place the cables in a duct or clamp them. If not, dangling cables may swing or inadvertently be pulled, resulting in malfunction or damage to modules or cables.
  In addition, the weight of the cables may put stress on modules in an environment of strong vibrations and shocks.
  Do not clamp the extension cables with the jacket stripped. Doing so may change the characteristics of the cables, resulting in malfunction.
- Check the interface type and correctly connect the cable. Incorrect wiring (connecting the cable to an incorrect interface) may cause failure of the module and external device.
- Tighten the terminal screws or connector screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, fire, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, fire, or malfunction.
- When disconnecting the cable from the module, do not pull the cable by the cable part. For the cable with connector, hold the connector part of the cable. For the cable connected to the terminal block, loosen the terminal screw. Pulling the cable connected to the module may result in malfunction or damage to the module or cable.
- Prevent foreign matter such as dust or wire chips from entering the module. Such foreign matter can cause a fire, failure, or malfunction.
- When a protective film is attached to the top of the module, remove it before system operation.
  If not, inadequate heat dissipation of the module may cause a fire, failure, or malfunction.
- Programmable controllers must be installed in control panels. Connect the main power supply to the power supply module in the control panel through a relay terminal block. Wiring and replacement of a power supply module must be performed by qualified maintenance personnel with knowledge of protection against electric shock. For wiring, refer to the MELSEC iQ-R Module Configuration Manual.
- For Ethernet cables to be used in the system, select the ones that meet the specifications in the user's manual for the module used. If not, normal data transmission is not guaranteed.

## [Startup and Maintenance Precautions]

## ⚠ WARNING

- Do not touch any terminal while power is on. Doing so will cause electric shock or malfunction.
- Correctly connect the battery connector. Do not charge, disassemble, heat, short-circuit, solder, or throw the battery into the fire. Also, do not expose it to liquid or strong shock. Doing so will cause the battery to produce heat, explode, ignite, or leak, resulting in injury and fire.
- Shut off the external power supply (all phases) used in the system before cleaning the module or retightening the terminal screws, connector screws, or module fixing screws. Failure to do so may result in electric shock.

## [Startup and Maintenance Precautions]

## ⚠ CAUTION

- When connecting an external device with a CPU module or intelligent function module to modify data of a running programmable controller, configure an interlock circuit in the program to ensure that the entire system will always operate safely. For other forms of control (such as program modification, parameter change, forced output, or operating status change) of a running programmable controller, read the relevant manuals carefully and ensure that the operation is safe before proceeding. Improper operation may damage machines or cause accidents.
- Especially, when a remote programmable controller is controlled by an external device, immediate action cannot be taken if a problem occurs in the programmable controller due to a communication failure. To prevent this, configure an interlock circuit in the program, and determine corrective actions to be taken between the external device and CPU module in case of a communication failure.
- Do not disassemble or modify the modules. Doing so may cause failure, malfunction, injury, or a fire.
- Use any radio communication device such as a cellular phone or PHS (Personal Handy-phone System) more than 25cm away in all directions from the programmable controller. Failure to do so may cause malfunction.
- Shut off the external power supply (all phases) used in the system before mounting or removing the module. Failure to do so may cause the module to fail or malfunction.
- Tighten the screws within the specified torque range. Undertightening can cause drop of the component or wire, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- After the first use of the product, do not perform each of the following operations more than 50 times (IEC 61131-2/JIS B 3502 compliant).
  Exceeding the limit may cause malfunction.
    - Mounting/removing the module to/from the base unit
    - Inserting/removing the extended SRAM cassette or battery-less option cassette to/from the CPU module
    - Mounting/removing the terminal block to/from the module
    - Connecting/disconnecting the extension cable to/from the base unit
- After the first use of the product, do not insert/remove the SD memory card to/from the CPU module more than 500 times. Exceeding the limit may cause malfunction.
- Do not touch the metal terminals on the back side of the SD memory card. Doing so may cause malfunction or failure of the module.
- Do not touch the integrated circuits on the circuit board of an extended SRAM cassette or a battery-less option cassette. Doing so may cause malfunction or failure of the module.

## [Startup and Maintenance Precautions]

## ⚠ CAUTION

● Do not drop or apply shock to the battery to be installed in the module. Doing so may damage the battery, causing the battery fluid to leak inside the battery. If the battery is dropped or any shock is applied to it, dispose of it without using.

● Startup and maintenance of a control panel must be performed by qualified maintenance personnel with knowledge of protection against electric shock. Lock the control panel so that only qualified maintenance personnel can operate it.

● Before handling the module, touch a conducting object such as a grounded metal to discharge the static electricity from the human body. Wearing a grounded antistatic wrist strap is recommended. Failure to discharge the static electricity may cause the module to fail or malfunction.

● After unpacking, eliminate static electricity from the module to prevent electrostatic discharge from affecting the module. If an electrostatically charged module comes in contact with a grounded metal object, a sudden electrostatic discharge of the module may cause failure.
For details on how to eliminate static electricity from the module, refer to the following.
Antistatic Precautions Before Using MELSEC iQ-R Series Products (FA-A-0368)

● Use a clean and dry cloth to wipe off dirt on the module.

● Before testing the operation, set a low speed value for the speed limit parameter so that the operation can be stopped immediately upon occurrence of a hazardous condition.

● Confirm and adjust the program and each parameter before operation. Unpredictable movements may occur depending on the machine.

● When using the absolute position system function, on starting up, and when the module or absolute position motor has been replaced, always perform a home position return.

● Before starting the operation, confirm the brake function.

● Do not perform a megger test (insulation resistance measurement) during inspection.

● After maintenance and inspections are completed, confirm that the position detection of the absolute position detection function is correct.

● Lock the control panel and prevent access to those who are not certified to handle or install electric equipment.

## [Operating Precautions]

## ⚠ CAUTION

● When changing data and operating status, and modifying program of the running programmable controller from an external device such as a personal computer connected to an intelligent function module, read relevant manuals carefully and ensure the safety before operation. Incorrect change or modification may cause system malfunction, damage to the machines, or accidents.

● Do not power off the programmable controller or reset the CPU module while the setting values in the buffer memory are being written to the flash ROM in the module. Doing so will make the data in the flash ROM and SD memory card undefined. The values need to be set in the buffer memory and written to the flash ROM and SD memory card again. Doing so also may cause malfunction or failure of the module.

● Note that when the reference axis speed is specified for interpolation operation, the speed of the partner axis (2nd, 3rd, or 4th axis) may exceed the speed limit value.

● Do not go near the machine during test operations or during operations such as teaching. Doing so may lead to injuries.

## [Disposal Precautions]

### ⚠ CAUTION

● When disposing of this product, treat it as industrial waste.
● When disposing of batteries, separate them from other wastes according to the local regulations. For details on battery regulations in EU member states, refer to the MELSEC iQ-R Module Configuration Manual.

## [Transportation Precautions]

### ⚠ CAUTION

● When transporting lithium batteries, follow the transportation regulations. For details on the regulated models, refer to the MELSEC iQ-R Module Configuration Manual.
● The halogens (such as fluorine, chlorine, bromine, and iodine), which are contained in a fumigant used for disinfection and pest control of wood packaging materials, may cause failure of the product. Prevent the entry of fumigant residues into the product or consider other methods (such as heat treatment) instead of fumigation. The disinfection and pest control measures must be applied to unprocessed raw wood.

# CONDITIONS OF USE FOR THE PRODUCT

(1) MELSEC programmable controller ("the PRODUCT") shall be used in conditions;

   i) where any problem, fault or failure occurring in the PRODUCT, if any, shall not lead to any major or serious accident; and

   ii) where the backup and fail-safe function are systematically or automatically provided outside of the PRODUCT for the case of any problem, fault or failure occurring in the PRODUCT.

(2) The PRODUCT has been designed and manufactured for the purpose of being used in general industries.
MITSUBISHI ELECTRIC SHALL HAVE NO RESPONSIBILITY OR LIABILITY (INCLUDING, BUT NOT LIMITED TO ANY AND ALL RESPONSIBILITY OR LIABILITY BASED ON CONTRACT, WARRANTY, TORT, PRODUCT LIABILITY) FOR ANY INJURY OR DEATH TO PERSONS OR LOSS OR DAMAGE TO PROPERTY CAUSED BY the PRODUCT THAT ARE OPERATED OR USED IN APPLICATION NOT INTENDED OR EXCLUDED BY INSTRUCTIONS, PRECAUTIONS, OR WARNING CONTAINED IN MITSUBISHI ELECTRIC USER'S, INSTRUCTION AND/OR SAFETY MANUALS, TECHNICAL BULLETINS AND GUIDELINES FOR the PRODUCT.
("Prohibited Application")

Prohibited Applications include, but not limited to, the use of the PRODUCT in;

- Nuclear Power Plants and any other power plants operated by Power companies, and/or any other cases in which the public could be affected if any problem or fault occurs in the PRODUCT.
- Railway companies or Public service purposes, and/or any other cases in which establishment of a special quality assurance system is required by the Purchaser or End User.
- Aircraft or Aerospace, Medical applications, Train equipment, transport equipment such as Elevator and Escalator, Incineration and Fuel devices, Vehicles, Manned transportation, Equipment for Recreation and Amusement, and Safety devices, handling of Nuclear or Hazardous Materials or Chemicals, Mining and Drilling, and/or other applications where there is a significant risk of injury to the public or property.

Notwithstanding the above restrictions, Mitsubishi Electric may in its sole discretion, authorize use of the PRODUCT in one or more of the Prohibited Applications, provided that the usage of the PRODUCT is limited only for the specific applications agreed to by Mitsubishi Electric and provided further that no special quality assurance or fail-safe, redundant or other safety features which exceed the general specifications of the PRODUCTs are required. For details, please contact the Mitsubishi Electric representative in your region.

(3) Mitsubishi Electric shall have no responsibility or liability for any problems involving programmable controller trouble and system trouble caused by DoS attacks, unauthorized access, computer viruses, and other cyberattacks.

# INTRODUCTION

Thank you for purchasing the Mitsubishi Electric MELSEC iQ-R series programmable controllers.
This manual describes the system configuration, specifications, installation, wiring, maintenance and inspection, and troubleshooting of the relevant products listed below.
Before using this product, please read this manual and the relevant manuals carefully and develop familiarity with the functions and performance of the MELSEC iQ-R series programmable controller to handle the product correctly.
When applying the program examples provided in this manual to an actual system, ensure the applicability and confirm that it will not cause system control problems.
Please make sure that the end users read this manual.

## Relevant products

R16MTCPU, R32MTCPU, R64MTCPU

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# RELEVANT MANUALS

| Manual Name [Manual Number] | Description | Available form |
|---|---|---|
| MELSEC iQ-R Motion Controller Programming Manual (Advanced Synchronous Control) [IB-0300243] (This manual) | This manual explains the dedicated instructions to use synchronous control by synchronous control parameters, device lists, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller User's Manual [IB-0300235] | This manual explains specifications of the Motion CPU modules, SSCNETⅢ cables, synchronous encoder, troubleshooting, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller Programming Manual (Common) [IB-0300237] | This manual explains the Multiple CPU system configuration, performance specifications, common parameters, auxiliary/applied functions, error lists, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller Programming Manual (Program Design) [IB-0300239] | This manual explains the functions, programming, debugging for Motion SFC, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller Programming Manual (Positioning Control) [IB-0300241] | This manual explains the servo parameters, positioning instructions, device lists, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller Programming Manual (Machine Control) [IB-0300309] | This manual explains the dedicated instructions to use machine control by machine control parameters, machine positioning data, device lists, etc. | Print book |
| | | e-Manual PDF |
| MELSEC iQ-R Motion Controller Programming Manual (G-Code Control) [IB-0300371] | This manual explains the dedicated instructions to use G-code control by G-code control parameters and G-code programs. | Print book |
| | | e-Manual PDF |

Point

e-Manual refers to the Mitsubishi FA electronic book manuals that can be browsed using a dedicated tool.

e-Manual has the following features:
 • Required information can be cross-searched in multiple manuals.
 • Other manuals can be accessed from the links in the manual.
 • The hardware specifications of each part can be found from the product figures.
 • Pages that users often browse can be bookmarked.

# TERMS

Unless otherwise specified, this manual uses the following terms.

| Term | Description |
|------|-------------|
| R64MTCPU/R32MTCPU/R16MTCPU or Motion CPU (module) | Abbreviation for MELSEC iQ-R series Motion controller |
| MR-J5(W)-☐B | Servo amplifier model MR-J5-☐B/MR-J5W-☐B |
| MR-J4(W)-☐B | Servo amplifier model MR-J4-☐B/MR-J4W-☐B |
| MR-J3(W)-☐B | Servo amplifier model MR-J3-☐B/MR-J3W-☐B |
| MR-JE-☐B | Servo amplifier model MR-JE-☐B/MR-JE-☐BF |
| AMP or Servo amplifier | General name for "Servo amplifier model MR-J5-☐B/MR-J5W-☐B/MR-J4-☐B/MR-J4W-☐B/MR-J3-☐B/MR-J3W-☐B/MR-JE-☐B/MR-JE-☐BF" |
| RnCPU, PLC CPU or PLC CPU module | Abbreviation for MELSEC iQ-R series CPU module |
| Multiple CPU system or Motion system | Abbreviation for "Multiple PLC system of the R series" |
| CPUn | Abbreviation for "CPU No.n (n = 1 to 4) of the CPU module for the Multiple CPU system" |
| Operating system software | General name for "SW10DNC-RMTFW" |
| Engineering tool | General name for MT Developer2/GX Works3/GX LogViewer |
| MT Works2 | General product name for the Motion controller engineering software "SW1DND-MTW2" |
| MT Developer2 | Abbreviation for the programming software included in the "MT Works2" Motion controller engineering software |
| GX Works3 | General product name for the MELSEC PLC software package "SW1DND-GXW3" |
| GX LogViewer | Product name for the logging data display and analysis tool "SW1DNN-VIEWER" |
| Serial absolute synchronous encoder or Q171ENC-W8 | Abbreviation for "Serial absolute synchronous encoder (Q171ENC-W8)" |
| SSCNETⅢ/H[1] | High speed synchronous network between Motion controller and servo amplifier |
| SSCNETⅢ[1] | |
| SSCNETⅢ(/H) | General name for SSCNETⅢ/H, SSCNETⅢ |
| Absolute position system | General name for "system using the servo motor and servo amplifier for absolute position" |
| Intelligent function module | General name for module that has a function other than input or output such as A/D converter module and D/A converter module. |
| SSCNETⅢ/H head module[1] | Abbreviation for "MELSEC-L series SSCNETⅢ/H head module (LJ72MS15)" |
| Optical hub unit or MR-MV200 | Abbreviation for SSCNETⅢ/H Compatible Optical Hub Unit (MR-MV200) |
| Sensing module | General name for SSCNETⅢ/H compatible sensing module MR-MT2000 series |
| Sensing SSCNETⅢ/H head module[1] or MR-MT2010 | Abbreviation for SSCNETⅢ/H head module (MR-MT2010) |
| Sensing extension module | General name for I/O module (MR-MT2100), pulse I/O module (MR-MT2200), analog I/O module (MR-MT2300), encoder I/F module (MR-MT2400) |
| Sensing I/O module or MR-MT2100 | Abbreviation for I/O module (MR-MT2100) |
| Sensing pulse I/O module or MR-MT2200 | Abbreviation for pulse I/O module (MR-MT2200) |
| Sensing analog I/O module or MR-MT2300 | Abbreviation for analog I/O module (MR-MT2300) |
| Sensing encoder I/F module or MR-MT2400 | Abbreviation for encoder I/F module (MR-MT2400) |

[1]  SSCNET: Servo System Controller NETwork

# MANUAL PAGE ORGANIZATION

## Representation of numerical values used in this manual

### ■Axis No. representation

In the positioning dedicated signals, "n" in "M3200+20n", etc. indicates a value corresponding to axis No. as shown in the following table.

| Axis No. | n | Axis No. | n | Axis No. | n | Axis No. | n | Axis No. | n | Axis No. | n | Axis No. | n | Axis No. | n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 9 | 8 | 17 | 16 | 25 | 24 | 33 | 32 | 41 | 40 | 49 | 48 | 57 | 56 |
| 2 | 1 | 10 | 9 | 18 | 17 | 26 | 25 | 34 | 33 | 42 | 41 | 50 | 49 | 58 | 57 |
| 3 | 2 | 11 | 10 | 19 | 18 | 27 | 26 | 35 | 34 | 43 | 42 | 51 | 50 | 59 | 58 |
| 4 | 3 | 12 | 11 | 20 | 19 | 28 | 27 | 36 | 35 | 44 | 43 | 52 | 51 | 60 | 59 |
| 5 | 4 | 13 | 12 | 21 | 20 | 29 | 28 | 37 | 36 | 45 | 44 | 53 | 52 | 61 | 60 |
| 6 | 5 | 14 | 13 | 22 | 21 | 30 | 29 | 38 | 37 | 46 | 45 | 54 | 53 | 62 | 61 |
| 7 | 6 | 15 | 14 | 23 | 22 | 31 | 30 | 39 | 38 | 47 | 46 | 55 | 54 | 63 | 62 |
| 8 | 7 | 16 | 15 | 24 | 23 | 32 | 31 | 40 | 39 | 48 | 47 | 56 | 55 | 64 | 63 |

- The range of axis No.1 to 16 (n=0 to 15) is valid in the R16MTCPU. The range of axis No.1 to 32 (n=0 to 31) is valid in the R32MTCPU.
- Calculate as follows for the device No. corresponding to each axis.

Ex.

For axis No. 32 in Q series Motion compatible device assignment

M3200+20n ([Rq.1140] Stop command)=M3200+20×31=M3820

M3215+20n ([Rq.1155] Servo OFF command)=M3215+20×31=M3835

In the positioning dedicated signals, "n" in "M10440+10n", etc. of the "Synchronous encoder axis status", "Synchronous encoder axis command signal", "Synchronous encoder axis monitor device" and "Synchronous encoder axis control device" indicates a value corresponding to synchronous encoder axis No. as shown in the following table.

| Synchronous encoder axis No. | n | Synchronous encoder axis No. | n | Synchronous encoder axis No. | n |
|---|---|---|---|---|---|
| 1 | 0 | 5 | 4 | 9 | 8 |
| 2 | 1 | 6 | 5 | 10 | 9 |
| 3 | 2 | 7 | 6 | 11 | 10 |
| 4 | 3 | 8 | 7 | 12 | 11 |

- Calculate as follows for the device No. corresponding to each synchronous encoder.

Ex.

For synchronous encoder axis No.12 in Q series Motion compatible device assignment

M10440+10n ([St.320] Synchronous encoder axis setting valid flag)=M10440+10×11=M10550

D13240+20n ([Md.320] Synchronous encoder axis current value)=D13240+20×11=D13460

## ■Machine No. representation

In the positioning dedicated signals, "m" in "M43904+32m", etc. indicates a value corresponding to machine No. as shown in the following table.

| Machine No. | m | Machine No. | m |
|---|---|---|---|
| 1 | 0 | 5 | 4 |
| 2 | 1 | 6 | 5 |
| 3 | 2 | 7 | 6 |
| 4 | 3 | 8 | 7 |

 • Calculate as follows for the device No. corresponding to each machine.

**Ex.**

For machine No.8 in MELSEC iQ-R Motion device assignment

M43904+32m ([St.2120] Machine error detection) M43904+32×7=M44128

D53168+128m ([Md.2020] Machine type)=M53168+28×7=D54064

## ■Line No. representation in G-code control

In the positioning dedicated signals, "s" in "D54496+128s", etc. indicates a value corresponding to line No. as shown in the following table.

| Line No. | s |
|---|---|
| 1 | 0 |
| 2 | 1 |

 • Calculate as follows for the device No. corresponding to each line.

**Ex.**

For line No.2 in MELSEC iQ-R Motion device assignment

D54440.0+4s ([St.3208] During G-code control)=D54440.0+4×1=D54444.0

D54496+128s ([Md.3016] Number of axes on line)=D54496+128×1=D54624

## ■Line No. and axis No. representation in G-code control

In the positioning dedicated signals, "sn" in "D54278+16sn", etc. indicates a value corresponding to line No. and axis No. as shown in the following table.

| Line No. | Axis No. | sn | Line No. | Axis No. | sn |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 2 | 1 | 8 |
| | 2 | 1 | | 2 | 9 |
| | 3 | 2 | | 3 | 10 |
| | 4 | 3 | | 4 | 11 |
| | 5 | 4 | | 5 | 12 |
| | 6 | 5 | | 6 | 13 |
| | 7 | 6 | | 7 | 14 |
| | 8 | 7 | | 8 | 15 |

 • Calculate as follows for the device No. corresponding to each line.

**Ex.**

For line No.2, axis No. 8 in MELSEC iQ-R Motion device assignment

D54448.0+2sn ([St.3076] Smoothing zero)=D54448.0+2×15=D54478.0

D54754+32sn ([Md.3146] Rotating axis setting status)=D54754+32×15=D55234

## Representation of device No. used in this manual

The "R" and "Q" beside the device No. of positioning dedicated signals such as "[Rq.1140] Stop command (R: M34480+32n/ Q: M3200+20n)" indicate the device No. for the device assignment methods shown below. When "R" and "Q" are not beside the device No., the device No. is the same for both device assignment methods.

| Symbol | Device assignment method |
|--------|--------------------------|
| R | MELSEC iQ-R Motion device assignment |
| Q | Q series Motion compatible device assignment |

# 1 OVERVIEW

## 1.1 Overview of Synchronous Control

"Synchronous control" can be achieved using software instead of controlling mechanically with gear, shaft, speed change gear or cam etc.

"Synchronous control" synchronizes movement with the input axis (servo input axis, command generation axis, synchronous encoder axis), by setting "the parameters for synchronous control" and starting synchronous control on each output axis.
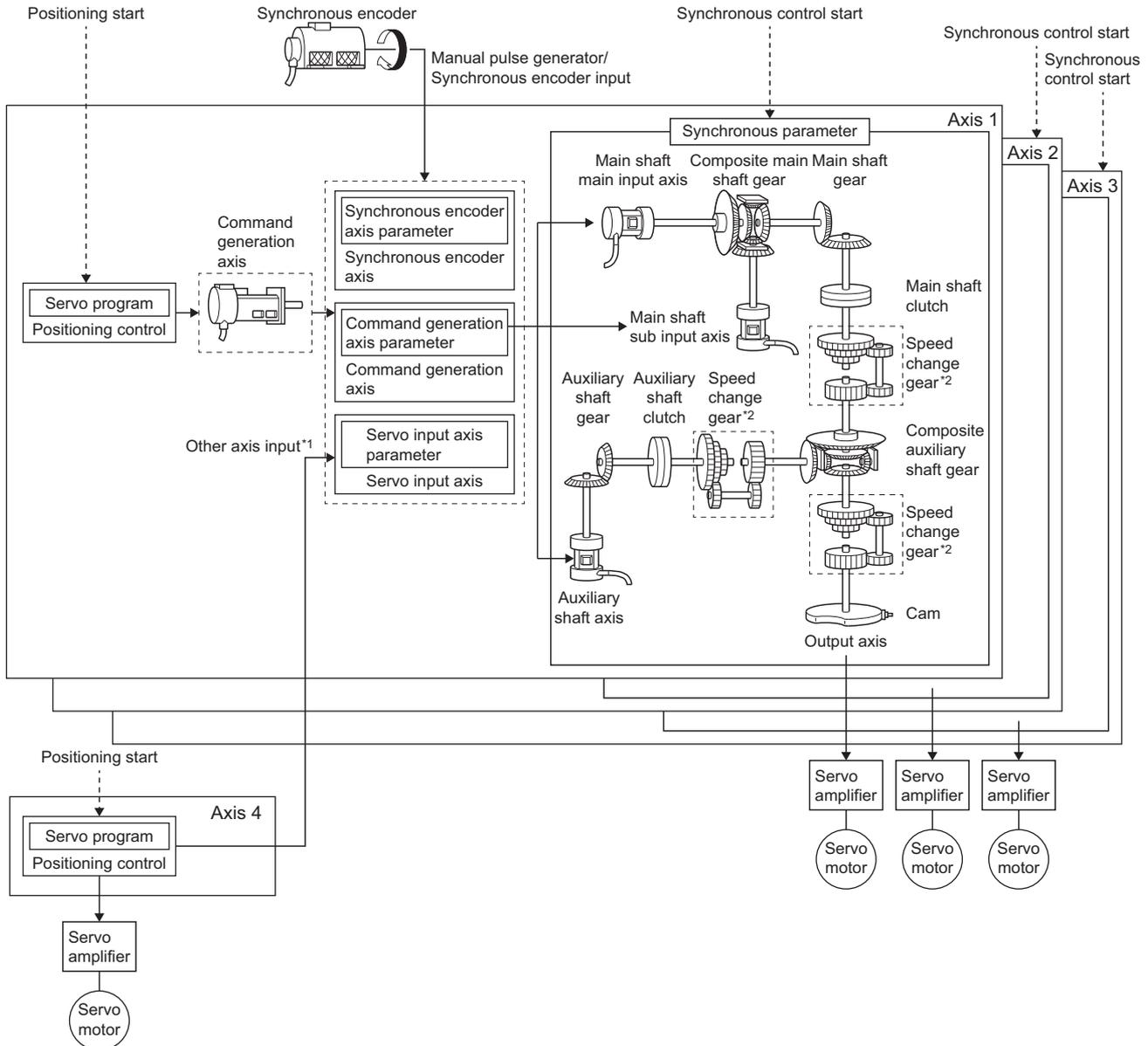


*1 It is possible to drive the servo input axis except the positioning control (home position return, manual control, speed-torque control, synchronous control).
📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

*2 Speed change gear can be arranged on two of "Main shaft side", "Auxiliary shaft side" or "After composite auxiliary shaft gear".

# 1.2 Performance Specifications

## Synchronous control specifications

| Item | | Number of settable axes | | |
|---|---|---|---|---|
| | | **R64MTCPU** | **R32MTCPU** | **R16MTCPU** |
| Input axis | Servo input axis | 64 axes/module | 32 axes/module | 16 axes/module |
| | Command generation axis | 64 axes/module | 32 axes/module | 16 axes/module |
| | Synchronous encoder axis | 12 axes/module | | |
| Composite main shaft gear | | 1/output axis | | |
| Main shaft main input axis | | 1 axis/output axis | | |
| Main shaft sub input axis | | 1 axis/output axis | | |
| Main shaft gear | | 1/output axis | | |
| Main shaft clutch | | 1/output axis | | |
| Auxiliary shaft | | 1 axis/output axis | | |
| Auxiliary shaft gear | | 1/output axis | | |
| Auxiliary shaft clutch | | 1/output axis | | |
| Composite auxiliary shaft gear | | 1/output axis | | |
| Speed change gear | | 2/output axis | | |
| Output axis (Cam axis) | | 64 axes/module | 32 axes/module | 16 axes/module |

## Cam specifications

| Item | | | Specification |
|---|---|---|---|
| Memory capacity | Cam file | Standard ROM | 12Mbytes |
| | | SD memory card | SD memory card capacity |
| | Cam open area | | 16Mbytes |
| Number of cam registration[*1] | | | Up to 1024<br>(Dependent on memory capacity, cam resolution and coordinate number) |
| Comment | | | Up to 32 characters per cam data |
| Cam data | Stroke ratio data format | Cam resolution | 256/512/1024/2048/4096/8192/16384/32768 |
| | | Stroke ratio | -214.7483648 to 214.7483647[%] |
| | Coordinate data format | Coordinate number | 2 to 65535 |
| | | Coordinate data | Input value: 0 to 2147483647<br>Output value: -2147483648 to 2147483647 |

*1 The maximum number of cam registration by the cam resolution is shown below (In case it created by the same cam resolution).
• Stroke ratio data format

| Cam resolution | Maximum number of cam registration |
|---|---|
| 256 | 1024 |
| 512 | 1024 |
| 1024 | 1024 |
| 2048 | 1024 |
| 4096 | 1024 |
| 8192 | 512 |
| 16384 | 256 |
| 32768 | 128 |

• Coordinate data format

| Coordinate number | Maximum number of cam registration |
| --- | --- |
| 512 | 1024 |
| 1024 | 1024 |
| 2048 | 1024 |
| 4096 | 512 |
| 8192 | 256 |
| 16384 | 128 |
| 32768 | 64 |
| 65535 | 32 |

## Cam operation specifications

| Item | Specification |
| --- | --- |
| Operation method of cam data | • MT Developer2<br>　Write/read/verify to cam file<br>• Motion SFC program (Advanced synchronous control instruction)<br>　Write/read to cam file and cam open area |
| Cam auto-generation function | Automatically generate the following cam data<br>• Cam for rotary cutter<br>• Easy stroke ratio cam<br>• Advanced stroke ratio cam |
| Cam position calculation function | Calculate the cam position by the Motion SFC program.<br>Used to calculate the cam axis feed current value after calculating the cam axis current value per cycle for the synchronous control initial position before starting synchronous control. |

## Synchronous encoder axis specifications

| Item | | Specification |
| --- | --- | --- |
| Number of control axes | | 12 |
| Synchronous encoder axis type | | Via module/Via servo amplifier/Via device/Multiple CPU advanced synchronous control/Via sensing module |
| Control unit | | mm, inch, degree, pulse<br>(Possible to select the decimal places of position unit and speed unit) |
| Unit conversion | Numerator | -2147483648 to 2147483647<br>[Synchronous encoder axis position unit] |
| | Denominator | 1 to 2147483647<br>[pulse] |
| Length per cycle setting range | | 1 to 2147483647<br>[Synchronous encoder axis position unit] |
| Current value range | Current value | -2147483648 to 2147483647<br>[Synchronous encoder axis position unit] |
| | Current value per cycle | 0 to (Length per cycle-1)<br>[Synchronous encoder axis position unit] |
| Control method | Control instruction | Current value change, Counter disable, Counter enable |
| | Current value setting address | Address setting range: -2147483648 to 2147483647<br>[Synchronous encoder axis position unit] |

# 2 STARTING UP THE SYSTEM

The procedure for synchronous control positioning control is shown below.

## 2.1 Starting Up the Advanced Control System

The procedure to start up for synchronous control system is shown below.

**Preparation**

**STEP 1**
- Set the following common parameter.
  - R series common parameter
  - Motion CPU common parameter
  → • 📖MELSEC iQ-R Motion controller Programming Manual (Common)

- Set the following positioning control parameter.
  - Motion control parameters
  → • 📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

- Set input axis parameters. Refer to Chapter 4. ([Pr.300] to [Pr.304], [Pr.320] to [Pr.332], [Pr.340] to [Pr.354])
  → • Input axis module [*1]

- Set the cam data.
  → • Cam function [*2]

- Set synchronous control parameters. ([Pr.400] to [Pr.468], [Pr.490] to [Pr.493])
  → • Synchronous control [*3]
  → • Synchronous control initial position parameters [*4]

**STEP 2**
- Create a program (Motion SFC program, sequence program, servo program) that executes to start/change control/stop synchronous control. (Set "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)", start and stop the input axis operation)

**STEP 3**
- Write the parameter and program, which is created in STEP1 and STEP2, to the Motion CPU. (Write the sequence program to the PLC CPU.)

- Reset the Multiple CPU system.

**Start synchronous control**

**STEP 4**
- Turn ON the synchronous control start signal of the axis that start synchronous control.
  → • Turn ON the "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" and start synchronous control by the program in STEP 2.

- Verify that it's during synchronous control.
  → • Verify that it's during synchronous control in "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)".

- Operate the input axis.
  → • Operate the input axis by the program in STEP 2.

**Monitor synchronous control, change control**

**STEP 5**
- Monitor the synchronous control operation status. Execute the change for the speed change or synchronous control parameter.
  → • Monitor using MT Developer2. Changing the control by the program in STEP 2.

**Complete synchronous control**

**STEP 6**
- Stop the input axis.
  → • Stop the input axis by the program in STEP 2.

- Verify the output axis is stopped and turn OFF the synchronous control start signal that stop synchronous control.
  → • Turn OFF the "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" to stop synchronous control by the sequence program in STEP 2.

**End of control**

*1 Input axis module(☞ Page 30 INPUT AXIS MODULE)
*2 Cam function(☞ Page 83 CAM FUNCTION)
*3 Synchronous control(☞ Page 92 SYNCHRONOUS CONTROL)
*4 Synchronous Control Initial Position Parameters(☞ Page 148 Synchronous Control Initial Position Parameters)

# 2.2 Starting/Ending for Synchronous Control

Set the parameters for synchronous control for each output axis to start synchronous control.
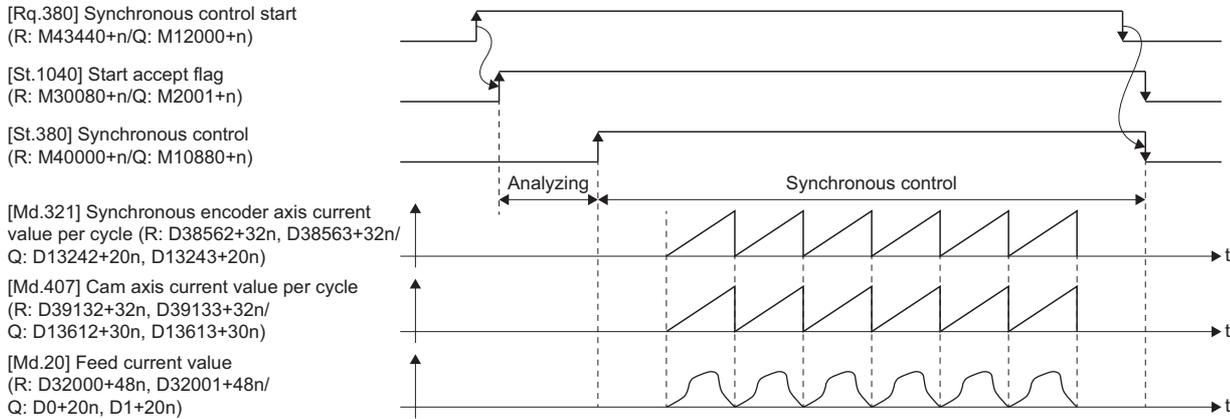
The status changes to synchronous control after the parameters are analyzed at the start of synchronous control, and the output axes synchronize with input axis operations.

The advanced synchronous control is started/ended by the operation of "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" ON/OFF.



## Synchronous control system control data

| Symbol | Setting item | Setting details | Setting value | Refresh cycle | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Rq.380 | Synchronous control start | • Synchronous control begins if the target axis bit device is turned ON.<br>• Synchronous control ends if the bit device is turned OFF during synchronous control. | OFF: Synchronous control end<br>ON: Synchronous control start | — | Operation cycle | OFF | M43440+n | M12000+n |
| Rq.381 | Synchronous analysis request | If the target axis bit device is turned ON and synchronous control is started, the analysis is only executed and the control does not start. | OFF: Synchronous analysis not requested<br>ON: Synchronous analysis requested | | At start of the synchronous control | OFF | M43520+n | M12032+n |

## Synchronous control system monitor data

| Symbol | Setting item | Setting details | Setting value | Refresh cycle | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|---|
| St.380 | Synchronous control | The bit device turns ON during synchronous control. | OFF: Normal operation<br>ON: Synchronous control | Operation cycle | — | — | M40000+n | M10880+n |
| St.381 | Synchronous analysis complete | • The bit device turns ON when the synchronous control analysis is completed.<br>• The bit device turns OFF when [Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n) turns from OFF to ON. | OFF: Synchronous control analysis not completed<br>ON: Synchronous control analysis completed | | | — | M40080+n | M10912+n |

## Starting method for synchronous control

Synchronous control can be started by turning "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" from OFF to ON after setting the parameters for synchronous control.

"[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)" turns ON at the synchronous control start, and the parameters for synchronous control are analyzed. "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" turns ON after completion of analysis, and the synchronous control starts.

Start the input axis operation after confirming that "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" of the output axis turns ON.

*Point*

When "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" is ON at the synchronous control start, "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" turns OFF by turning "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" from OFF to ON. However, "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" does not turn ON by the analysis completion at the synchronous control start. ("[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" turns ON by the analysis completion at the synchronous control analysis mode start.)

## Ending method for synchronous control

Synchronous control can be ended by turning "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" from ON to OFF after the input axis operation is stopped.

"[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" turns OFF at the synchronous control end, and the "[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)" turns OFF at the output axis stop.

Synchronous control can also be ended by turning "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" from ON to OFF during the input axis operation. However, it is recommended to end the synchronous control after stopping the input axis operation since the output axis stops immediately.

Refer to Stop Operation of Output Axis for the stop operation of output axis at the synchronous control end.(☞ Page 25 Stop Operation of Output Axis)

## [Md.1008] Execute program No. (R: D32012+48n/Q: D12+20n)

This register stores the starting program No. at the servo program starting.

"FFEF" is stored in the "[Md.1008] Execute program No. (R: D32012+48n/Q: D12+20n)" when starting advanced synchronous control.

## Status when starting synchronous control

The following signal are turned OFF when starting synchronous control.
- [St.1048] Automatic decelerating flag (R: M30208+n/Q: M2128+n)
- [St.1060] Positioning start complete (R: M32400+32n/Q: M2400+20n)
- [St.1061] Positioning complete (R: M32401+32n/Q: M2401+20n)
- [St.1063] Command in-position (R: M32403+32n/Q: M2403+20n)
- [St.1064] Speed controlling (R: M32404+32n/Q: M2404+20n)
- [St.1065] Speed/position switching latch (R: M32405+32n/Q: M2405+20n)
- [St.1070] Home position return complete (R: M32410+32n/Q: M2410+20n)

## Restrictions

- If "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" is turned ON simultaneously in multiple axes, control is not started simultaneously since the analysis is processed for each axis in numerical order. When the multiple axes must be started simultaneously, start the input axis operation after confirming that all axes are configured for the synchronous control.
- If the input axis operates during the analysis at the synchronous control start, the travel value or the change amount resulting from a current value change of the input axis is reflected immediately after the synchronous control start. The output axis might suddenly accelerate depending on the travel value or change amount of the input axis. Start the input axis operation after confirming that are configured for synchronous control.
- The analysis process for synchronous control start might take time depending on the parameter setting for synchronous control, or when numerous axes are started simultaneously. When the analysis process takes time, change the operation cycle to a larger value. The processing times for when "0: Cam axis current value per cycle restoration" is set to "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" are shown below. Set "1: Cam reference position restoration" or "2: Cam axis current feed value restoration" in "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" to start synchronous control at high speed.

| Number of axes | Cam resolution | |
| --- | --- | --- |
| | 256 | 32768 |
| 1 | 0.44[ms] | 12.2[ms] |
| 8 | 1.78[ms] | 94.4[ms] |
| 16 | 3.55[ms] | 249[ms] |
| 32 | 7.10[ms] | 483[ms] |
| 64 | 12.4[ms] | 831[ms] |

- When the synchronous control parameter is set to the value outside the setting range, the synchronous control does not start, and the error code corresponding to each data of error axis is stored in the data register.

# 2.3 Stop Operation of Output Axis

If the following causes occur in stopping the output axis during synchronous control, "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" turns OFF, and stops processing for the output axis is completed. After that, the "[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)" turns OFF, and the synchronous control is completed. Synchronous alignment must be executed for the output axis to restart the synchronous control. (☞ Page 143 Synchronous Control Initial Position)

| Stop cause | Stop process |
|---|---|
| "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" is turned from ON to OFF. | Immediate stop |
| Main shaft gear/auxiliary shaft gear/speed change gear 1/speed change gear 2 operation overflow error occurrence | |
| Forced stop (Motion controller forced stop (Device)) | |
| Forced stop (Forced input terminal of servo amplifier) | |
| Servo error occurrence | |
| Servo amplifier control circuit power supply is turned from ON to OFF. | |
| Software stroke limit error occurrence | Deceleration stop |
| External input signal (STOP/FLS/RLS) input (Deceleration processing on STOP input: Deceleration stop) | |
| The Motion CPU is turned from RUN to STOP | |
| Stop command input | |
| External input signal (STOP/FLS/RLS) input (Deceleration processing on STOP input: Rapid stop) | Rapid stop |
| Rapid stop command input | |

## Immediate stop

The operation stops without decelerate. The Motion CPU immediately stops the command, but the operation will coast for the droop pulses accumulated in the deviation counter of the servo amplifier.
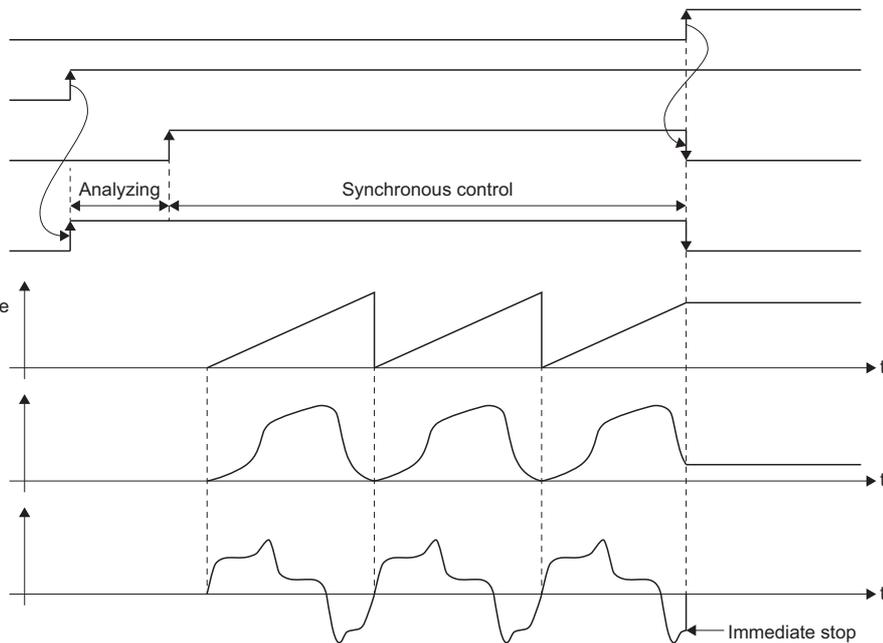
## Deceleration stop/rapid stop

The output axis stops with deceleration according to the stop and rapid stop conditions. The deceleration time and deceleration time for rapid stop are according to the parameter block conditions specified by "[Pr.448] Synchronous control deceleration time parameter block No. (R: D42709+160n/Q: D15069+150n)".

When the synchronous control ends as the deceleration stop begins, the output axis monitor device is not updated, and only the monitor device for each axis is updated.



Deceleration stop/rapid stop cause

[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)

[St.380] Synchronous control (R: M40000+n/Q: M10880+n)

[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)

Analyzing | Synchronous control

[Md.407] Cam axis current value per cycle (R: D39132+32n, D39133+32n/ Q: D13612+30n, D13613+30n)

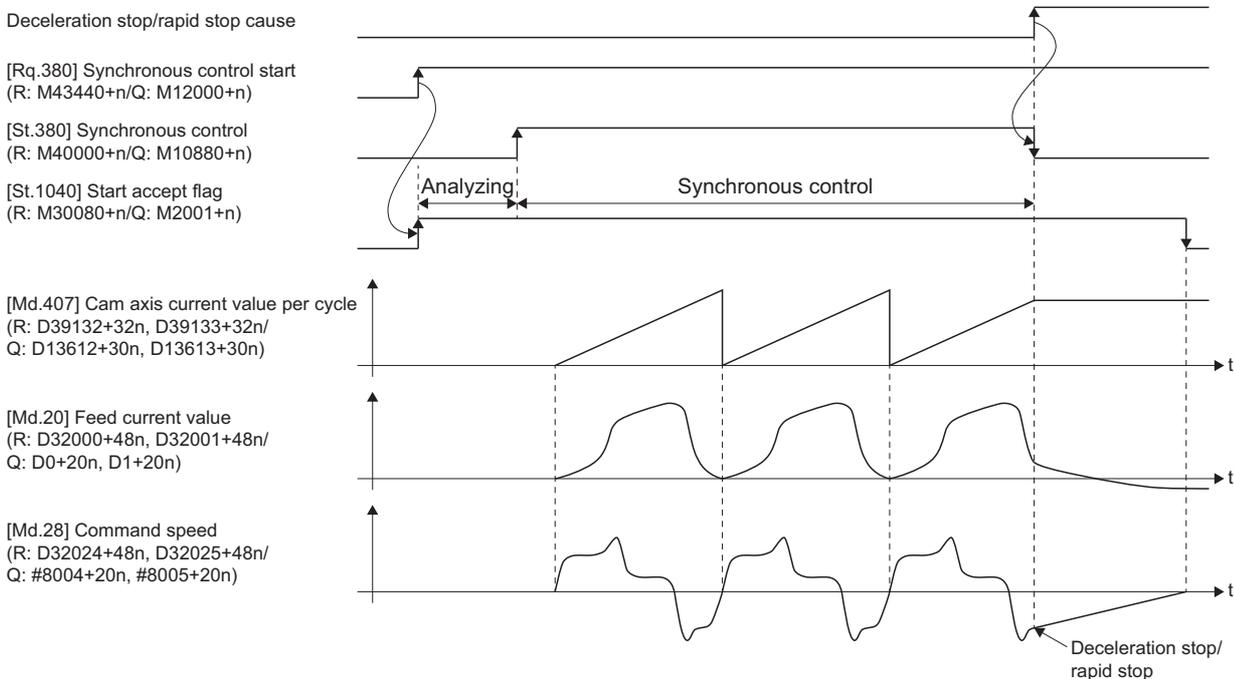[Md.20] Feed current value (R: D32000+48n, D32001+48n/ Q: D0+20n, D1+20n)

[Md.28] Command speed (R: D32024+48n, D32025+48n/ Q: #8004+20n, #8005+20n)

Deceleration stop/ rapid stop

**Point**

- Since the synchronous control ends by the output axis stop, the current feed value during deceleration stop draws the path regardless of the cam operation. Therefore, the input axis must be stopped when the output axis is in deceleration stop/rapid stop synchronizing with the input axis.
- Since the synchronous control ends by the output axis stop, [Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n) turning from ON to OFF during output axis deceleration is invalid. During output axis stop, use the rapid stop command and forced stop.

# 3 SYNCHRONOUS CONTROL MODULE

## 3.1 List of Synchronous Control Module

The module is used in synchronous control as follows.
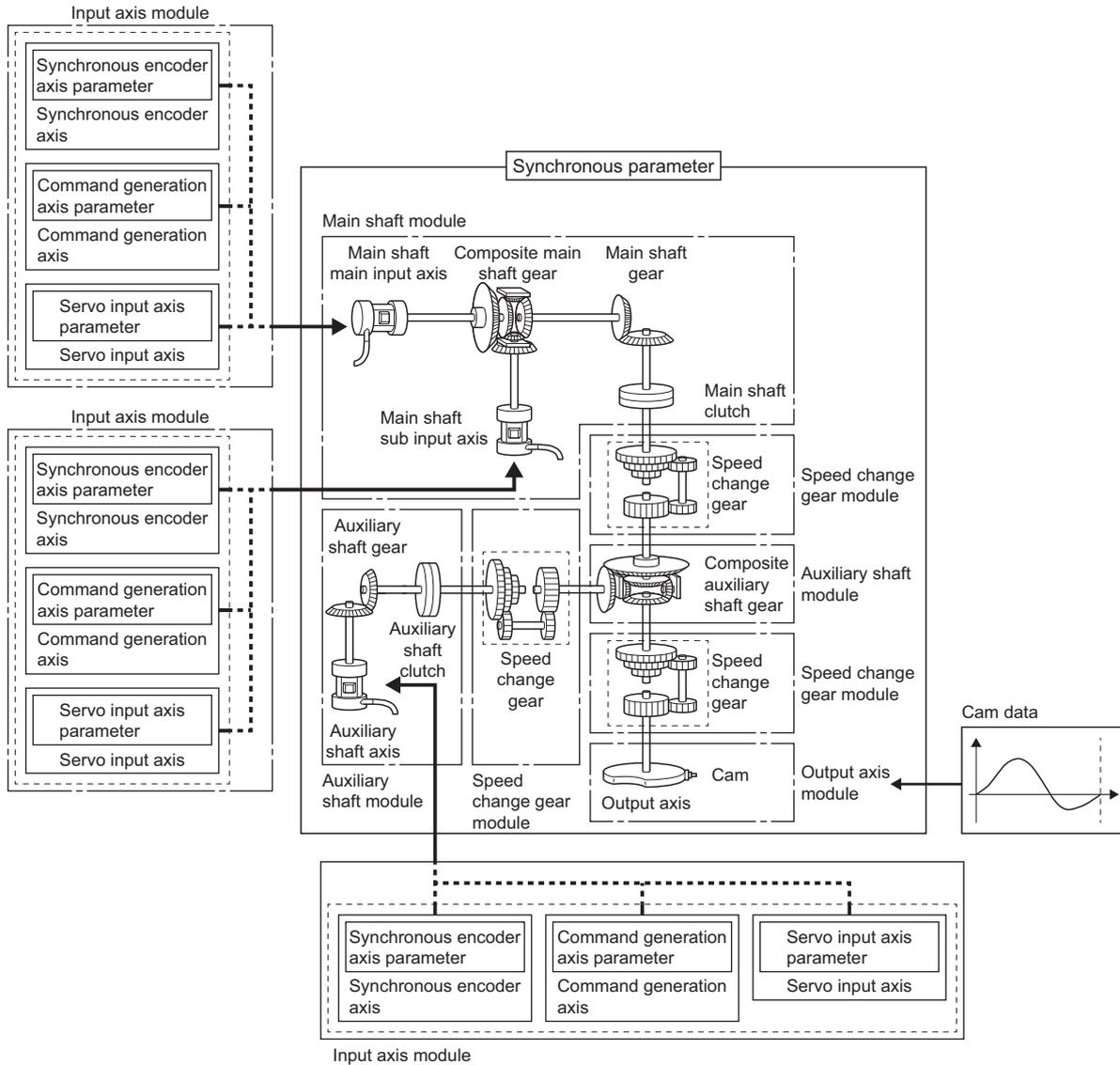
**Point**

- Input axis module can be set to one of servo input axis, command generation axis or synchronous encoder axis.
- Speed change gear can be arranged on two of main shaft side, auxiliary shaft side or after composite auxiliary shaft gear.
- Set the travel value of input axis module so large as possible to prevent the speed fluctuation of output axis module in the synchronous control. If the travel value of input axis module is small, the speed fluctuation of output axis module may occur depending on the setting for synchronous parameter.
- All synchronous control monitor data, and the rotation direction of the main shaft main input axis, main shaft sub input axis, auxiliary shaft, output axis (cam axis feed current value) can be monitored in the MT Developer2 synchronous control image screen.

## Input axis

| Classification | Name | Parts | Function description | Maximum number of usable | | | | Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Number per module | | | Number per axis | |
| | | | | R64MTCPU | R32MTCPU | R16MTCPU | | |
| Input axis module | Servo input axis | — | Used to drive the input axis with the position of the servo motor controlled by the Motion CPU. | 64 | 32 | 16 | — | ☞Page 30 Servo Input Axis |
| | Command generation axis | — | Used to drive the input axis with the only position command generated in the servo program. | 64 | 32 | 16 | — | ☞Page 37 Command Generation Axis |
| | Synchronous encoder axis | — | Used to drive the input axis with input pulse from the synchronous encoder. | 12 | | | — | ☞Page 53 Synchronous Encoder Axis |

## Output axis

| Classification | Name | Parts | Function description | Maximum number of usable | | | | Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Number per module | | | Number per axis | |
| | | | | R64MTCPU | R32MTCPU | R16MTCPU | | |
| Main shaft module | Main shaft main input axis |  | • The input axis on the main side of the main shaft module.<br>• The reference position on the main shaft. | 64 | 32 | 16 | 1 | ☞Page 92 Main Shaft Module |
| | Main shaft sub input axis |  | • The input axis on the sub side of the main shaft module.<br>• It is used to compensate for the position of the main shaft main input axis. | 64 | 32 | 16 | 1 | ☞Page 92 Main Shaft Module |
| | Composite main shaft gear |  | The composite travel value of the main shaft main input axis and the main shaft sub input axis are transmitted to the main shaft gear. | 64 | 32 | 16 | 1 | ☞Page 92 Main Shaft Module |
| | Main shaft gear |  | The converting travel value after composite main shaft gear is transmitted by the setting gear ratio. | 64 | 32 | 16 | 1 | ☞Page 92 Main Shaft Module |
| | Main shaft clutch |  | The main shaft travel value is transmitted by the clutch ON/OFF. | 64 | 32 | 16 | 1 | ☞Page 92 Main Shaft Module ☞Page 111 Clutch |
| Auxiliary shaft module | Auxiliary shaft axis |  | The input axis of the auxiliary shaft module. | 64 | 32 | 16 | 1 | ☞Page 102 Auxiliary Shaft Module |
| | Auxiliary shaft gear |  | The converting auxiliary shaft travel value is transmitted by the setting gear ratio. | 64 | 32 | 16 | 1 | ☞Page 102 Auxiliary Shaft Module |
| | Auxiliary shaft clutch |  | The auxiliary shaft travel value is transmitted by the clutch ON/OFF. | 64 | 32 | 16 | 1 | ☞Page 102 Auxiliary Shaft Module ☞Page 111 Clutch |
| | Composite auxiliary shaft gear |  | The composite travel value of the main shaft and the auxiliary shaft are transmitted. | 64 | 32 | 16 | 1 | ☞Page 102 Auxiliary Shaft Module |

| Classifi cation | Name | Parts | Function description | Maximum number of usable | | | | Reference |
|---|---|---|---|---|---|---|---|---|
| | | | | Number per module | | | Number per axis | |
| | | | | R64MTCPU | R32MTCPU | R16MTCPU | | |
| Speed change gear module | Speed change gear | | It is used to change the speed by setting speed change ratio during the operation. | 128 | 64 | 32 | 2 | ☞ Page 122 Speed Change Gear Module |
| Output axis module | Output axis | | The cam conversion is processed based on the input travel value and the setting cam data. The current feed value is output as the command to the servo amplifier. | 64 | 32 | 16 | 1 | ☞ Page 125 Output Axis Module |
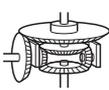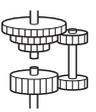
## Cam data

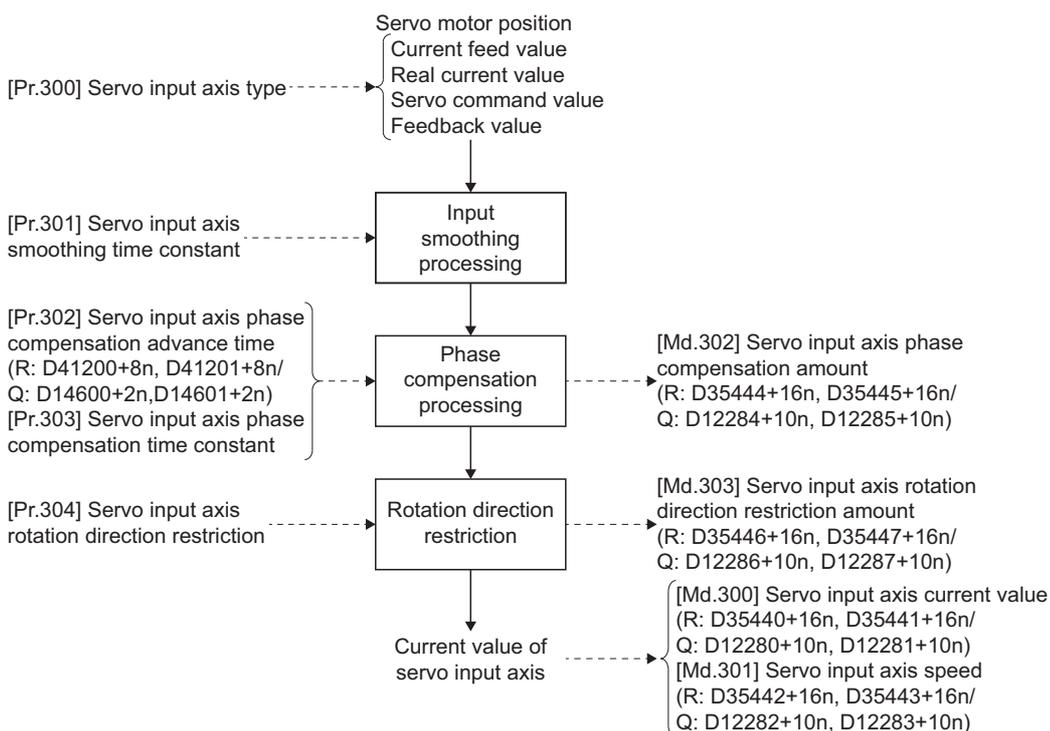| Classification | Name | Function description | Maximum number of usable | Reference |
|---|---|---|---|---|
| | | | Number per module | |
| Cam data | Cam data | It controls the operation pattern of the output axis (two-way operation and feed operation), which is corresponding to the input travel value of the output axis module. | Up to 1024 | ☞ Page 83 CAM FUNCTION |

**3**

# 4 INPUT AXIS MODULE

## 4.1 Servo Input Axis

### Overview of servo input axis

The servo input axis is used to drive the input axis based on the position of the servo motor that is being controlled by the Motion CPU.

The status of a servo input axis can be monitored even before the synchronous control start since the setting of a servo input axis is valid after Multiple CPU system's power supply ON.

The following shows the relationship between the position of the servo motor and the servo input axis.

```
[Pr.300] Servo input axis type --------▶   Servo motor position
                                            Current feed value
                                            Real current value
                                            Servo command value
                                            Feedback value
                                                   │
                                                   ▼
[Pr.301] Servo input axis                     ┌──────────────┐
smoothing time constant  ------------▶        │    Input     │
                                              │  smoothing   │
                                              │  processing  │
                                              └──────────────┘
                                                   │
                                                   ▼
[Pr.302] Servo input axis phase               ┌──────────────┐      [Md.302] Servo input axis phase
compensation advance time                     │    Phase     │      compensation amount
(R: D41200+8n, D41201+8n/          ---- ▶     │ compensation │ ---▶ (R: D35444+16n, D35445+16n/
Q: D14600+2n,D14601+2n)                       │  processing  │      Q: D12284+10n, D12285+10n)
[Pr.303] Servo input axis phase               └──────────────┘
compensation time constant                         │
                                                   ▼
[Pr.304] Servo input axis                     ┌──────────────┐      [Md.303] Servo input axis rotation
rotation direction restriction     ---- ▶     │   Rotation   │      direction restriction amount
                                              │  direction   │ ---▶ (R: D35446+16n, D35447+16n/
                                              │ restriction  │      Q: D12286+10n, D12287+10n)
                                              └──────────────┘
                                                   │                [Md.300] Servo input axis current value
                                                   ▼                (R: D35440+16n, D35441+16n/
                                            Current value of         Q: D12280+10n, D12281+10n)
                                            servo input axis  ---▶  [Md.301] Servo input axis speed
                                                                    (R: D35442+16n, D35443+16n/
                                                                    Q: D12282+10n, D12283+10n)
```

### Control method for servo input axis

All controls (including synchronous control) can be executed for a servo input axis.

Refer to the following for the controls other than synchronous control.

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

> **Point**
>
> When the axis during speed control, torque control, or continuous operation to torque control or the synchronous control output axis is set to the servo input axis, the input axis is driven based on the position of an operation cycle before.

## Restrictions

- If "1: Current feed value" or "2: Real current value" is set in "[Pr.300] Servo input axis type", turn ON the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)" to start the speed/position switching control. If the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)" turns OFF, minor error (error code: 1BA7H) will occur and the control will not start.
- If "[Pr.300] Servo input axis type" is set to other than "0: Invalid", when the speed control (Ⅱ) is started, the minor error (error code: 1BDFH) will occur and the control will not start.

## Units for the servo input axis

The position units and speed units for the servo input axis are shown below for the setting "[Pr.300] Servo input axis type" and "Unit setting" of fixed parameter.

### ■Servo input axis position units

| Setting value of "[Pr.300] Servo input axis type" | Setting value of unit setting | Servo input axis position unit | Range |
|---|---|---|---|
| 1: Current feed value<br>2: Real current value | 0: mm | $\times 10^{-4}$mm($10^{-1}$μm) | -214748.3648 to 214748.3647[mm]<br>(-214748364.8 to 214748364.7[μm]) |
| | 1: inch | $\times 10^{-5}$inch | -21474.83648 to 21474.83647[inch] |
| | 2: degree | $\times 10^{-5}$degree | -21474.83648 to 21474.83647[degree] |
| | 3: pulse | pulse | -2147483648 to 2147483647[pulse] |
| 3: Servo command value<br>4: Feedback value | — | pulse | -2147483648 to 2147483647[pulse] |

### ■Servo input axis speed units

| Setting value of "[Pr.300] Servo input axis type" | Setting value of unit setting | Servo input axis speed unit | Range |
|---|---|---|---|
| 1: Current feed value<br>2: Real current value | 0: mm | $\times 10^{-2}$mm/min | -21474836.48 to 21474836.47[mm/min] |
| | 1: inch | $\times 10^{-3}$inch/min | -2147483.648 to 2147483.647[inch/min] |
| | 2: degree | $\times 10^{-3}$degree/min[1] | -2147483.648 to 2147483.647[degree/min][1] |
| | 3: pulse | pulse/s | -2147483648 to 2147483647[pulse/s] |
| 3: Servo command value<br>4: Feedback value | — | pulse/s | -2147483648 to 2147483647[pulse/s] |

[1] When Speed control 10 × multiplier setting for degree axis is valid, this will be the speed unit "$\times 10^{-2}$degree/min" (Range: -21474836.48 to 21474836.47 [degree/min]).

**Point**
- When "1: Current feed value" or "3: Servo command value" is set in "[Pr.300] Servo input axis type", and the servo input axis becomes servo OFF by the servo error or forced stop, the amount of value change may be large. This can be prevented by setting "2: Real current value" or "4: Feedback value" in "[Pr.300] Servo input axis type".
- When a home position return for the axis where "1: Current feed value" or "2: Real current value" is set in "[Pr.300] Servo input axis type" is performed, if the servo input axis operation during home position return is used as the input value, the input is stopped in the midway of home position return. When the servo input axis operation during home position return is used as the input value, set "3: Servo command value" or "4: Feedback value" in "[Pr.300] Servo input axis type".

# Servo input axis parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.300 | Servo input axis type | Set the current value type to be generated of the input value for the servo input axis. | 0: Invalid<br>1: Current feed value<br>2: Real current value<br>3: Servo command value<br>4: Feedback value | At power supply ON | 0 | — | — |
| Pr.301 | Servo input axis smoothing time constant | Set to smooth the input value. | 0 to 5000[ms] | | 0[ms] | — | — |
| Pr.302 | Servo input axis phase compensation advance time | Set the time to advance or delay the phase. | -2147483648 to 2147483647[μs] | Operation cycle | 0[μs] | D41200+8n<br>D41201+8n | D14600+2n<br>D14601+2n |
| Pr.303 | Servo input axis phase compensation time constant | Set the time constant to affect the phase compensation. | 0 to 65535[ms] | At power supply ON | 10[ms] | — | — |
| Pr.304 | Servo input axis rotation direction restriction | Set this parameter to restrict the input travel value to one direction. | 0: Without rotation direction restriction<br>1: Enable only for current value increase direction<br>2: Enable only for current value decrease direction | | 0 | — | — |

## [Pr.300] Servo input axis type

Set the current value type to be generated of the input value for the servo input axis.

| Setting value | Description |
|---|---|
| 0: Invalid | Servo input axis is invalid. |
| 1: Current feed value | Generate the input value based on "[Md.20] Feed current value (R: D32000+48n, D32001+48n/Q: D0+20n, D1+20n)". |
| 2: Real current value | Generate the input value based on the real current value, which is converted units of the encoder feedback pulses from the servo amplifier. |
| 3: Servo command value | Generate the input value based on the command pulse (encoder pulse units) to the servo amplifier. |
| 4: Feedback value | Generate the input value based on the encoder feedback pulse from the servo amplifier. |

Motion CPU
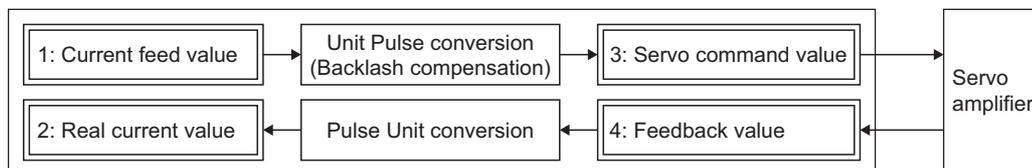
## [Pr.301] Servo input axis smoothing time constant

Set the averaging time to execute a smoothing process for the input travel value from the servo input axis. The smoothing process can moderate speed fluctuation, when the "Real current value" or "Feedback value" is used as input values.

The input response is delayed depending on the time corresponding to the setting by smoothing process setting.
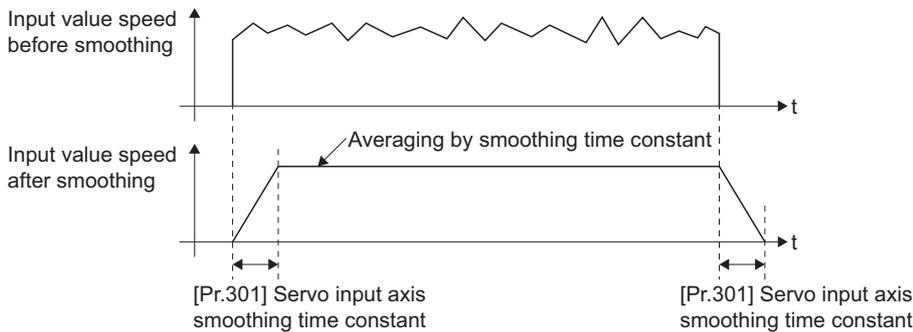


## [Pr.302] Servo input axis phase compensation advance time (R: D41200L+8n/Q: D14600L+2n)

Set the time to advance or delay the phase (input response) of the servo input axis.

Refer to delay time peculiar to the system for a servo input axis for the peculiar time delay of the system using the servo input axis.( ☞ Delay time peculiar to the system for a servo input axis)

| Setting value | Description |
|---|---|
| 1 to 2147483647 [μs] | Advance the phase (input response) according to the setting time. |
| 0 [μs] | Do not execute phase compensation. |
| -2147483648 to -1 [μs] | Delay the phase (input response) according to the setting time. |

If the setting time is too long, the system experiences overshoot or undershoot at acceleration/deceleration of the input speed. In this case, set longer time to affect the phase compensation amount in "[Pr.303] Servo input axis phase compensation time constant".

## [Pr.303] Servo input axis phase compensation time constant

Set the time constant to affect the phase compensation amount for the first order delay.

63 [%] of the phase compensation amount are reflected in the time constant setting.
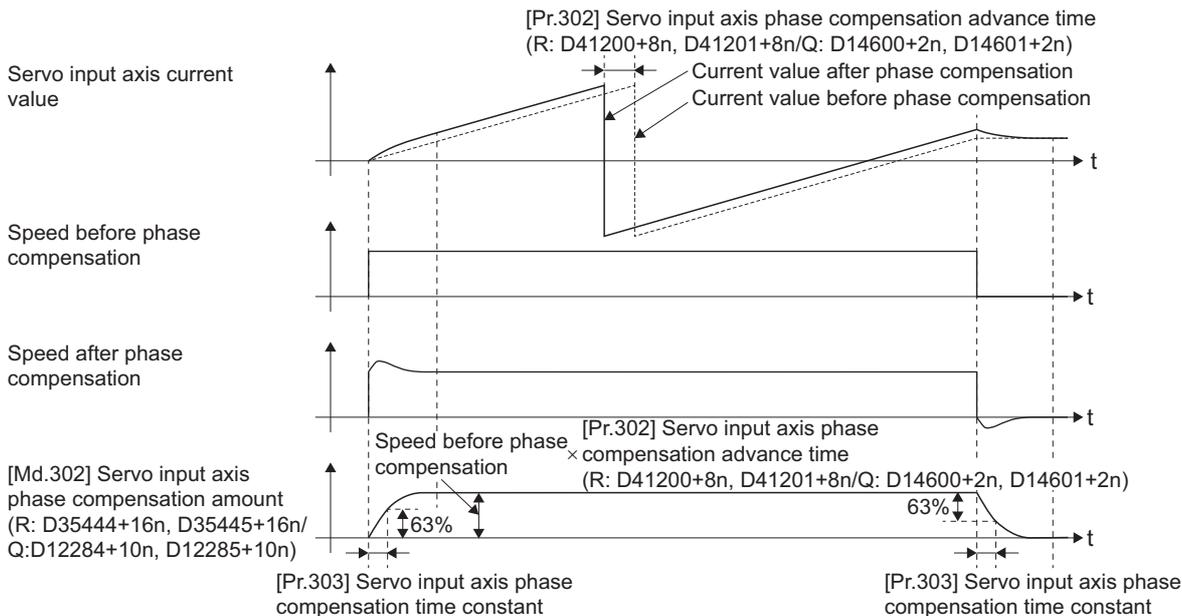
## [Pr.304] Servo input axis rotation direction restriction

Set this parameter to restrict the input travel value for the servo input axis to one direction.

This helps to avoid reverse operation caused by machine vibration, etc. when "Real current value" or "Feedback value" is used as input values.

| Setting value | Description |
|---|---|
| 0: Without rotation direction restriction | Rotation direction restriction is not executed. |
| 1: Enable only for current value increase direction | Enable only the input travel value in the increasing direction of the servo input axis current value. |
| 2: Enable only for current value decrease direction | Enable only the input travel value in the decreasing direction of the servo input axis current value. |

The input travel value in the opposite direction of the enable direction accumulates as a rotation direction restricted amount, and will be reflected when the input travel value moves in the enabled direction again. Therefore, the current value of servo input does not deviate when the reverse operation is repeated.

The rotation direction restricted amount is set to 0 at the following timing.

- At home position return complete
- At current value change complete
- At speed control (I) complete[1]
- At fixed-pitch feed control start
- At servo amplifier connection/disconnection
- At speed/position switching control start[1]

[1] When the control is started by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)".

For "1: Enable only for current value increase direction" is set in "[Pr.304] Servo input axis rotation direction restriction".

Speed before rotation direction restriction

[Md.301] Servo input axis speed
(R: D35442+16n, D35443+16n/
Q: D12282+10n, D12283+10n)
(Speed after rotation direction restriction)

[Md.303] Servo input axis rotation direction restriction amount
(R: D35446+16n, D35447+16n/
Q: D12286+10n, D12287+10n)
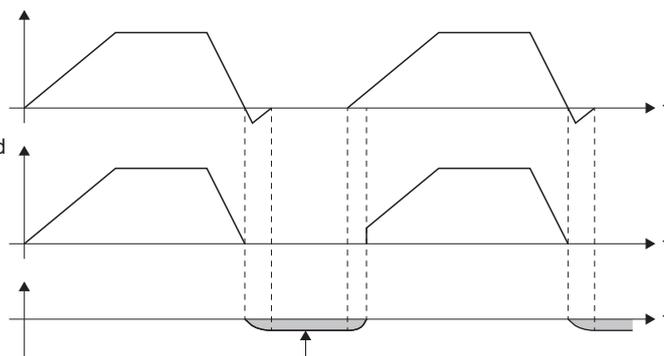
The input travel value is accumulated as a rotation direction restricted amount, and will be reflected when the input travel value moves in the enable direction.

# Servo input axis monitor data

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. | |
|---|---|---|---|---|---|---|
| | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Md.300 | Servo input axis current value | The current value for the servo input axis is stored. | -2147483648 to 2147483647 [Servo input axis position units][1] | Operation cycle | D35440+16n D35441+16n | D12280+10n D12281+10n |
| Md.301 | Servo input axis speed | The speed for the servo input axis is stored. | -2147483648 to 2147483647 [Servo input axis speed units][2] | | D35442+16n D35443+16n | D12282+10n D12283+10n |
| Md.302 | Servo input axis phase compensation amount | The current phase compensation amount is stored. | -2147483648 to 2147483647 [Servo input axis position units][1] | | D35444+16n D35445+16n | D12284+10n D12285+10n |
| Md.303 | Servo input axis rotation direction restriction amount | While the rotation direction is restricted, the accumulation for the input travel value in the opposite direction of the enable direction is stored. | -2147483648 to 2147483647 [Servo input axis position units][1] | | D35446+16n D35447+16n | D12286+10n D12287+10n |

*1 Servo input axis position units(☞ Page 31 Servo input axis position units)
*2 Servo input axis speed units(☞ Page 31 Servo input axis speed units)

## [Md.300] Servo input axis current value (R: D35440L+16n/Q: D12280L+10n)

The current value for the servo input axis is stored in servo input axis position units as follows.(☞ Page 31 Servo input axis position units)

The current value for the servo input axis is the value after processing the smoothing, the phase compensation and the rotation direction restriction.

| Setting value of "[Pr.300] Servo input axis type" | Storage details |
|---|---|
| 1: Current feed value 2: Real current value | • The accumulative current value started with Current feed value/Real current value for the connection to the servo amplifier is stored. It is also stored in the range from -21474.83648 to 21474.83647 [degree] for degree units. • When the Current feed value/Real current value is changed by a home position return or a current value change, the value is changed to the new current value. |
| 3: Servo command value 4: Feedback value | • When of the absolute position detection system setting is invalid, the accumulative current value that starts from 0 for the connected servo amplifier is stored. • When of the absolute position detection system setting is valid, the accumulative current value that starts from the absolute position command/encoder feedback pulse for the connected servo amplifier is stored. • The servo input axis current value will not change, even if a home position return or the current value is changed. |

## [Md.301] Servo input axis speed (R: D35442L+16n/Q: D12282L+10n)

The speed for the servo input axis is stored in servo input axis speed units. (☞ Page 31 Servo input axis speed units)

The speed for the servo input axis is the value after processing smoothing, phase compensation, and rotation direction restriction.

## [Md.302] Servo input axis phase compensation amount (R: D35444L+16n/Q: D12284L+10n)

The phase compensation amount for a servo input axis is stored in servo input axis position units. (☞ Page 31 Servo input axis position units)

The phase compensation amount for a servo input axis is the value after processing smoothing and phase compensation.

## [Md.303] Servo input axis rotation direction restriction amount (R: D35446L+16n/Q: D12286L+10n)

While the rotation direction is restricted for a servo input axis, the accumulation for input travel value in the opposite direction of the enabled direction is stored in servo input axis position units as follows. ( ☞ Page 31 Servo input axis position units)

| Setting value of "[Pr.304] Servo input axis rotation direction restriction" | Storage details |
| --- | --- |
| 1: Enable only for current value increase direction | A negative accumulation is stored during rotation direction restriction.<br>0 is stored if there is no restriction. |
| 2: Enable only for current value decrease direction | A positive accumulation is stored during rotation direction restriction.<br>0 is stored if there is no restriction. |

Rotation direction restriction is processed after phase compensation processing. Therefore, if undershoot occurs from phase compensation during deceleration stop, the rotation direction restriction amount might remain.

# 4.2 Command Generation Axis

## Overview of command generation axis

Command generation axis is the axis that performs only the command generation. It can be controlled independently with the axis to which the servo amplifier is connected. It is used to drive the input axis by the servo program or JOG operation. The command generation axis can be controlled or the state of command generation axis can be monitored after Multiple CPU system's power ON.

### Control method for command generation axis

The command generation axis uses the servo program within the range assigned to the command generation axis program with the command generation axis program allocation setting of MT Developer2. JOG operation can be executed with Forward rotation JOG command/Reverse rotation JOG command of command generation axis.

The controls that can be used with command generation axis are shown below.

○: Usable, ×: Unusable

| Control mode | Servo instruction | | Usable/unusable |
|---|---|---|---|
| Linear control | ABS-1  ABS-2  ABS-3  ABS-4  INC-1  INC-2  INC-3  INC-4 | | ○ |
| Circular interpolation control | ABS circular  INC circular | | ○ |
| Helical interpolation control | ABS helical  INC helical | | ○ |
| Fixed-pitch feed | FEED-1  FEED-2  FEED-3 | | ○ |
| Continuous trajectory control | CPSTART1  CPSTART2  CPSTART3 | | ○ |
| Speed control (I) | VF  VR | | ○ |
| Speed control (II) | VVF  VVR | | × |
| Speed/position switching control | VPF  VPR  VPSTART | | × |
| Position follow-up control | PFSTART | | ○ |
| Speed control with fixed position stop | PVF  PVR | | ○ |
| Simultaneous start | START | | ○ |
| JOG operation | Individual start | | ○ |
| | Simultaneous start | | × |
| Manual pulse generator operation | | | × |
| High-speed oscillation | OSC | | × |
| Home position return | ZERO | | × |
| Speed-torque control | | | × |
| Pressure control | | | × |

For the servo instruction data item of command generation axis, "torque limit value" and "deceleration processing on STOP input" cannot be set. The items other than that can be set.

Refer to the following for details of servo instruction.

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

### ■Servo program start request M(P).SVST/D(P).SVST instruction of command generation axis

When executing M(P).SVST/D(P).SVST instruction (Servo program start request) for the command generation axis, specify the axis No. with "Jn". The No. of servo program to be executed must be assigned to the range used by the command generation axis with the command generation axis program allocation setting.

## ■Command generation axis start accept flag (System area)

When the servo program start is executed by specifying "Jn" as axis No., the complete status of start accept flag is stored in the address of the start accept flag in the CPU shared memory for target CPU.

| CPU shared memory address( ) is decimal address | Description |
|---|---|
| 20EH(526)<br>20FH(527)<br>210H(528)<br>211H(529) | The command generation axis start accept flag for 64 axes are stored corresponding to each bit. Bits are actually set as the following.<br> • R64MTCPU: J1 to J64<br> • R32MTCPU: J1 to J32<br> • R16MTCPU: J1 to J16<br>OFF: Start accept enable<br>ON:  Start accept disable |

| | b15 | | b2 | b1 | b0 |
|---|---|---|---|---|---|
| 20EH(526) address | J16 | •••••••• | | J2 | J1 |
| 20FH(527) address | J32 | •••••••• | | J18 | J17 |
| 210H(528) address | J48 | •••••••• | | J34 | J33 |
| 211H(529) address | J64 | •••••••• | | J50 | J49 |

## ■Control change for the command generation axis

The following control change can be performed for the command generation axis.

 • Current value change
  • When CHGA instruction of servo program (Kn) is used
   CHGA instruction of servo program assigned to the range used by the command generation axis with the command generation axis program allocation setting is used.
  • When the current value changed is executed by Motion dedicated PLC instruction
   M(P).CHGAS/D(P).CHGAS instruction is used.

**Ex.**

The current value is changed to 1000 for the command generation axis 3 of CPU No.2.

```
─┤ ├──────────────[ MP.CHGAS  H3E1   "J3"    K1000 ]─
```

 • Speed change
  • When the speed changed is executed by Motion SFC program
   CHGVS instruction is used.

**Ex.**

The speed is changed to 100000 for the command generation axis 4.

```
CHGVS(K4,K100000)
```

  • When the speed changed is executed by Motion dedicated PLC instruction
   M(P).CHGVS/D(P).CHGVS instruction is used.

**Ex.**

The speed is changed to 300000 for the command generation axis 5 of CPU No.2.

```
─┤ ├──────────────[ MP.CHGVS  H3E1   "J5"    K300000 ]─
```

## ■Simultaneous start instruction of command generation axis program

In simultaneous start instruction (START), the simultaneous start is not possible with real axis program and command generation axis program mixed. If the mixed programs are started with the programs mixed, the minor error (error code: 1A4FH) will occur.

## Units for the command generation axis

The position units and speed units for the command generation axis are shown below for the setting "[Pr.341] Command generation axis type".

### ■Command generation axis position units

| Setting value of "[Pr.341] Command generation axis type" | Command generation axis position unit | Range |
|---|---|---|
| 0: mm | $\times 10^{-1}\mu m$ | -214748364.8 to 214748364.7[μm] |
| 1: inch | $\times 10^{-5}inch$ | -21474.83648 to 21474.83647[inch] |
| 2: degree | $\times 10^{-5}degree$ | -21474.83648 to 21474.83647[degree] |
| 3: pulse | pulse | -2147483648 to 2147483647[pulse] |

### ■Command generation axis speed units

| Setting value of "[Pr.341] Command generation axis type" | Command generation axis position unit | Range |
|---|---|---|
| 0: mm | $\times 10^{-2}mm/min$ | -21474836.48 to 21474836.47[mm/min] |
| 1: inch | $\times 10^{-3}inch/min$ | -2147483.648 to 2147483.647[inch/min] |
| 2: degree | $\times 10^{-3}degree/min$[1] | -2147483.648 to 2147483.647[degree/min][1] |
| 3: pulse | pulse/s | -2147483648 to 2147483647[pulse/s] |

*1 When "[Pr.345] Command generation axis speed control 10 × multiplier setting for degree axis" is valid, this will be the speed unit "$\times 10^{-2}degree/min$" (Range: -21474836.48 to 21474836.47 [degree/min]).

## Speed control with fixed position stop for command generation axis

Speed control with fixed position stop can be performed for the command generation axis.
Speed control with fixed position stop is started using the PVF (forward rotation) or PVR (reverse rotation) of servo program instruction.

### ■Control details

• After starting of command generation axis, control at the specified speed is executed until the fixed position stop command turns on.

| Servo instruction | Description |
|---|---|
| PVF | Forward rotation direction (Address increase direction) start |
| PVR | Reverse rotation direction (Address decrease direction) start |

• When the fixed position stop command turns on, a positioning control to the position of the address specified by "[Md.347] Command generation axis current value per cycle (R: D36490+32n, D36491+32n/Q: D12610+20n, D12611+20n)" is executed.

• Speed control with fixed position stop can be executed in the command generation axis with all the control units where "[Pr.346] Command generation axis length per cycle" is set to 1 to 2147483647. When "[Pr.346] Command generation axis length per cycle" is "0", the minor error (error code: 19EAH) will occur, and the control will not start.

• Address setting range is "0 to ("[Pr.346] Command generation axis length per cycle"-1)" in the indirect setting of positioning address. If it is set outside the setting range, a minor error (error code: 1A31H) occurs and it does not start. Positioning address is input at the program start.

• It is controlled in the fixed position stop acceleration/deceleration time set in the servo program at positioning start, speed change request (CHGVS) and fixed position stop command ON. The fixed acceleration/deceleration time method is used as an acceleration/deceleration processing in this case.

• The setting range of fixed position stop acceleration/deceleration time is "1 to 8388608[ms][1]".

*1 When the number of words used is set to 1 word in the MT Developer2 options screen, the setting range is "1 to 65535[ms]". Refer to "Acceleration/Deceleration Time and Command Torque Time Constant 1 Word Setting Function" in the following manual for details on the 1 word setting.
📖MELSEC iQ-R Motion Controller Programming Manual (Common)

- In the case of indirect setting, the fixed position stop acceleration/deceleration time is input in the following timing.
  - Positioning start
  - Speed change request (CHGVS)
  - Fixed position stop command ON
- When the positioning to specified address completes, the "[St.341] Command generation axis positioning complete signal (R: M36561+32n/Q: M9801+20n)" turns ON. It does not turn on at the time of stop by the "[Rq.341] Command generation axis stop command (R: M40160+32n/Q: M10960+20n)"/"[Rq.342] Command generation axis rapid stop command (R: M40161+32n/Q: M10961+20n)". The "[St.341] Command generation axis positioning complete signal (R: M36561+32n/Q: M9801+20n)" turns off at leading edge (from OFF to ON) of "[Rq.345] Command generation axis complete signal OFF command (R: M40164+32n/Q: M10964+20n)" or positioning start.
- Speed change can be executed any number of times by the speed change request (CHGVS) instruction during operation.
- Deceleration speed by the "[Rq.341] Command generation axis stop command (R: M40160+32n/Q: M10960+20n)"/"[Rq.342] Command generation axis rapid stop command (R: M40161+32n/Q: M10961+20n)" is controlled with fixed inclination (deceleration speed). Deceleration processing is executed using the speed limit value or deceleration/rapid stop deceleration time set in the parameter block.
- When the fixed position stop command turns on, the command in-position check starts. When the absolute value of difference between the setting address and feed current value below the "[Pr.344] Command generation axis command in-position range" set in the command generation axis parameter, the "[St.342] Command generation axis command in-position (R: M36563+32n/Q: M9803+20n)" turns on. The "[St.342] Command generation axis command in-position (R: M36563+32n/Q: M9803+20n)" turns OFF by a positioning start.
- A positioning control is executed the speed specified with the speed limit value when the fixed position stop command turns on with speed "0" (before PVF instruction execution/at speed change to speed "0" during PVF instruction execution).

# Command generation axis parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Device No. Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.340 | Command generation axis valid setting | Set the invalid/valid of command generation to be used. | 0: Invalid<br>1: Valid | At power supply ON | 0 | — | |
| Pr.341 | Command generation axis unit setting | Set the unit of command generation axis. | 0: mm<br>1: inch<br>2: degree<br>3: pulse | | 3 | — | |
| Pr.342 | Command generation axis upper stroke limit | Set the upper stroke limit of command generation axis. | -2147483648 to 2147483647 (degree: 0 to 35999999) [Command generation axis position units][1] | | 0 | — | |
| Pr.343 | Command generation axis lower stroke limit | Set the lower stroke limit of command generation axis. | -2147483648 to 2147483647 (degree: 0 to 35999999) [Command generation axis position units][1] | | 0 | — | |
| Pr.344 | Command generation axis command in-position range | Set the in-position range of command generation axis. | 1 to 2147483647 [Command generation axis position units][1] | | 100 | — | |
| Pr.345 | Command generation axis speed control 10 × multiplier setting for degree axis | Set whether the positioning control is executed with a value 10 × multiplier the speed of a command speed setting, when a control unit is degree axis. | 0: Invalid<br>1: Valid | | 0 | — | |
| Pr.346 | Command generation axis length per cycle | Set the length per cycle of command generation axis. | 0: Invalid<br>1 to 2147483647 [Command generation axis position units][1] | | 0 | — | |
| Pr.347 | Command generation axis JOG speed limit value | Set the speed limit value at the JOG operation of command generation axis. | 1 to 2147483647 [Command generation axis speed units][2] | | 20000 | — | |
| Pr.348 | Command generation axis JOG operation parameter block setting | Set the parameter block No. to be used at the JOG operation of command generation axis. | 1 to 64 | At JOG operation start | 1 | D41762+8n | D14682+4n |
| Pr.349 | Command generation axis acceleration/ deceleration time change enable device[3] | Set the bit device to enable the change of acceleration/ deceleration time at a speed change request. | Bit device[4] | At power supply ON | — | Optional device | |
| Pr.350 | Command generation axis new acceleration time value device[3] | Set the word device to set the change value of acceleration time. | Word device[4] | | — | Optional device | |
| Pr.351 | Command generation axis new deceleration time value device[3] | Set the word device to set the change value of deceleration time. | Word device[4] | | — | Optional device | |
| Pr.352 | Command generation axis ABS direction in degrees device[3] | Set the word device to set the positioning direction when the degree axis is positioning by the absolute system. | Word device[4] | At program start[5] | — | Optional device | |

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Pr.353 | Command generation axis override ratio setting device | Set the word device to set the override ratio. | Word device[4] | Operation cycle | — | Optional device | |
| Pr.354 | Command generation axis operation cycle selection | Set the operation cycle of the command generation axis. | 0: Operation cycle<br>1: Low speed operation cycle | At power supply ON | 0 | — | |

*1   Command generation axis position units (☞ Page 39 Command generation axis position units)
*2   Command generation axis speed units (☞ Page 39 Command generation axis speed units)
*3   This setting can be omitted.
*4   Refer to the following for the setting range of usable devices.
      📖 MELSEC iQ-R Motion controller Programming Manual (Common)
*5   During position follow-up control, the values of devices that were indirectly set at the change of the positioning address are input again.

## [Pr.340] Command generation axis valid setting

Set the invalid/valid of command generation axis.

| Setting value | Description |
|---|---|
| 0: Invalid | Command generation axis is invalid. |
| 1: Valid | Command generation axis is valid. |

## [Pr.341] Command generation axis unit setting

Set the unit of command generation axis. (☞ Page 39 Units for the command generation axis)

## [Pr.342] Command generation axis upper stroke limit

Set the upper limit for the command generation axis travel range.
To invalidate the software stroke limit, set the setting value to "upper limit value = lower limit value".

## [Pr.343] Command generation axis lower stroke limit

Set the lower limit for the command generation axis travel range.
To invalidate the software stroke limit, set the setting value to "upper limit value = lower limit value".

## [Pr.344] Command generation axis command in-position range

Set the output range for the in-position signal of command generation axis.

## [Pr.345] Command generation axis speed control 10 x multiplier setting for degree axis

Set whether the positioning control is executed with a value 10 × multiplier the speed of a command speed setting, when a unit setting of control generation axis is degree.

| Setting value | Command generation axis speed unit | Range |
|---|---|---|
| 0: Invalid | $\times 10^{-3}$degree/min | -2147483.648 to 2147483.647[degree/min] |
| 1: Valid | $\times 10^{-2}$degree/min | -21474836.48 to 21474836.47[degree/min] |

## [Pr.346] Command generation axis length per cycle

Set the length per cycle for the command generation axis current value per cycle.

The current value of command generation axis is stored in "[Md.347] Command generation axis current value per cycle (R: D36490+32n, D36491+32n/Q: D12610+20n, D12611+20n)" at ring counter based on the setting value.

The unit settings are in command generation axis position units. ( 🖙 Page 39 Command generation axis position units)

Set within the range from "1 to 2147483647".

When "0" is set, "[Md.347] Command generation axis current value per cycle (R: D36490+32n, D36491+32n/Q: D12610+20n, D12611+20n)" is not updated.

## [Pr.347] Command generation axis JOG speed limit value

Set the maximum speed the JOG operation of command generation axis.

## [Pr.348] Command generation axis JOG operation parameter block setting (R: D41762+8n/Q: D14682+4n)

Set the parameter block No. to be used at the JOG operation of command generation axis.

## [Pr.349] Command generation axis acceleration/deceleration time change enable device

Set the device to enable the change of acceleration/deceleration time at a command generation axis speed change request (CHGVS, M(P).CHGVS/D(P).CHGVS).

This setting can be omitted.

The following describes the operation for ON and OFF of the acceleration/deceleration time change enable device.

| Setting value | Description |
|---|---|
| ON | Speed change is executed at a speed change request by changing the acceleration/deceleration time values of "[Pr.350] Command generation axis new acceleration time value device" and "[Pr.351] Command generation axis new deceleration time value device". |
| OFF | Does not change acceleration/deceleration time at a speed change request. |

Refer to the following for the setting range of usable bit devices.

📖MELSEC iQ-R Motion controller Programming Manual (Common)

## [Pr.350] Command generation axis new acceleration time value device

Set the device to set the change value when changing the acceleration time at a speed change request.

This setting can be omitted.

The following change values are set in the new acceleration time value device.

| Setting value | Description |
|---|---|
| 1 to 8388608[ms][1] | If a speed change request is executed when the "[Pr.349] Command generation axis acceleration/deceleration time change enable device" is ON, speed change is executed by changing the acceleration time to the set value. |
| Other than the above | Acceleration time change is disabled, and speed change is maintained at the current acceleration time. |

[1] When the number of words used is set to 1 word in the MT Developer2 options screen, the setting range is "1 to 65535[ms]". Refer to "Acceleration/Deceleration Time and Command Torque Time Constant 1 Word Setting Function" in the following manual for details on the 1 word setting.
📖MELSEC iQ-R Motion Controller Programming Manual (Common)

Refer to the following for the setting range of usable word devices.

📖MELSEC iQ-R Motion controller Programming Manual (Common)

## [Pr.351] Command generation axis new deceleration time value device

Set the device to set the change value when changing the deceleration time at a speed change request.

This setting can be omitted.

The following change values are set in the new deceleration time value device.

| Setting value | Description |
|---|---|
| 1 to 8388608[ms][*1] | If a speed change request is executed when the "[Pr.349] Command generation axis acceleration/deceleration time change enable device" is ON, speed change is executed by changing the acceleration time to the set value. |
| Other than the above | Acceleration time change is disabled, and speed change is maintained at the current acceleration time. |

*1  When the number of words used is set to 1 word in the MT Developer2 options screen, the setting range is "1 to 65535[ms]". Refer to "Acceleration/Deceleration Time and Command Torque Time Constant 1 Word Setting Function" in the following manual for details on the 1 word setting.
📖MELSEC iQ-R Motion Controller Programming Manual (Common)

Refer to the following for the setting range of usable word devices.
📖MELSEC iQ-R Motion controller Programming Manual (Common)

> **Point**
>
> • When the setting of "[Pr.349] Command generation axis acceleration/deceleration time change enable device" is omitted, change of acceleration/deceleration time at a speed change request is not executed. When changing acceleration/deceleration time at a speed change, set this parameter.
> • When the setting of "[Pr.350] Command generation axis new acceleration time value device" and "[Pr.351] Command generation axis new deceleration time value device" is omitted, change of acceleration/deceleration time of the omitted devices is not executed.
> • Use the operating system software version "26" or later when using "[Pr.350] Command generation axis new acceleration time value device" and "[Pr.351] Command generation axis new deceleration time value device" with the number of words used set to 1 word. If the operating system software version "25" or earlier is installed with the number of words used set to 1 word, a moderate error (error code: 2220H) occurs when the Multiple CPU system power supply is turned ON again after installation.

## [Pr.352] Command generation axis ABS direction in degrees device

By setting the positioning direction, positioning control can be performed in a specified direction.

Refer to the following for details on ABS direction in degrees device.
📖MELSEC iQ-R Motion Controller Programming Manual (Positioning Control)

## [Pr.353] Command generation axis override ratio setting device

Set the device to set the override ratio for the override function.

Refer to the following for details on override ratio setting device.
📖MELSEC iQ-R Motion Controller Programming Manual (Positioning Control)

## [Pr.354] Command generation axis operation cycle selection

Set the cycle for the operation control of the command generation axis.

| Setting value | Description |
|---|---|
| 0: Operation cycle | The applicable axis operates at the operation cycle. |
| 1: Low speed operation cycle | The applicable axis operates at the low speed operation cycle. |

Refer to the following for details on low speed operation cycle.
📖MELSEC iQ-R Motion Controller Programming Manual (Common)

> **Point**
>
> When [Motion CPU Common Parameter] ⇨ [Basic Setting] ⇨ "Low Speed Operation Cycle Magnification Setting" is set to "Not Used", this setting is ignored.

# Command generation axis control data (Word device)

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Cd.340 | Command generation axis JOG speed setting | Set the JOG speed of command generation axis. | 1 to 2147483647 [Command generation axis speed units][1] | At JOG operation start | 0 | D41760+8n D41761+8n | D14680+4n D14681+4n |

[1] Command generation axis speed units (☞ Page 39 Command generation axis speed units)

### [Cd.340] Command generation axis JOG speed setting (R: D41760L+8n/Q: D14680L+4n)

Set the JOG speed of command generation axis.

# Command generation axis control data (Bit device)

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Rq.341 | Command generation axis stop command | Set the stop command of command generation axis. | ON: Stop requested OFF: Stop not requested | Operation cycle | OFF | M40160+32n | M10960+20n |
| Rq.342 | Command generation axis rapid stop command | Set the rapid stop command of command generation axis. | ON: Rapid stop requested OFF: Rapid stop not requested | | OFF | M40161+32n | M10961+20n |
| Rq.343 | Command generation axis forward rotation JOG start command | Set the forward rotation JOG start command of command generation axis. | ON: Forward rotation started OFF: Forward rotation not started | Main cycle | OFF | M40162+32n | M10962+20n |
| Rq.344 | Command generation axis reverse rotation JOG start command | Set the reverse rotation JOG start command of command generation axis. | ON: Reverse rotation started OFF: Reverse rotation not started | | OFF | M40163+32n | M10963+20n |
| Rq.345 | Command generation axis complete signal OFF command | Set the complete signal OFF command of command generation axis. | ON: Complete signal is turned OFF | | OFF | M40164+32n | M10964+20n |
| Rq.346 | Command generation axis error reset command | Set the error reset command of command generation axis. | ON: Error is reset | | OFF | M40167+32n | M10967+20n |
| Rq.347 | Feed current value update request command | Set whether update the feed current value in speed control of command generation axis or not. | ON: Feed current value is updated. OFF: Feed current value is 0 cleared and not updated at start. | At start | OFF | M40172+32n | M10972+20n |
| Rq.348 | Command generation axis FIN signal | Set the FIN signal of command generation axis. | OFF to ON: M code outputting signal is turned OFF. ON to OFF: Transition to the positioning of next block. | Operation cycle | OFF | M40179+32n | M10979+20n |

### [Rq.341] Command generation axis stop command (R: M40160+32n/Q: M10960+20n)

This command is a signal which stop a starting command generation axis from an external source and becomes effective at leading edge (from OFF to ON) of signal. (A command generation axis for which the stop command is turning on cannot be started.)

The operation at stop command input is the same as the "[Rq.1140] Stop command (R: M34480+32n/Q: M3200+20n)" of each axis.

Refer to the following for details of "[Rq.1140] Stop command (R: M34480+32n/Q: M3200+20n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

### [Rq.342] Command generation axis rapid stop command (R: M40161+32n/Q: M10961+20n)

This command stops a starting command generation axis rapidly from an external source and becomes effective at leading edge (from OFF to ON) of signal. (A command generation axis for which the rapid stop command is turning on cannot be started.)

The operation at rapid stop command input is the same as the "[Rq.1141] Rapid stop command (R: M34481+32n/Q: M3201+20n)" of each axis.

Refer to the following for details of "[Rq.1141] Rapid stop command (R: M34481+32n/Q: M3201+20n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

### [Rq.343] Command generation axis forward rotation JOG start command (R: M40162+32n/Q: M10962+20n)

JOG operation to the address increase direction is executed while "[Rq.343] Command generation axis forward rotation JOG start command (R: M40162+32n/Q: M10962+20n)" is turning on. When "[Rq.343] Command generation axis forward rotation JOG start command (R: M40162+32n/Q: M10962+20n)" is turned off, a deceleration stop is executed in the deceleration time set in the parameter block.

The operation at forward rotation JOG start command input is the same as the "[Rq.1142] Forward rotation JOG start command (R: M34482+32n/Q: M3202+20n)" of each axis.

Refer to the following for details of "[Rq.1142] Forward rotation JOG start command (R: M34482+32n/Q: M3202+20n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

### [Rq.344] Command generation axis reverse rotation JOG start command (R: M40163+32n/Q: M10963+20n)

JOG operation to the address decrease direction is executed while "[Rq.344] Command generation axis reverse rotation JOG start command (R: M40163+32n/Q: M10963+20n)" is turning on. When "[Rq.344] Command generation axis reverse rotation JOG start command (R: M40163+32n/Q: M10963+20n)" is turned off, a deceleration stop is executed in the deceleration time set in the parameter block.

The operation at reverse rotation JOG start command input is the same as the "[Rq.1143] Reverse rotation JOG start command (R: M34483+32n/Q: M3203+20n)" of each axis.

Refer to the following for details of "[Rq.1143] Reverse rotation JOG start command (R: M34483+32n/Q: M3203+20n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

### [Rq.345] Command generation axis complete signal OFF command (R: M40164+32n/Q: M10964+20n)

This command is used to turn off the "[St.340] Command generation axis positioning start complete (R: M36560+32n/Q: M9800+20n)" and "[St.341] Command generation axis positioning complete (R: M36561+32n/Q: M9801+20n)".

The operation at complete signal OFF command input is the same as the "[Rq.1144] Complete signal OFF command (R: M34484+32n/Q: M3204+20n)" of each axis.

Refer to the following for details of "[Rq.1144] Complete signal OFF command (R: M34484+32n/Q: M3204+20n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [Rq.346] Command generation axis error reset command (R: M40167+32n/Q: M10967+20n)

This command is used to clear the "[Md.341] Command generation axis minor error code (R: D36482+32n/Q: D12602+20n)" and "[Md.342] Command generation axis major error code (R: D36483+32n/Q: D12603+20n)" storage register of a command generation axis for which the error detection signal has turn on "[St.344] Command generation axis error detection signal (R: M36567+32n/Q: M9807+20n)": ON), and reset the [St.344] Command generation axis error detection signal (R: M36567+32n/Q: M9807+20n).

## [Rq.347] Feed current value update request command (R: M40172+32n/Q: M10972+20n)

This signal is used to set whether the feed current value will be updated or not at the speed control of command generation axis.

ON/OFF state is loaded at speed control start.

| Setting value | Description |
|---|---|
| ON | The feed current value is updated. |
| OFF | The feed current value is cleared at start and is not updated. |

## [Rq.348] Command generation axis FIN signal (R: M40179+32n/Q: M10979+20n)

When a M-code is set in a servo program, transit to the next block does not execute until the FIN signal changes as follows: OFF to ON and again to OFF. Positioning to the next block begins after the FIN signal changes as above.

It is valid, only when the FIN acceleration/deceleration is set and FIN signal wait function is selected.

The operation at FIN signal input is the same as the "[Rq.1159] FIN signal (R: M34499+32n/Q: M3219+20n)" of each axis.

Refer to the following for details of "[Rq.1159] FIN signal (R: M34499+32n/Q: M3219+20n)".

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

# Command generation axis monitor data (Word device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. MELSEC iQ-R Motion device assignment | Device No. Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|
| Md.340 | Command generation axis feed current value | The feed current value for the command generation axis is stored. | -2147483648 to 2147483647 [Command generation axis position units][1] | Operation cycle | D36480+32n D36481+32n | D12600+20n D12601+20n |
| Md.341 | Command generation axis warning code | The warning code for the command generation axis is stored. | Warning code[2] | Immediate | D36482+32n | D12602+20n |
| Md.342 | Command generation axis error code | The error code for the command generation axis is stored. | Error code[2] | | D36483+32n | D12603+20n |
| Md.343 | Command generation axis execute program No. | The execute program No. for the command generation axis is stored. | 0 to 8191 : Servo program No. -1(HFFFF): JOG operation 256(HFF00): Power supply ON -32(HFFE0): Current value change execution by the Motion dedicated instruction -31(HFFE1): Direct positioning start by the Motion dedicated instruction | At start | D36484+32n | D12604+20n |
| Md.344 | Command generation axis M-code | The M-code for the command generation axis is stored. | 0 to 32767 | Operation cycle | D36485+32n | D12605+20n |
| Md.345 | Command generation axis accumulative current value | The accumulative current value for the command generation axis is stored. | -2147483648 to 2147483647 [Command generation axis position units][1] | | D36486+32n D36487+32n | D12606+20n D12607+20n |
| Md.346 | Command generation axis data set pointer for continuous trajectory control | The data set pointer for continuous trajectory control for the command generation axis is stored. | 0 to 32767 | At start/ during start | D36489+32n | D12609+20n |
| Md.347 | Command generation axis current value per cycle | The current value per cycle for the command generation axis is stored. | 0 to (Command generation axis length per cycle -1) [Command generation axis position units][1] | Operation cycle | D36490+32n D36491+32n | D12610+20n D12611+20n |
| Md.348 | Command generation axis command speed | The command speed for the command generation axis is stored. | -2147483648 to 2147483647 [Command generation axis speed units][3] | | D36492+32n D36493+32n | D12612+20n D12613+20n |

*1 Command generation axis position units (☞ Page 39 Command generation axis position units)
*2 Refer to the following for details.
　📖MELSEC iQ-R Motion Controller Programming Manual (Common)
*3 Command generation axis speed units (☞ Page 39 Command generation axis speed units)

## [Md.340] Command generation axis feed current value (R: D36480L+32n/Q: D12600L+20n)

The feed current value for the command generation axis is stored in command generation axis position units (☞ Page 39 Command generation axis position units)

## [Md.341] Command generation axis warning code (R: D36482+32n/Q: D12602+20n)

• This register stores the corresponding warning code at the warning occurrence of command generation axis. If another warning occurs after warning code storing, the previous warning code is overwritten by the new warning code.
• Warning codes can be cleared by a "[Rq.346] Command generation axis error reset command (R: M40167+32n/Q: M10967+20n)".

**Point**

Refer to the following for details of warning codes.
📖MELSEC iQ-R Motion controller Programming Manual (Common)

## [Md.342] Command generation axis error code (R: D36483+32n/Q: D12603+20n)

- This register stores the corresponding error code at the error occurrence of command generation axis. If another error occurs after error code storing, the previous error code is overwritten by the new error code.
- Error codes can be cleared by a "[Rq.346] Command generation axis error reset command (R: M40167+32n/Q: M10967+20n)".

> **Point**
>
> Refer to the following for details of error codes.
> 📖 MELSEC iQ-R Motion controller Programming Manual (Common)

## [Md.343] Command generation axis execute program No. (R: D36484+32n/Q: D12604+20n)

This register stores the starting program No. of command generation axis at the servo program starting.

## [Md.344] Command generation axis M-code (R: D36485+32n/Q: D12605+20n)

This register stores the M-code set to the executed servo program of command generation axis at the positioning start.
If M-code is not set in the servo program, the value "0" is stored.

## [Md.345] Command generation axis accumulative current value (R: D36486L+32n/Q: D12606L+20n)

The accumulative current value of a command generation axis is stored in command generation axis position units.
(☞ Page 39 Command generation axis position units)
For the axis where the unit setting is other than "degree", this will be "feed current value = accumulative current value".

## [Md.346] Command generation axis data set pointer for control (R: D36489+32n/Q: D12609+20n)

This pointer is used in the continuous trajectory control of command generation axis when specifying positioning data indirectly and substituting positioning data during operation.
The details operation is the same as "[Md.1011] Data set pointer for continuous trajectory control (R: D32015+48n/Q: D15+20n)" of each axis.
Refer to the following for details of "[Md.1011] Data set pointer for continuous trajectory control (R: D32015+48n/Q: D15+20n)".
📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [Md.347] Command generation axis current value per cycle (R: D36490L+32n/Q: D12610L+20n)

The current value per cycle for a command generation axis is stored in the range from "0 to ([Pr.346] Command generation axis length per cycle-1)".
The unit is command generation axis position units. (☞ Page 39 Command generation axis position units)

## [Md.348] Command generation axis command speed (R: D36492L+32n/Q: D12612L+20n)

The command speed for a command generation axis is stored in command generation axis speed units. (☞ Page 39 Command generation axis speed units)

# Command generation axis monitor data (Bit device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|
| St.340 | Command generation axis positioning start complete | The positioning start complete signal for the command generation axis is stored. | ON: Positioning start complete OFF: Positioning start incomplete | Operation cycle | M36560+32n | M9800+20n |
| St.341 | Command generation axis positioning complete | The positioning complete signal for the command generation axis is stored. | ON: Positioning complete OFF: Positioning incomplete | | M36561+32n | M9801+20n |
| St.342 | Command generation axis command in-position | The command in-position signal for the command generation axis is stored. | ON: Less than the command in-position range OFF: Outside the command in-position range | | M36563+32n | M9803+20n |
| St.343 | Command generation axis speed controlling | The speed controlling signal for the command generation axis is stored. | ON: Speed control OFF: Control other than speed control | | M36564+32n | M9804+20n |
| St.344 | Command generation axis error detection | The error detection signal for the command generation axis is stored. | ON: Error occurred OFF: No error | Immediate | M36567+32n | M9807+20n |
| St.345 | Command generation axis start accept flag | The start accept flag for the command generation axis is stored. | ON: Starting OFF: Not started | Operation cycle | M36570+32n | M9810+20n |
| St.346 | Command generation axis speed change accepting flag | The speed change accepting flag for the command generation axis is stored. | ON: Speed change accepting OFF: Speed change not accepting | | M36571+32n | M9811+20n |
| St.347 | Command generation axis speed change "0" accepting flag | The speed change "0" accepting flag for the command generation axis is stored. | ON: Speed change "0" accepting OFF: Speed change "0" not accepting | | M36572+32n | M9812+20n |
| St.348 | Command generation axis automatic decelerating flag | The automatic decelerating flag for the command generation axis is stored. | ON: Automatic deceleration OFF: No automatic deceleration | | M36573+32n | M9813+20n |
| St.349 | Command generation axis M-code outputting | The M-code outputting flag for the command generation axis is stored. | ON: M code outputting OFF: M code not outputting | | M36579+32n | M9819+20n |

## [St.340] Command generation axis positioning start complete (R: M36560+32n/Q: M9800+20n)

This signal turns on with the start completion for the positioning control of the command generation axis specified with the servo program.

It does not turn on at the starting using JOG operation or speed control.

It can be used to read a M-code at the positioning start.

The details operation is the same as "[St.1060] Positioning start complete (R: M32400+32n/Q: M2400+20n)" of each axis.

Refer to the following for details of "[St.1060] Positioning start complete (R: M32400+32n/Q: M2400+20n)".

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.341] Command generation axis positioning complete (R: M36561+32n/Q: M9801+20n)

This signal turns on with the completion of the positioning control for the command generation axis specified with the servo program.

It does not turn on at the start or stop on the way using JOG operation or speed control.

It does not turn on at the stop on the way during positioning.

It can be used to read a M-code at the positioning completion.

The details operation is the same as "[St.1061] Positioning complete (R: M32401+32n/Q: M2401+20n)" of each axis.

Refer to the following for details of "[St.1061] Positioning complete (R: M32401+32n/Q: M2401+20n)".

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.342] Command generation axis command in-position (R: M36563+32n/Q: M9803+20n)

This signal turns on when the absolute value of difference between the command position and feed current value becomes below the "[Pr.344] Command generation axis command in-position range".

This signal turns off in the following cases.

- Positioning control start
- Speed control
- JOG operation

The details operation is the same as "[St.1063] Command in-position (R: M32403+32n/Q: M2403+20n)" of each axis.

Refer to the following for details of "[St.1063] Command in-position (R: M32403+32n/Q: M2403+20n)".

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.343] Command generation axis speed controlling (R: M36564+32n/Q: M9804+20n)

- This signal turns on during speed control of command generation axis, and can be used to judge whether command generation axis is during speed control or position control.
- This signal turns off at the power supply on and during position control.

## [St.344] Command generation axis error detection (R: M36567+32n/Q: M9807+20n)

- This signal turns on with detection of a warning or error of command generation axis, and can be used to judge whether there is a warning or error or not. The applicable warning code is stored in the "[Md.341] Command generation axis warning code (R: D36482+32n/Q: D12602+20n)" with detection of a warning. The applicable error code is stored in the "[Md.342] Command generation axis error code (R: D36483+32n/Q: D12603+20n)" with detection of an error.
- This signal turns off when the "[Rq.346] Command generation axis error reset command (R: M40167+32n/Q: M10967+20n)" turns on.

Point💡

Refer to the following for the warning codes and error codes with detection of warnings and errors.
📖MELSEC iQ-R Motion controller Programming Manual (Common)

## [St.345] Command generation axis start accept flag (R: M36570+32n/Q: M9810+20n)

This flag turns on when the servo program of command generation axis is started. The start accept flag corresponding to an axis specified with the servo program turns on.

The details operation is the same as "[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)" of each axis.

Refer to the following for details of "[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)".

📖MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.346] Command generation axis speed change accepting flag (R: M36571+32n/Q: M9811+20n)

This flag turns on at the start of speed change of command generation axis by the control change (CHGVS) instruction of the Motion SFC program or Motion dedicated PLC instruction (M(P).CHGVS/D(P).CHGVS).

## [St.347] Command generation axis speed change "0" accepting flag (R: M36572+32n/Q: M9812+20n)

This flag turns on while the command generation axis is accepting a speed change request to speed "0" or negative speed change request.

The details operation is the same as "[St.1049] Speed change "0" accepting flag (R: M30272+n/Q: M2240+n)" of each axis.

Refer to the following for details of "[St.1049] Speed change "0" accepting flag (R: M30272+n/Q: M2240+n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.348] Command generation axis automatic decelerating flag (R: M36573+32n/Q: M9813+20n)

This signal turns on while automatic deceleration processing is performed during the positioning control or position follow-up control of command generation axis.

The details operation is the same as "[St.1048] Automatic decelerating flag (R: M30208+n/Q: M2128+n)" of each axis.

Refer to the following for details of "[St.1048] Automatic decelerating flag (R: M30208+n/Q: M2128+n)".

📖 MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## [St.349] Command generation axis M-code outputting (R: M36579+32n/Q: M9819+20n)

- This signal turns on during M-code output of command generation axis.
- This signal turns off when the stop command, cancel signal, skip signal or FIN signal are inputted.

# 4.3 Synchronous Encoder Axis

## Overview of synchronous encoder axis

The synchronous encoder is used to drive the input axis based on input pulse from a synchronous encoder that is connected externally.

The status of a synchronous encoder axis can also be monitored after the Multiple CPU system power supply turns ON.
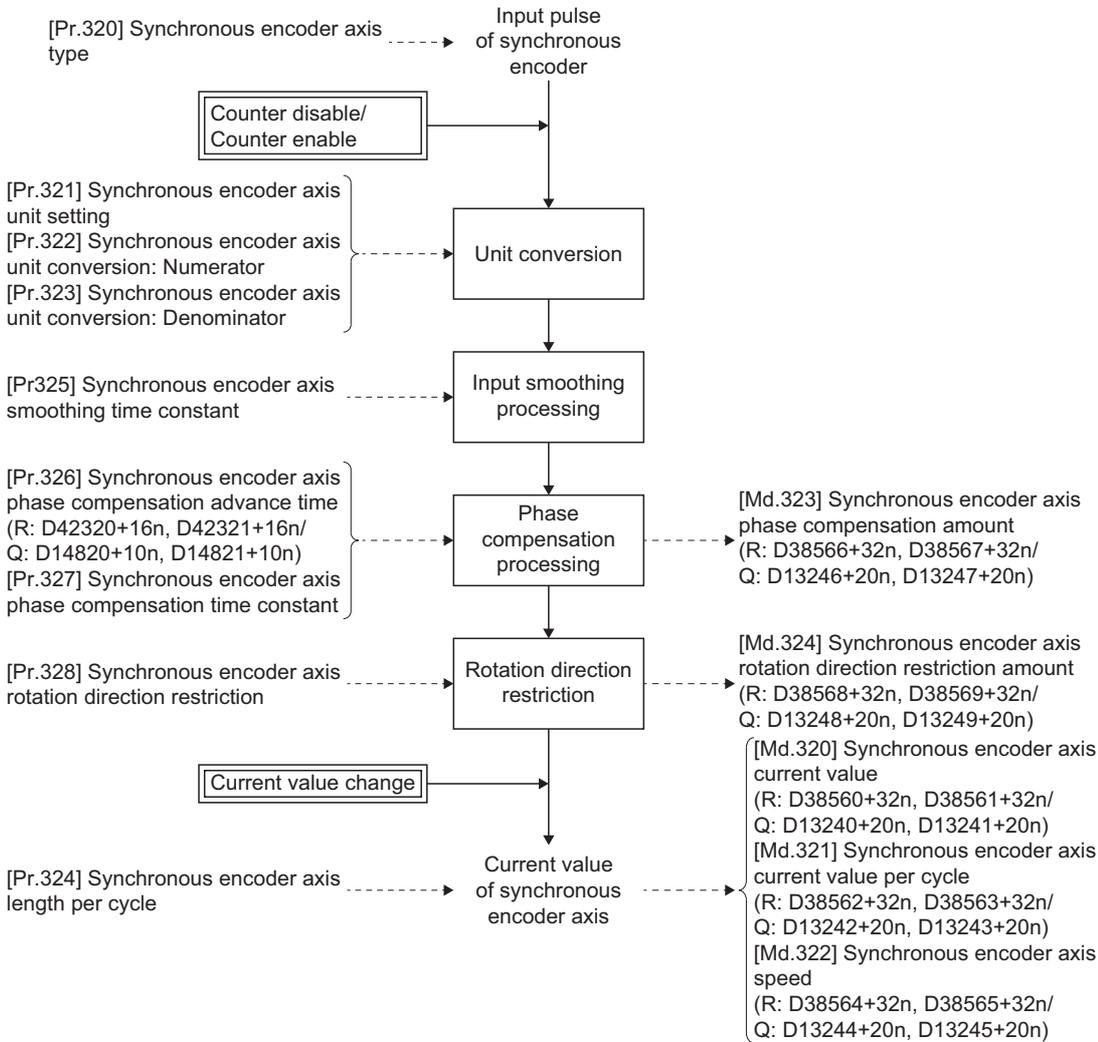
## Synchronous encoder axis type

The following synchronous encoders can be used for the synchronous encoder axis.

Refer to setting method for synchronous encoder for the setting method for each synchronous encoder axis. (☞ Page 57 Setting method for synchronous encoder)

| Synchronous encoder axis type | | Details |
|---|---|---|
| Via module | | The encoder value is acquired via a module controlled by Motion CPU.<br>Used to operate an encoder that is connected to a high-speed counter module, etc. as the synchronous encoder axis. |
| Via servo amplifier | | The following devices connected to the servo amplifier can be used as a synchronous encoder axis.<br>• Rotary servo motor (HK-KT) connected to a servo amplifier (MR-J5(W)-□B)<br>• Absolute/incremental scale connected to a servo amplifier (MR-J5(W)-□B/MR-J4(W)-□B)<br>• Serial absolute synchronous encoder (Q171ENC-W8) connected to CN2L connector of a servo amplifier (MR-J4-□B-RJ)[1] (axis 1 to 32)<br>• Rotary servo motor (HG-KR, HG-MR) connected to a servo amplifier (MR-J4(W)-□B) (axis 1 to 32) |
| Via device | | The encoder value is loaded via Motion CPU device.<br>Used to operate a gray code encoder that is connected to the input module as the synchronous encoder axis. |
| Multiple CPU advanced synchronous control[2] | Master CPU servo input axis | Used to operate the servo input axis of the master CPU (axis 1 to axis 64) as the synchronous encoder axis. |
| | Master CPU command generation axis | Used to operate the command generation axis of the master CPU (axis 1 to axis 64) as the synchronous encoder axis. |
| | Master CPU synchronous encoder axis | Used to operate the synchronous encoder axis of the master CPU (axis 1 to axis 12) as the synchronous encoder axis. |
| Via sensing module | | Used to get the position information of the encoder connected to the sensing encoder I/F module (MR-MT2400) for Motion control. |

*1 Use software version "B0" or later for the servo amplifier (MR-J4-□B-RJ) which connects the synchronous encoder.
*2 Can be set when operating as a slave CPU in a Multiple CPU advanced synchronous control configuration. (☞ Multiple CPU Advanced Synchronous Control)

## Control method for synchronous encoder axis

The following controls can be executed for the synchronous encoder axis by using "[Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: M11601+4n)" and "[Cd.321] Synchronous encoder axis control method (R: D42323+16n/Q: D14823+10n)".

| Setting value of "[Cd.321] Synchronous encoder axis control method (R: D42323+16n/Q: D14823+10n)" | Control details |
|---|---|
| 0: Current value change | "[Md.320] Synchronous encoder axis current value (R: D38560+32n, D38561+32n/ Q: D13240+20n, D13241+20n)" and "[Md.321] Synchronous encoder axis current value per cycle (R: D38562+32n, D38563+32n/Q: D13242+20n, D13243+20n)" are changed based on the setting of "[Cd.322] Synchronous encoder axis current value setting address (R: D42324+16n, D42325+16n/ Q: D14824+10n, D14825+10n)". |
| 1: Counter disable | Input from the synchronous encoder is disabled. |
| 2: Counter enable | Input from the synchronous encoder is enabled. |

## Units for the synchronous encoder axis

The position units and speed units for the synchronous encoder axis are shown below for the setting of "[Pr.321] Synchronous encoder axis unit setting".

### ■Synchronous encoder axis position units

| Setting value of "[Pr.321] Synchronous encoder axis unit setting" | | Synchronous encoder axis position unit | Range |
|---|---|---|---|
| Control unit | Number of decimal places for position | | |
| 0:  mm | 0 | mm | -2147483648 to 2147483647[mm] |
| | ⋮ | ⋮ | ⋮ |
| | 9 | $\times 10^{-9}$mm | -2.147483648 to 2.147483647[mm] |
| 1:  inch | 0 | inch | -2147483648 to 2147483647[inch] |
| | ⋮ | ⋮ | ⋮ |
| | 9 | $\times 10^{-9}$inch | -2.147483648 to 2.147483647[inch] |
| 2:  degree | 0 | degree | -2147483648 to 2147483647[degree] |
| | ⋮ | ⋮ | ⋮ |
| | 9 | $\times 10^{-9}$degree | -2.147483648 to 2.147483647[degree] |
| 3:  pulse | 0 | pulse | -2147483648 to 2147483647[pulse] |
| | ⋮ | ⋮ | ⋮ |
| | 9 | $\times 10^{-9}$pulse | -2.147483648 to 2.147483647[pulse] |

### ■Synchronous encoder axis speed units

| Setting value of "[Pr.321] Synchronous encoder axis unit setting" | | | Synchronous encoder axis speed unit | Range |
|---|---|---|---|---|
| Control unit | Speed time unit | Number of decimal places for speed | | |
| 0:  mm | 0:  s | 0 | mm/s | -2147483648 to 2147483647[mm/s] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$mm/s | -2.147483648 to 2.147483647[mm/s] |
| | 1:  min | 0 | mm/min | -2147483648 to 2147483647[mm/min] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$mm/min | -2.147483648 to 2.147483647[mm/min] |
| 1:  inch | 0:  s | 0 | inch/s | -2147483648 to 2147483647[inch/s] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$inch/s | -2.147483648 to 2.147483647[inch/s] |
| | 1:  min | 0 | inch/min | -2147483648 to 2147483647[inch/min] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$inch/min | -2.147483648 to 2.147483647[inch/min] |
| 2:  degree | 0:  s | 0 | degree/s | -2147483648 to 2147483647[degree/s] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$degree/s | -2.147483648 to 2.147483647[degree/s] |
| | 1:  min | 0 | degree/min | -2147483648 to 2147483647[degree/min] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$degree/min | -2.147483648 to 2.147483647[degree/min] |
| 3:  pulse | 0:  s | 0 | pulse/s | -2147483648 to 2147483647[pulse/s] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$pulse/s | -2.147483648 to 2.147483647[pulse/s] |
| | 1:  min | 0 | pulse/min | -2147483648 to 2147483647[pulse/min] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$pulse/min | -2.147483648 to 2.147483647[pulse/min] |

## Data refresh cycle of synchronous encoder axis

The data refresh cycle of the synchronous encoder input travel value is as follows depending on the setting for "[Pr.320] Synchronous encoder axis type".

| [Pr.320] Synchronous encoder axis type | Refresh cycle | Remarks |
|---|---|---|
| Via module | The longer of the operation cycle and inter-module synchronization cycle.[*1] (The operation cycle when inter-module synchronization is not used) | Refer to the following for the setting of inter-module synchronization cycle. ▫MELSEC iQ-R Motion controller Programming Manual (Common) |
| Via servo amplifier | Operation cycle 1.777[ms] or less: Operation cycle[*1*2] Operation cycle 3.555[ms] or more: 3.555[ms][*1] | |
| Via device | Operation cycle | |
| Multiple CPU advanced synchronous control | | |
| Via sensing module | Operation cycle 1.777[ms] or less: Operation cycle Operation cycle 3.555[ms] or more: 3.555[ms][*1] | |

*1 Synchronous encoder axis monitor data is refreshed at the operation cycle.
*2 When a servo amplifier axis with a synchronous encoder connected is controlling at the low speed operation cycle, data is refreshed at the low speed operation cycle.

# Setting method for synchronous encoder

## Via module

### ■Setting method

Used to operate an encoder that is connected to a high-speed counter module, etc. controlled by Motion CPU as the synchronous encoder axis.

By setting "1: Via module" in "[Pr.320] Synchronous encoder axis type", and setting "[Pr.331] I/O number" and "[Pr.332] Channel number" of a module, the encoder value is acquired via the module controlled by the Motion CPU and controls the synchronous encoder axis.

The encoder value can be used as a cycle counter within the range from 0 to (Resolution of synchronous encoder via module/device - 1).

Connect the synchronous encoder to the I/O number, channel number assigned to high-speed counter module set in GX Works3.

When the synchronous encoder axis connection is valid after Multiple CPU system's power supply ON, "Synchronous encoder axis current value", "Synchronous encoder axis current value per cycle" and "Counter enabling status" will be as follows.

| Connection method | [Md.320] Synchronous encoder axis current value (R: D38560+32n, D38561+32n/Q: D13240+20n, D13241+20n) | [Md.321] Synchronous encoder axis current value per cycle (R: D38562+32n, D38563+32n/Q: D13242+20n, D13243+20n) | Counter enable/ Counter disable |
|---|---|---|---|
| High-speed counter module | 0 | 0 | Counter enable |

### ■Setting of high-speed counter module

Set the high-speed counter module which connects the synchronous encoder as follows.
- Setting of GX Works3

    Set the self Motion CPU as the control CPU in control CPU setting.

☞ [System Parameter] ⇨ [I/O Assignment Setting] ⇨ "Control CPU Setting"
- Setting of MT Developer2

    Set the following in the detailed settings of the module.

☞ [R Series Common Parameter] ⇨ [Module Configuration List] ⇨ "Setting item" ⇨ "Detailed" button

| Setting item | Details |
|---|---|
| Counter type | Set to "Ring counter". |
| Counter operation mode | Set to "Pulses counter mode". |

If a fault is detected when the above setting is checked during initialization of a Motion CPU, a moderate error (error code: 30D1H) is output and the Motion CPU does not run.

> **Point**
>
> Enabling the inter-module synchronization function for a high-speed counter module will reduce fluctuation of the input speed.

## ■Setting example

The following shows an example for setting an incremental synchronous encoder via a high-speed counter module (I/O number: 0040, channel number:1) as synchronous encoder axis 2.
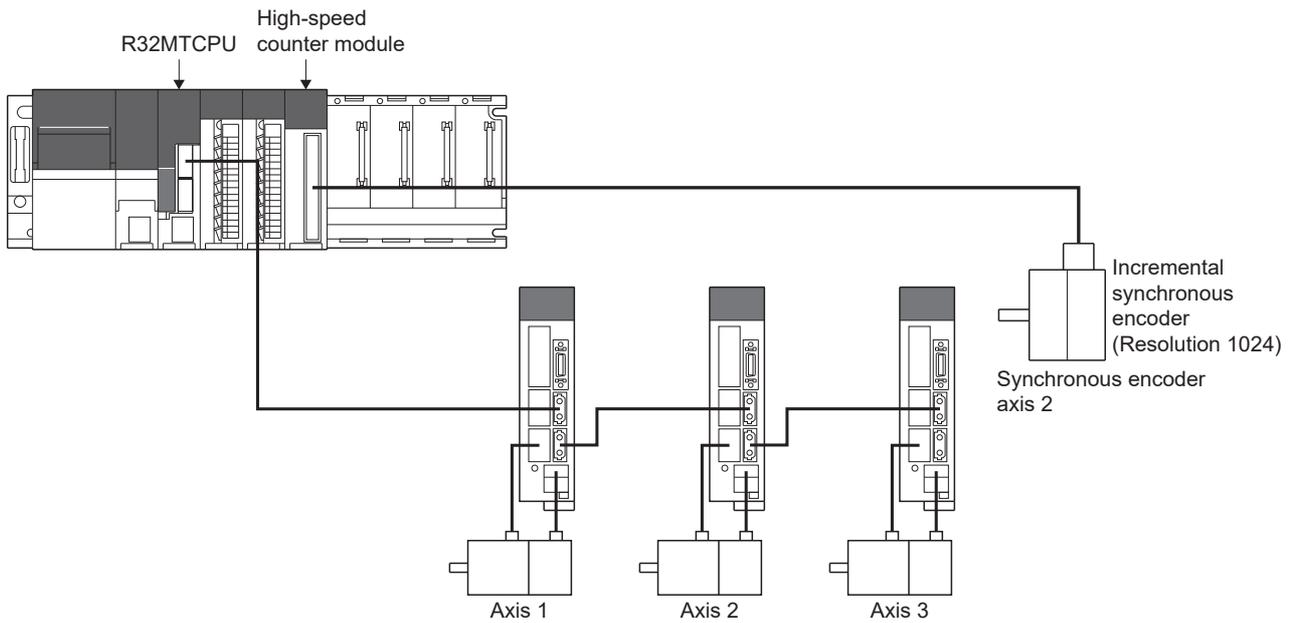


Set the following in Synchronous encoder axis settings for synchronous encoder axis 2 on the synchronous encoder axis parameter screen.

| Setting item | Setting value |
|---|---|
| [Pr.320] Synchronous encoder axis type | 1: Via Module |
| [Pr.331] I/O number | H0040 |
| [Pr.332] Channel number | 1 |

☜ [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Input Axis Parameter] ⇨ [Synchronous Encoder Axis Parameter]

Window
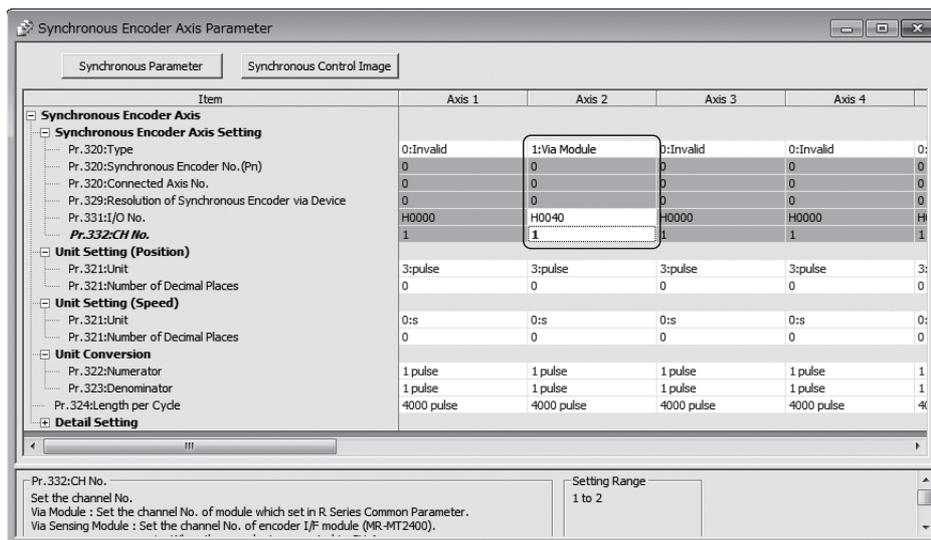
# Via servo amplifier

## ■Setting method

The device connected to the servo amplifier is used as the synchronous encoder axis.

The following shows a list of devices that can be connected as a synchronous encoder axis depending on the type of servo amplifier used.

| Servo amplifier model | Devices |
|---|---|
| MR-J5-□B | • Rotary servo motor (HK-KT)<br>• Absolute/incremental scale |
| MR-J5W-□B | |
| MR-J5-□B-RJ | |
| MR-J4-□B | • Rotary servo motor (HG-KR, HG-MR)<br>• Absolute/incremental scale |
| MR-J4W-□B | |
| MR-J4-□B-RJ | • Serial absolute synchronous encoder (Q171ENC-W8) connected to CN2L<br>• Rotary servo motor (HG-KR, HG-MR)<br>• Absolute/incremental scale |

Setting "101: Via servo amplifier" in "[Pr.320] Synchronous encoder axis type" and "ABS" or "INC" in the "External synchronous encoder input" of amplifier setting enables the serial absolute synchronous encoder connected to the specified servo amplifier axis to be used.

When a servo amplifier axis with a serial absolute synchronous encoder or ABS scale installed is connected, the synchronous encoder axis connection becomes valid. The synchronous encoder axis current value and the synchronous encoder axis current value per cycle are restored, and the synchronous encoder axis connection is on the counter enabling status. When a servo amplifier axis with an incremental scale installed is connected, the synchronous encoder axis connection becomes valid. "0" is set to the initial value of the synchronous encoder axis current value and the synchronous encoder axis current value per cycle, and the synchronous encoder axis connection is on the counter enabling status. When the applicable servo amplifier axis is not connected, the synchronous encoder axis connection is invalid.

For servo amplifiers performing "Via servo amplifier", use the software version that supports each encoder connected. The software version that supports each encoder is shown in the table below.

—: There is no restriction by the version.

| Servo amplifier model | Software version |
|---|---|
| MR-J5-□B | — |
| MR-J5-□B-RJ | |
| MR-J5W-□B | |
| MR-J4-□B | B0 or later |
| MR-J4-□B-RJ | |
| MR-J4W-□B | |

**Point**

- Servo amplifiers with "ABS" or "INC" set to "External synchronous encoder input" of amplifier setting, have servo parameter "Scale measurement function selection[*1]" set. (When servo parameter "Scale measurement function selection[*1]" has been changed, after transmitting parameter to the servo amplifier, the power supply of the servo amplifier must be turned OFF once, and turned ON again.)
- When a servo amplifier with servo parameter "Scale measurement function selection[*1]" set does not support "Scale measurement function", AL.37 (parameter error) occurs in the servo amplifier.
- When the battery of the servo amplifier is disconnected, the serial absolute synchronous encoder (Q171ENC-W8) can be used as an incremental system (INC) by setting "External synchronous encoder input" of amplifier setting to "INC".
- When using the scale measurement function with MR-J5(W)-□B, the Motion CPU internal processing converts the synchronous encoder travel distance so that an encoder resolution of 67108864[pulse/rev] becomes a resolution of 4194304[pulse/rev].
  Therefore, "[Pr.322] Synchronous encoder axis unit conversion: Numerator" and "[Pr.323] Synchronous encoder axis unit conversion: Denominator" should be set assuming the encoder resolution is 4194304[pulse/rev].
- *1: The "Scale measurement function selection" servo parameter in the following servo parameters depending on the servo amplifier used.
  · MR-J5(W)-□B: Servo parameter (PA22.3)
  · MR-J4(W)-□B: Servo parameter (PA22)
  Refer to the following for details of servo parameters.
  📖Servo amplifier Instruction Manual

## ■Setting example

The following shows an example for setting a serial absolute synchronous encoder (Q171ENC-W8) via servo amplifier (MR-J4-□B-RJ, axis 3) as synchronous encoder axis 2.
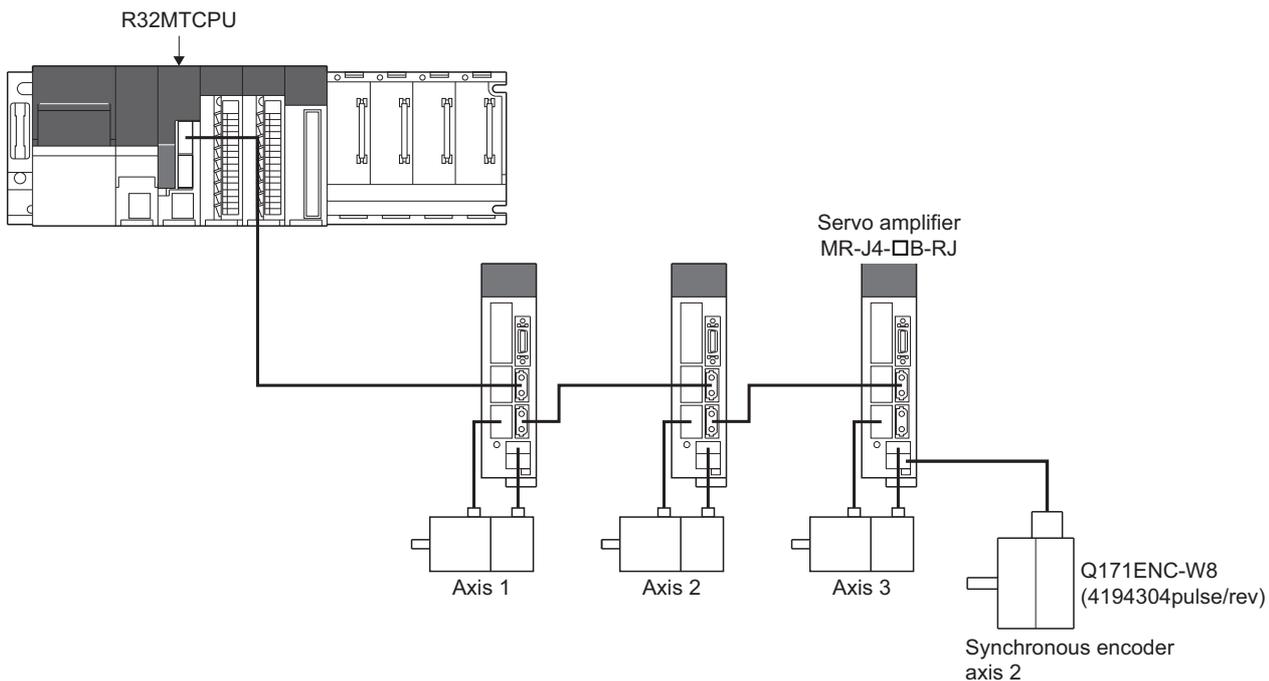


- Set the following in amplifier setting.

| Setting item | Setting value |
|---|---|
| Amplifier model | MR-J4(W)-B(-RJ) |
| Amplifier Operation Mode | Standard |
| External Synchronous Encoder Input | ABS |

☞ [Motion CPU Common Parameter] ⇨ [Servo Network Setting] ⇨ "Amplifier Setting"

## Window
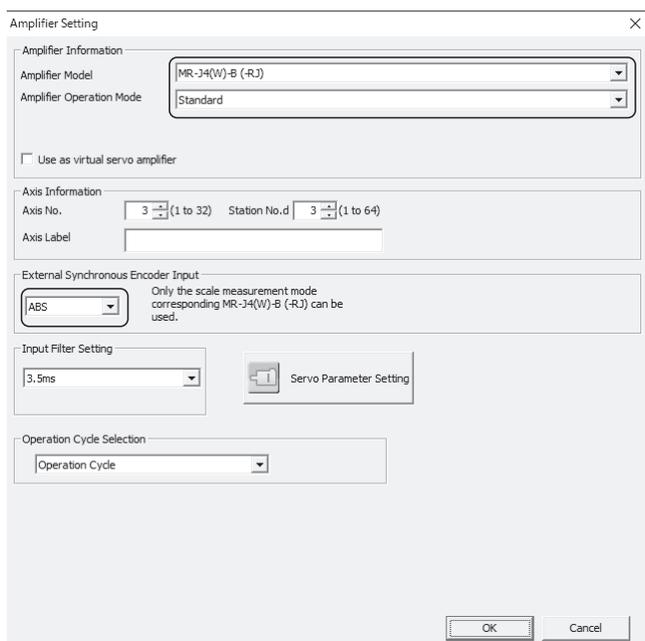
- Set the following in synchronous encoder axis setting for the synchronous encoder axis 1 on the synchronous encoder axis parameter screen.

| Setting item | Setting value |
| --- | --- |
| [Pr.320] Synchronous encoder axis type | 101: Via Servo Amplifier |
| Connected axis No. | 3 |

&#9758; [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Input Axis Parameter] ⇨ [Synchronous Encoder Axis Parameter]

## Window
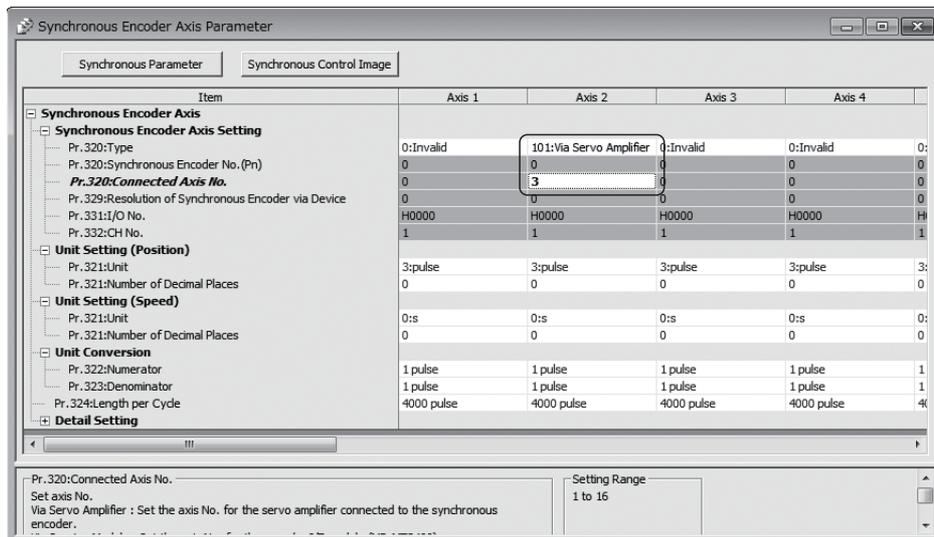


- Set servo parameter "Function selection C-8 (PC26) (Load-side encoder communication method)" of servo amplifier 3 to "1: Four-wire type".

**Point**

- Set the axis No. (1 to 64) set in the amplifier setting for connected axis No.
- Turn ON the Multiple CPU system's and servo amplifier's power supply again to validate the set parameter settings in the servo amplifier.
- Refer to the following when connecting an encoder other than a serial absolute synchronous encoder (Q171ENC-W8).
  📖 Servo amplifier Instruction Manual

# ■Restrictions

- When optional data monitor is set to a servo amplifier axis selected as "101: Via servo amplifier" by "[Pr.320] Synchronous encoder axis type", set the number of communication data points so that the total comes to 2 points or less per axis.
- When servo error (AL.25, AL.70, AL.71, AL.72) occurs in a servo amplifier axis selected as "101: Via servo amplifier" by "[Pr.320] Synchronous encoder axis type", the servo amplifier axis is in a servo OFF state.
- The following cases are minor errors (error code: 1BAAH)
    - When the servo amplifier axis selected as "101: Via servo amplifier" by "[Pr.320] Synchronous encoder axis type" does not support synchronous encoder via servo amplifier.
    - When a servo amplifier axis which has not been set by amplifier setting is set as the connected axis No. for the synchronous encoder via servo amplifier.
    - When a servo amplifier axis which has "External synchronous encoder input" set to "Invalid" in the amplifier setting is set as the connected axis No. for the synchronous encoder via servo amplifier.
- When an incremental scale is connected to a servo amplifier which has "External synchronous encoder input" set to "ABS", a servo error (AL.37) occurs, and the connected scale cannot be used as a synchronous encoder.
- When "Amplifier operation mode" is set to "Fully closed" for a servo amplifier axis that has "External synchronous encoder input" set to "ABS", or "INC", a servo error (AL.37) occurs.
- When the control cycle for a servo amplifier axis set as "101: Via servo amplifier" by "[Pr.320] Synchronous encoder axis type" is a low speed operation cycle of 1.777[ms] or less, data of the synchronous encoder is refreshed at low speed operation cycle intervals. To refresh data at every operation cycle, connect the synchronous encoder to a servo amplifier axis that is controlling at the operation cycle.

**4**

# Via device (Synchronous encoder value input of via device)

## ■Setting method

Used to operate a gray code encoder that is connected to the input module of the Motion CPU control as a synchronous encoder axis.

By setting "201: Via device" in "[Pr.320] Synchronous encoder axis type", the synchronous encoder is controlled by the encoder value which is the input value of "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)".

The encoder value can be used as a cycle counter within the range from 0 to (Resolution of synchronous encoder via device - 1).

Connection is invalid just after the system's power supply is ON. When the "[Rq.324] Connection command of synchronous encoder via device/master CPU (R: M42242+8n/Q: M11602+4n)" turns ON, the synchronous encoder axis current value and the synchronous encoder axis current value per cycle are restored based on "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)". Therefore, connection becomes valid, and will be on the counter enabling status.

The synchronous encoder axis is controlled based on the amount of change of "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" while it is connecting.

## ■Setting example

The following shows an example for setting a synchronous encoder via device as synchronous encoder axis 4.
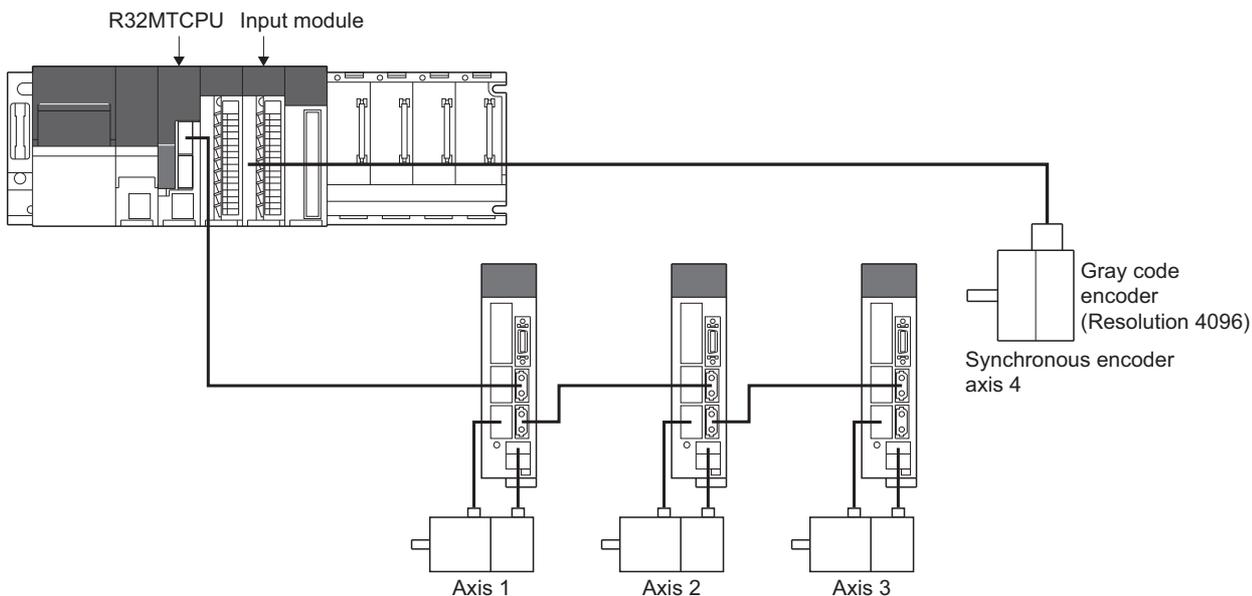


Set the following in Synchronous encoder axis setting Resolution of synchronous encoder via device of synchronous encoder axis 4 on the synchronous encoder axis parameter screen of MT Developer2.

| Setting item | Setting value |
|---|---|
| [Pr.320] Synchronous encoder axis type | 201: Via Device |
| [Pr.329] Resolution of synchronous encoder via device | 4096 |

Read the encoder value of the gray code encoder with a sequence program, and update "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" of the synchronous encoder axis 4 at every time.

    [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Input Axis Parameter] ⇨ [Synchronous Encoder Axis Parameter]

### Window
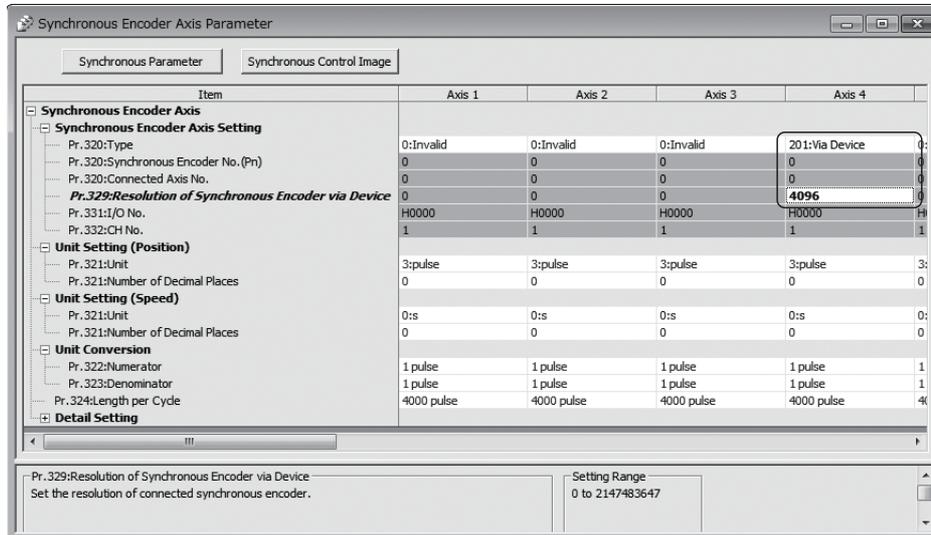


### ■Restrictions

The synchronous encoder current value that is restored for the synchronous encoder connection gets restored into a converted value from the following range based on the synchronous encoder travel value on disconnection.

| Setting value of "[Pr.329] Resolution of synchronous encoder via device" | Range of restored synchronous encoder current value |
|---|---|
| 1 or more | - (Resolution of synchronous encoder via device ÷ 2) to + (Resolution of synchronous encoder via device ÷ 2 - 1)[pulse]<br>*: If the resolution of a synchronous encoder via device is an odd number, round down a negative value after the decimal point, round up a positive value after decimal point. |
| 0 | -2147483648 to 2147483647[pulse] |

## Multiple CPU advanced synchronous control

Used to operate the servo input axis, command generation axis, and synchronous encoder axis of the master CPU as the synchronous encoder axis.

By setting the input axis type of the master CPU in "[Pr.320] Synchronous encoder axis type" to the following, the change from the master CPU is used as the input value for operating the synchronous encoder axis.

Refer to selection of slave CPU input axis type for details on the setting method. ()

| Input axis of the master CPU | Setting value |
|---|---|
| Master CPU servo input axis | 301: Master CPU servo input axis |
| Master CPU command generation axis | 401: Master CPU command generation axis |
| Master CPU synchronous encoder axis | 501: Master CPU synchronous encoder axis |

## Via sensing module

### ■Setting method

The encoder that is connected to the sensing encoder I/F module (MR-MT2400) is used as a synchronous encoder axis. By setting "601: Via sensing module" in "[Pr.320] Synchronous encoder axis type", and setting the channel No. (CH.A is "1", CH.B is "2") of the connector (CN1/CN2) for encoder signal input where the encoder is connected, in "[Pr.332] Channel number", the position information of the encoder is obtained via the sensing encoder I/F module and controls the synchronous encoder axis.

When a sensing encoder I/F module with an incremental scale encoder installed is connected, the synchronous encoder axis connection becomes valid, the initial values of synchronous encoder axis current value and synchronous encoder axis current value per cycle are set to "0", and the axis is in a counter enabling status.

Refer to the following for details on the encoder communication I/F that can be connected to the sensing encoder I/F module.
📖Sensing Module Instruction Manual

> **Point**
>
> • Set the encoder communication I/F for connecting to the sensing encoder I/F module in the "Encoder protocol selection (CH.A/CH.B common setting)(PTE001)" servo parameter. After setting "Encoder protocol selection (CH.A/CH.B common setting)(PTE001)", set the required parameters according to the connected encoder communication I/F. Refer to the following for details of servo parameters.
> 📖Sensing Module Instruction Manual
> • A battery cannot be connected to the sensing encoder I/F module for the purpose of retaining the absolute position data of the servo amplifier. For this reason, even when an absolute scale encoder is connected, the Motion CPU operates in the same way as if an incremental scale encoder were connected.

### ■Setting example

The following shows an example for setting a synchronous encoder via the sensing encoder I/F module (MR-MT2400, RIO axis 603, channel No. 1), as synchronous encoder axis 1.
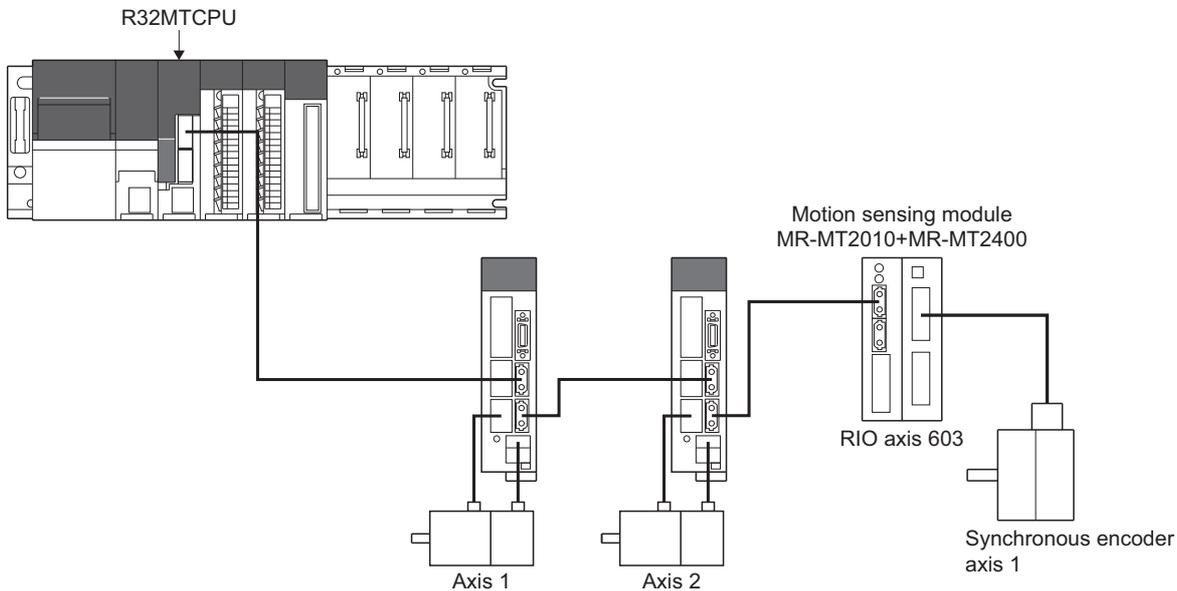
• Set the following in amplifier setting

| Setting item | Setting value |
|---|---|
| Amplifier model | MR-MT2010 |
| RIO axis No. | 603 |
| Operation mode | Station occupying mode |
| Number of connected expansion modules | 1 |
| Extension module setting information | MR-MT2400 |

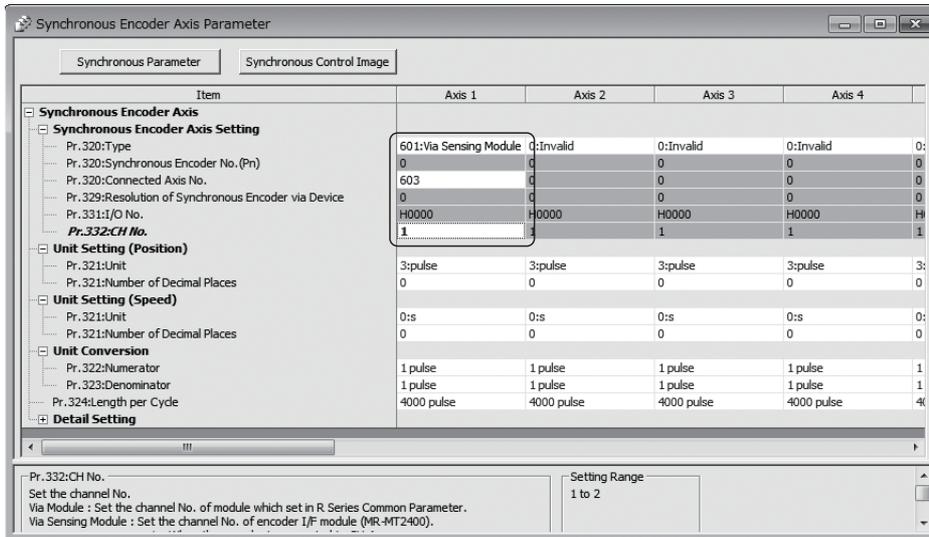[Motion CPU Common Parameter] ⇨ [Servo Network Setting] ⇨ "Amplifier Setting"

## Window
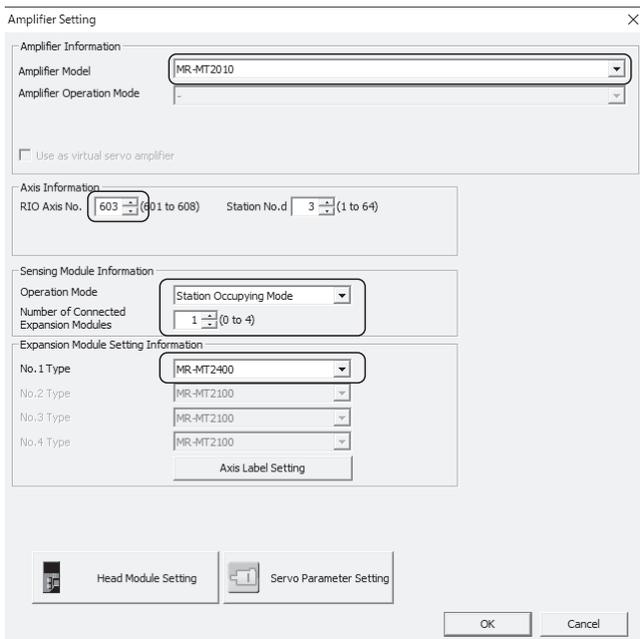


• Set the following synchronous encoder axis settings for the synchronous encoder axis 1 in the synchronous encoder axis parameter screen of MT Developer2.

| Setting item | Setting value |
|---|---|
| [Pr.320] Synchronous encoder axis type | 601: Via sensing module |
| Connected axis No. | 603 |
| [Pr.332] Channel Number | 1 |

☞ [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Input Axis Parameter] ⇨ [Synchronous Encoder Axis Parameter]

## Window

| Synchronous Encoder Axis Parameter | | | | | |
|---|---|---|---|---|---|
| Synchronous Parameter    Synchronous Control Image | | | | | |
| Item | Axis 1 | Axis 2 | Axis 3 | Axis 4 | |
| ⊟ **Synchronous Encoder Axis** | | | | | |
| ⊟ Synchronous Encoder Axis Setting | | | | | |
| Pr.320:Type | 601:Via Sensing Module | 0:Invalid | 0:Invalid | 0:Invalid | 0: |
| Pr.320:Synchronous Encoder No.(Pn) | 0 | 0 | 0 | 0 | 0 |
| Pr.320:Connected Axis No. | 603 | 0 | 0 | 0 | 0 |
| Pr.329:Resolution of Synchronous Encoder via Device | 0 | 0 | 0 | 0 | 0 |
| Pr.331:I/O No. | H0000 | H0000 | H0000 | H0000 | H |
| *Pr.332:CH No.* | 1 | 1 | 1 | 1 | 1 |
| ⊟ **Unit Setting (Position)** | | | | | |
| Pr.321:Unit | 3:pulse | 3:pulse | 3:pulse | 3:pulse | 3: |
| Pr.321:Number of Decimal Places | 0 | 0 | 0 | 0 | 0 |
| ⊟ **Unit Setting (Speed)** | | | | | |
| Pr.321:Unit | 0:s | 0:s | 0:s | 0:s | 0: |
| Pr.321:Number of Decimal Places | 0 | 0 | 0 | 0 | 0 |
| ⊟ **Unit Conversion** | | | | | |
| Pr.322:Numerator | 1 pulse | 1 pulse | 1 pulse | 1 pulse | 1 |
| Pr.323:Denominator | 1 pulse | 1 pulse | 1 pulse | 1 pulse | 1 |
| Pr.324:Length per Cycle | 4000 pulse | 4000 pulse | 4000 pulse | 4000 pulse | 40 |
| ⊞ **Detail Setting** | | | | | |

Pr.332:CH No.
Set the channel No.
Via Module : Set the channel No. of module which set in R Series Common Parameter.
Via Sensing Module : Set the channel No. of encoder I/F module (MR-MT2400).

Setting Range
1 to 2

- Set the servo parameters of RIO axis 603 to connect the sensing encoder I/F module and synchronous encoder. Set the servo parameters while referring to the manual of the sensing module. Refer to the following for details.
  📖 Sensing Module Instruction Manual

*Point*
- Set the RIO axis No. (601 to 608) set in the amplifier setting for connected axis No.
- Turn ON the Multiple CPU system power supply and the sensing module control circuit power supply again to validate the set parameter settings in the sensing module.
- When using a SSI serial communication compatible encoder, the data update cycle differs according to the servo parameter settings. When "Motion operation cycle < data update cycle", data is not updated every operation cycle. Set the operation cycle in [Motion CPU Common Parameter] ⇨ [Basic Setting] ⇨ "Operation Cycle", or change the data update cycle so that "Motion operation cycle ≥ data update cycle". Refer to the following for details of data update cycle.
  📖 Sensing Module Instruction Manual

## ■Restrictions
- In the following cases, a moderate error (error code: 30D1H) occurs.
  - When the sensing extension module set to connected axis No. of the synchronous encoder via sensing module is not a sensing encoder I/F module.
  - When the channel No. set to "[Pr.332] Channel number" of the synchronous encoder via sensing module is set to "0: Disable (not use)" in servo parameter "Encoder I/F input - CH. A function selection(PTE009)(Encoder I/F - CH.A valid/invalid selection)", or "Encoder I/F input - CH. B function selection(PTE065)(Encoder I/F - CH.B valid/invalid selection)".
- In the following cases a servo error (AL.16, AL.70) occurs.
  - When the encoder set to servo parameter "Encoder protocol selection (CH.A/CH.B common setting)(PTE001)(Encoder protocol selection)", and the encoder connected to the sensing encoder I/F module are different.
  - When a different encoder communication I/F is used for CH.A and CH.B in the encoder signal input connector (CN1/CN2).
  - When an encoder communication I/F that is not compatible is connected to the encoder signal input connector (CN1/CN2).
  - When the Motion CPU is connected while the sensing encoder I/F module and encoder are not connected.
- Encoder signal input connectors CN1 and CN2 of a sensing encoder I/F module can not be used simultaneously. Use one or the other.
- When using both CH.A and CH.B, if an error occurs in one channel, the operation of the other channel also stops.
- The following SSI serial communication compatible encoders may input an unintended input pulse from the synchronous encoder and therefore should not be set as synchronous encoder axes.
  - When "0: No conversion" has been set to servo parameters "CH. A function setting 1 at SSI selection (PTE037)(Code conversion function setting)" and "CH. B function setting 1 at SSI selection (PTE093)(Code conversion function setting)" .
  - A multi-turn encoder without a 2n resolution per revolution.

# Synchronous encoder axis parameters

| Symbol | Setting item | Setting details | Setting value | Setting value | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Pr.320 | Synchronous encoder axis type | • Set the synchronous encoder axis type to be used.<br>• When using as a slave CPU in Multiple CPU advanced synchronous control, set the input axis of the master CPU. | 0: Invalid<br>1: Via module<br>101: Via servo amplifier (Connected axis No.: 1 to 64)<br>201: Via device<br>301: Master CPU servo input axis (axis No.: 1 to 64)<br>401: Master CPU command generation axis (axis No.: 1 to 64)<br>501: Master CPU synchronous encoder axis (axis No.: 1 to 12 )<br>601: Via sensing module (connected axis No.: 601 to 608) | At power supply ON | 0 | — | |
| Pr.321 | Synchronous encoder axis unit setting | • Set the unit of the synchronous encoder axis.<br>• Set the position unit within the range from ×1 to $10^{-9}$ [control unit]<br>• Set the speed unit within the range from ×1 to $10^{-9}$ [control unit/s or control unit/min]. | Control unit<br>0: mm<br>1: inch<br>2: degree<br>3: pulse | | 3 | — | |
| | | | Number of decimal places<br>0 to 9 | | 0 | | |
| | | | Speed time unit<br>0: s<br>1: min | | 0 | | |
| | | | Number of decimal places for speed<br>0 to 9 | | 0 | | |
| Pr.322 | Synchronous encoder axis unit conversion: Numerator | Set the numerator to convert the unit from the encoder pulse of the synchronous encoder axis into the synchronous encoder axis unit. | -2147483648 to 2147483647 [Synchronous encoder axis position units][1] | | 1 | — | |
| Pr.323 | Synchronous encoder axis unit conversion: Denominator | Set the denominator to convert the unit from the encoder pulse of the synchronous encoder axis into the synchronous encoder axis unit. | 1 to 2147483647[pulse] | | 1[pulse] | — | |
| Pr.324 | Synchronous encoder axis length per cycle | Set the length per cycle of the synchronous encoder axis. | 1 to 2147483647 [Synchronous encoder axis position units][1] | | 4000 | — | |
| Pr.325 | Synchronous encoder axis smoothing time constant | Set the time to smooth for the input value. | 0 to 5000[ms] | | 0[ms] | — | |
| Pr.326 | Synchronous encoder axis phase compensation advance time | Set the time to advance or delay the phase. | -2147483648 to 2147483647[µs] | Operation cycle | 0[µs] | D42320+16n D42321+16n | D14820+10n D14821+10n |

| Symbol | Setting item | Setting details | Setting value | Setting value | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Pr.327 | Synchronous encoder axis phase compensation time constant | Set the time constant to affect the phase compensation. | 0 to 65535[ms] | At power supply ON | 10[ms] | — | |
| Pr.328 | Synchronous encoder axis rotation direction restriction | Set this parameter to restrict the input travel value to one direction. | 0: Without rotation direction restriction<br>1: Enable only for current value increase direction<br>2: Enable only for current value decrease direction | | 0 | — | |
| Pr.329 | Resolution of synchronous encoder via device | • Set the resolution of the synchronous encoder when the synchronous encoder axis type is set to via device.<br>• If 0 is set, the input value of synchronous encoder via device is processed as 32-bit counter. | 0 to 2147483647[pulse] | | 0[pulse] | — | |
| Pr.331 | I/I/O number | Set the I/O number of the module that is assigned to the high-speed counter module when "Via module" is set in the synchronous encoder axis type. | • Set in hexadecimal.<br>H0000 to H0FF0<br>*: Set in multiples of 16. | | 0000H | — | |
| Pr.332 | Channel number | • Set the channel number of the module that is assigned to the high-speed counter module when "Via module" is set in the synchronous encoder axis type.<br>• Set the channel number of the encoder signal input connector (CN1, CN2) to which the encoder is connected when "Via sensing module" is set in the synchronous encoder axis type. | 1 to 2 | | 1 | — | |

*1 Synchronous encoder axis position units (🖝 Page 55 Synchronous encoder axis position units)

## [Pr.320] Synchronous encoder axis type

Set the type of synchronous encoder that will be the source for generating the input value for the synchronous encoder axis.
When operating as a slave CPU in a Multiple CPU advanced synchronous control configuration, set the input axis of the master CPU.

| Setting value | Description |
|---|---|
| 0: Invalid | Synchronous encoder axis is invalid. |
| 1: Via module | Generate the input value based on the synchronous encoder input via module connected to the specified module. |
| 101: Via servo amplifier | Generate the input value based on the synchronous encoder via servo amplifier input connected to the specified servo amplifier (axis 1 to 64). |
| 201: Via device | Generate the input value with the value set in the "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" as the encoder value. |
| 301: Master CPU servo input axis[1] | Generate the input value based on the change of the master CPU servo input axis (axis 1 to 64). |
| 401: Master CPU command generation axis[1] | Generate the input value based on the change of the master CPU command generation axis (axis 1 to 64). |
| 501: Master CPU synchronous encoder axis[1] | Generate the input value based on the change of the synchronous encoder axis (axis 1 to 12). |
| 601: Via sensing module | Generate the input value based on the input of the encoder connected to the specified sensing encoder I/F module (RIO axis 601 to 608). |

*1  Can be set when "Slave CPU" is selected in Multiple CPU advanced synchronous control CPU setting.

## [Pr.321] Synchronous encoder axis unit setting

Set the position and speed unit of the synchronous encoder axis. (☞ Page 55 Units for the synchronous encoder axis)

## [Pr.322] Synchronous encoder axis unit conversion: Numerator

The input travel value of synchronous encoder is configured in encoder pulse units.
The units can be arbitrarily converted through unit conversation with setting "[Pr.322] Synchronous encoder axis unit conversion: Numerator".
Set "[Pr.322] Synchronous encoder axis unit conversion: Numerator" according to the controlled machine.

$$\text{Synchronous encoder axis travel value (Travel value after unit conversion)} = \text{Synchronous encoder input travel value (Encoder pulse units)} \times \frac{\text{[Pr.322] Synchronous encoder axis unit conversion: Numerator}}{\text{[Pr.323] Synchronous encoder axis unit conversion: Denominator}}$$

The travel value in pulses set in "[Pr.323] Synchronous encoder axis unit conversion: Denominator" is set in "[Pr.322] Synchronous encoder axis unit conversion: Numerator" in synchronous encoder axis position units. (☞ Page 55 Synchronous encoder axis position units)
The input travel value can be reversed by the setting negative values.

## [Pr.323] Synchronous encoder axis unit conversion: Denominator

The input travel value of synchronous encoder is configured in encoder pulse units.
The units can be arbitrarily converted through unit conversation with setting "[Pr.323] Synchronous encoder axis unit conversion: Denominator".
Set "[Pr.323] Synchronous encoder axis unit conversion: Denominator" according to the controlled machine.

$$\text{Synchronous encoder axis travel value (Travel value after unit conversion)} = \text{Synchronous encoder input travel value (Encoder pulse units)} \times \frac{\text{[Pr.322] Synchronous encoder axis unit conversion: Numerator}}{\text{[Pr.323] Synchronous encoder axis unit conversion: Denominator}}$$

Set "[Pr.323] Synchronous encoder axis unit conversion: Denominator" based on encoder pulse units from the synchronous encoder.
Set a value within the range from 1 to 2147483647.

# [Pr.324] Synchronous encoder axis length per cycle

Set the length per cycle for the synchronous encoder axis current value per cycle.

The current value of synchronous encoder axis is stored in "[Md.321] Synchronous encoder axis current value per cycle (R: D38562+32n, D38563+32n/Q: D13242+20n, D13243+20n)" at ring counter based on the setting value.

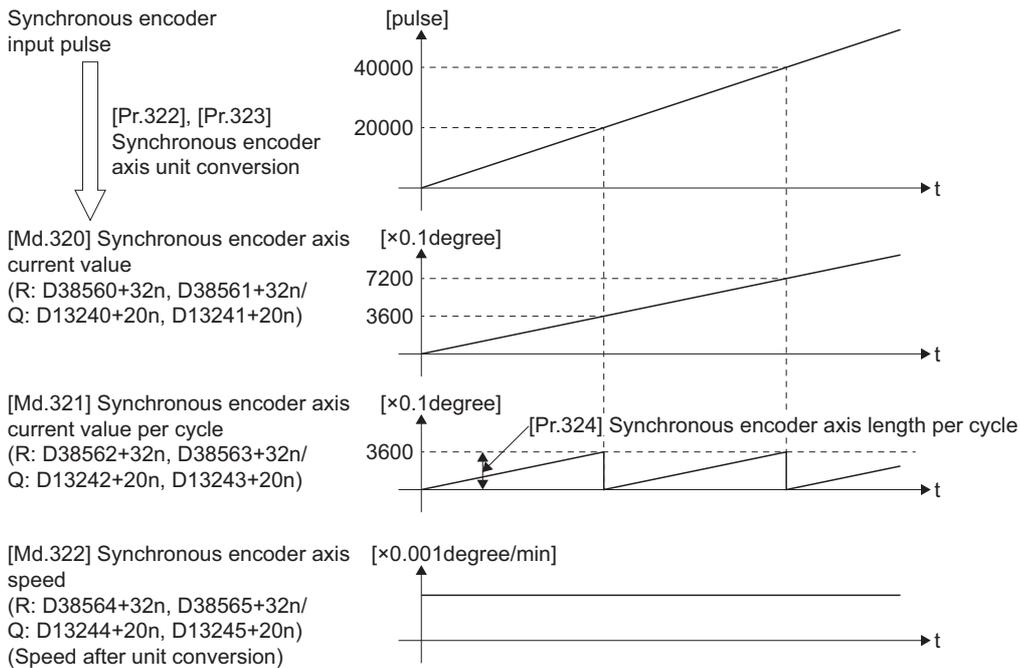The unit settings are in synchronous encoder axis position units. (☞ Page 55 Synchronous encoder axis position units)

Set a value within the range from 1 to 2147483647.

## ■Setting example of the unit conversion and the length per cycle

The following shows an example a rotary encoder is connected which resolution is 4000[pulse/rev] to the motor axis side on the rotation table that drives by 1/5 pulley system, and the control unit is degree.

- Position unit: 0.1[degree]
- Speed unit: 0.001[degree/min]
- Length per cycle: 360.0[degree] (1 cycle of the rotation table)

| Setting item | | Setting details | Setting value |
|---|---|---|---|
| [Pr.321] Synchronous encoder axis unit setting | Control unit | 2: degree | 3112H |
| | Number of decimal places for position | 1 | |
| | Speed time unit | 1: min | |
| | Number of decimal places for speed | 3 | |
| [Pr.322] Synchronous encoder axis unit conversion: Numerator | | 360.0 [degree]×1 | 3600 [×0.1degree] |
| [Pr.323] Synchronous encoder axis unit conversion: Denominator | | 4000 [pulse]×5 | 20000 [pulse] |
| [Pr.324] Synchronous encoder axis length per cycle | | 360.0 [degree] | 3600 [×0.1degree] |

Synchronous encoder input pulse

[Pr.322], [Pr.323] Synchronous encoder axis unit conversion

[Md.320] Synchronous encoder axis current value
(R: D38560+32n, D38561+32n/
Q: D13240+20n, D13241+20n)

[Md.321] Synchronous encoder axis current value per cycle
(R: D38562+32n, D38563+32n/
Q: D13242+20n, D13243+20n)

[Pr.324] Synchronous encoder axis length per cycle

[Md.322] Synchronous encoder axis speed
(R: D38564+32n, D38565+32n/
Q: D13244+20n, D13245+20n)
(Speed after unit conversion)

## [Pr.325] Synchronous encoder axis smoothing time constant

Set the averaging time to execute a smoothing process for the input travel value from synchronous encoder. The smoothing process can moderate speed fluctuation of the synchronous encoder input. The input response is delayed depending on the time corresponding to the setting by smoothing process setting.
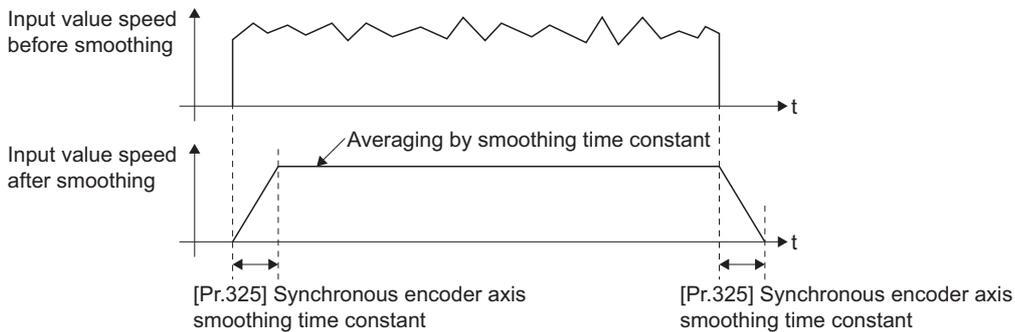


## [Pr.326] Synchronous encoder axis phase compensation advance time (R: D42320L+16n/Q: D14820L+10n)

Set the time to advance or delay the phase (input response) of the synchronous encoder axis. Refer to delay time peculiar to the system for a synchronous encoder axis for the peculiar time delay of the system using the synchronous encoder axis.

(☞ Page 167 Delay time peculiar to the system for a synchronous encoder axis)

| Setting value | Description |
| --- | --- |
| 1 to 2147483647 [μs] | Advance the phase (input response) according to the setting time. |
| 0 [μs] | Do not execute phase compensation. |
| -2147483648 to -1 [μs] | Delay the phase (input response) according to the setting time. |

If the setting time is too long, the system experiences overshoot or undershoot at acceleration/deceleration of the input speed. In this case, set a longer time to affect the phase compensation amount in "[Pr.327] Synchronous encoder axis phase compensation time constant".

## [Pr.327] Synchronous encoder axis phase compensation time constant

Set the time constant to affect the phase compensation amount for the first order delay.

63[%] of the phase compensation amount are reflected in the time constant setting.
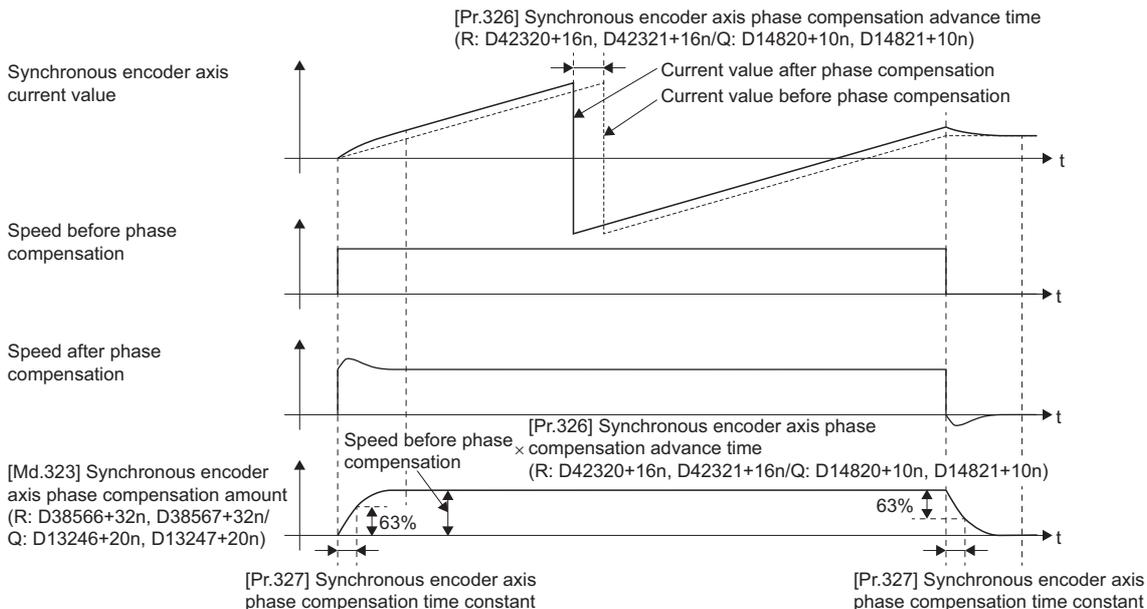
## [Pr.328] Synchronous encoder axis rotation direction restriction

Set this parameter to restrict the input travel value for the synchronous encoder axis to one direction. This helps to avoid reverse operation caused by machine vibration, etc. when "Real current value" or "Feedback value" is used as input values.

| Setting value | Description |
|---|---|
| 0: Without rotation direction restriction | Rotation direction restriction is not executed. |
| 1: Enable only for current value increase direction | Enable only the input travel value in the increasing direction of the synchronous encoder axis current value. |
| 2: Enable only for current value decrease direction | Enable only the input travel value in the decreasing direction of the synchronous encoder axis current value. |

The input travel value in the opposite direction of the enable direction accumulates as a rotation direction restricted amount, and it will be reflected when the input travel value moves in the enabled direction again. Therefore, the current value of synchronous encoder axis does not deviate when the reverse operation is repeated.

The rotation direction restricted amount is set to 0 at the synchronous encoder axis connection and current value change.

For "1: Enable only for current value increase direction" is set in "[Pr.328] Synchronous encoder axis rotation direction restriction"

Speed before rotation direction restriction
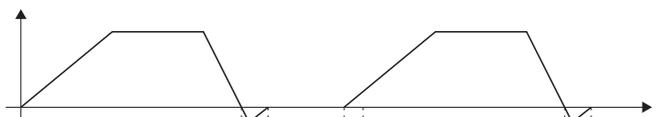
[Md.322] Synchronous encoder axis speed (R: D38564+32n, D38565+32n/ Q: D13244+10n, D13245+10n) (Speed after rotation direction restriction)

[Md.323] Synchronous encoder axis rotation direction restriction amount (R: D38568+32n, D38569+32n/ Q: D13248+20n, D13249+20n)
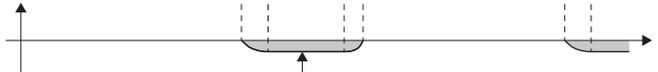


The input travel value is accumulated as a rotation direction restricted amount, and will be reflected when the input travel value moves in the enable direction.

## [Pr.329] Resolution of synchronous encoder via device

Set the resolution of connected synchronous encoder when "201: Via device" is set in "[Pr.320] Synchronous encoder axis type".

If 1 or more is set, "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" is processed as the cycle counter within the range from 0 to (resolution of synchronous encoder via device-1).

If 0 is set, "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" is processed as 32 bit counter within the range from -2147483648 to 2147483647.

**Point**

When 1 or more is set to "[Pr.329] Resolution of synchronous encoder via device", set the cycle counter within the range from "0 to (resolution of synchronous encoder via device-1)" to "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)" as the input value.

## [Pr.331] I/O number

Set the I/O number of the module that is assigned to the high-speed counter module when "1: Via module" is set in "[Pr.320] Synchronous encoder axis type".

Set a value within the range from "H0000 to H0FF0" in multiples of 16.

## [Pr.332] Channel number

Set the channel number of the module that is assigned to the high-speed counter module when "1: Via module" is set in "[Pr.320] Synchronous encoder axis type".

Set the channel number (CH.A is "1", CH.B is "2") of the encoder signal input connector (CN1/CN2) to which the encoder is connected when "601: Via sensing module" is set in "[Pr.320] Synchronous encoder axis type".

Set a value within the range from "1 to 2".

# Synchronous encoder axis control data (Word device)

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Cd.320 | Synchronous encoder axis control start condition | • If set to "101 to 164", the synchronous encoder axis control starts based on the high-speed input request signal at synchronous encoder axis control request ON.<br>• In the case of other than the above, the control starts without any condition at synchronous encoder axis control request turning from OFF to ON. | Other than below: Start without any condition<br>101 to 164: High-speed input request signal start (Signal 1 to 64) | At synchronous encoder axis control start | 0 | D42322+16n | D14822+10n |
| Cd.321 | Synchronous encoder axis control method | Set the control method for the synchronous encoder axis. | 0: Current value change<br>1: Counter disable<br>2: Counter enable | | 0 | D42323+16n | D14823+10n |
| Cd.322 | Synchronous encoder axis current value setting address | Set a new current value for changing the current value. | -2147483648 to 2147483647 [Synchronous encoder axis position units][1] | | 0 | D42324+16n<br>D42325+16n | D14824+10n<br>D14825+10n |
| Cd.325 | Input value for synchronous encoder via device | Set a value to be used every time as the input value for the synchronous encoder for the synchronous encoder via device. | -2147483648 to 2147483647 [pulse] | Operation cycle | 0 [pulse] | D42326+16n<br>D42327+16n | D14826+10n<br>D14827+10n |

[1] Synchronous encoder axis position units (☞ Page 55 Synchronous encoder axis position units)

## [Cd.320] Synchronous encoder axis control start condition (R: D42322+16n/Q: D14822+10n)

When "[Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: M11601+4n)" is turned ON, if set to other than "101 to 164", the synchronous encoder axis control starts without any condition.

If set to "101 to 164", the synchronous encoder axis control starts based on the specified high-speed input request signal.

**Point**

When the mixed operation cycle function is valid, set the setting No. of the high-speed input request signal that has "operation cycle" set in the high-speed input request signal control cycle setting.

## [Cd.321] Synchronous encoder axis control method (R: D42323+16n/Q: D14823+10n)

Set the control method for the synchronous encoder axis.

| Setting value | Description |
|---|---|
| 0: Current value change | The synchronous encoder axis current value and the synchronous encoder axis current value per cycle are changed as follows. Set the new current value in "[Cd.322] Synchronous encoder axis current value setting address (R: D42324+16n, D42325+16n/Q: D14824+10n, D14825+10n)". |
| | <table><tr><th>Item</th><th>Change value</th></tr><tr><td>[Md.320] Synchronous encoder axis current value</td><td>"[Cd.322] Synchronous encoder axis current value setting address (R: D42324+16n, D42325+16n/Q: D14824+10n, D14825+10n)"</td></tr><tr><td>[Md.321] Synchronous encoder axis current value per cycle</td><td>A value that is converted "[Cd.322] Synchronous encoder axis current value setting address (R: D42324+16n, D42325+16n/Q: D14824+10n, D14825+10n)" into the range from "0 to ("[Pr.324] Synchronous encoder axis length per cycle"-1)".</td></tr></table> |
| 1: Counter disable | Input from the synchronous encoder is invalid.<br>Smoothing processing, phase compensation processing and rotation direction restriction processing are continued. While these processes are valid, the input axis speed may not stop immediately when the counter disable is selected. |
| 2: Counter enable | Input from the synchronous encoder is valid. |

## [Cd.322] Synchronous encoder axis current value setting address (R: D42324L+16n/Q: D14824L+20n)

Set a new current value in synchronous encoder axis position units to apply to the current value change for the synchronous encoder axis. ( ☞ Page 55 Synchronous encoder axis position units)

## [Cd.325] Input value for synchronous encoder via device (R: D42326L+16n/Q: D14826L+10n)

Use this data when "201: Via device" is set in "[Pr.320] Synchronous encoder axis type".

Set a value to be used every time as the input value for the synchronous encoder in encoder pulse units.

If 1 or more is set in "[Pr.329] Resolution of synchronous encoder via device", it is processed as a cycle counter within the range from 0 to (resolution of synchronous encoder via device - 1).

# Synchronous encoder axis control data (Bit device)

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Rq.323 | Synchronous encoder axis error reset | If turns ON for resetting warning and error for the synchronous encoder axis, the warning code and error code are cleared, and the error detection and warning detection bits status are turned OFF. | ON: Error reset request | Main cycle[*1] | OFF | M42240+8n | M11600+4n |
| Rq.320 | Synchronous encoder axis control request | If turns ON, the synchronous encoder axis control is started. | ON: Control request ON OFF: Control request OFF | Operation cycle | OFF | M42241+8n | M11601+4n |
| Rq.324 | Connection command of synchronous encoder via device/master CPU | • If turns ON, the synchronous encoder via device/master CPU is connected. • If turns OFF, the synchronous encoder via device/master CPU is disconnected. | ON: Connect synchronous encoder via device/ master CPU OFF: Disconnect synchronous encoder via device/ master CPU | Main cycle[*1] | OFF | M42242+8n | M11602+4n |

*1 With the exception of positioning control, main cycle processing is executed during the next available time.

## [Rq.323] Synchronous encoder axis error reset (R: M42240+8n/Q: M11600+4n)

This command is used to clear the "[Md.327] Synchronous encoder axis warning code (R: D38570+32n/Q: D13250+20n)" and "[Md.326] Synchronous encoder axis error code (R: D38571+32n/Q: D13251+20n)" of an axis for which the error detection signal has turn on "[St.324] Synchronous encoder axis error detection flag (R: M38644+16n/Q: M10444+10n)": ON), and reset the "[St.324] Synchronous encoder axis error detection flag (R: M38644+16n/Q: M10444+10n)".

## [Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: M11601+4n)

• When this signal is ON, if a value other than "101 to 164" is set to "[Cd.320] Synchronous encoder axis control start condition (R: D42322+16n/Q: D14822+10n)", the synchronous encoder axis control starts without any condition.

[Md.320] Synchronous encoder axis current value
(R: D38560+32n, D38561+32n/
Q: D13240+20n, D13241+20n)

[Rq.320] Synchronous encoder axis control request
(R: M42241+8n/Q: M11601+4n)
[Cd.320] Synchronous encoder axis control start condition
(R: D42322+16n/Q: D14822+10n)

[St.325] Synchronous encoder axis control complete flag (R: M38646+16n/Q: M10446+10n)

[Cd.321] Synchronous encoder axis control method
(R: D42323+16n/Q: D14823+10n)
[Cd.322] Synchronous encoder axis current value setting address
(R: D42324+16n, D42325+16n/
Q: D14824+10n, D14825+10n)
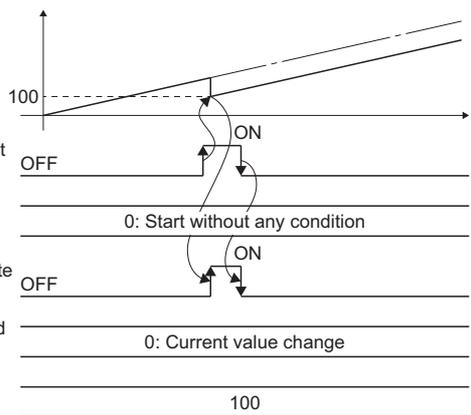
- When this signal is ON, if "101 to 164" is set to "[Cd.320] Synchronous encoder axis control start condition (R: D42322+16n/Q: D14822+10n)", the synchronous encoder axis control starts based on the corresponding high-speed input request signal.

[Md.320] Synchronous encoder axis current value
(R: D38560+32n, D38561+32n/
Q:D13240+20n, D13241+20n)

High-speed input request signal 3

[Rq.320] Synchronous encoder axis control request
(R: M42241+8n/Q: M11601+4n)

[Cd.320] Synchronous encoder axis control start
condition
(R: M42322+16n/Q: D14822+10n)

[St.325] Synchronous encoder axis control complete
flag (R: M38646+16n/Q: M10446+10n)

[Cd.321] Synchronous encoder axis control method
(R: D42323+16n/Q: D14823+10n)

[Cd.322] Synchronous encoder axis current value
setting address
(R: D42324+16n, D42325+16n/
Q: D14824+10n, D14825+10n)

- Set the control method for the synchronous encoder axis in "[Cd.321] Synchronous encoder axis control method (R: D42323+16n/Q: D14823+10n)". The "[St.325] Synchronous encoder axis control complete flag (R: M38646+16n/Q: M10446+10n)" turns ON at the after completion of the synchronous encoder axis control. When "[Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: M11601+4n)" is turned from ON to OFF during waiting for the corresponding high-speed input signal accept, the synchronous encoder axis control is cancelled.

## [Rq.324] Connection command of synchronous encoder via device/master CPU (R: M42242+8n/Q: M11602+4n)

Use this data when "201: Via device", "301: Master CPU servo input axis", "401: Master CPU command generation axis", "501: Master CPU synchronous encoder axis" is set in "[Pr.320] Synchronous encoder axis type".

### ■"201: Via device"

If device turns ON, the synchronous encoder axis is connected. Once connected, the synchronous encoder current value is restored based on the "[Cd.325] Input value for synchronous encoder via device (R: D42326+16n, D42327+16n/Q: D14826+10n, D14827+10n)".
If device turns OFF, the synchronous encoder axis is disconnected.

### ■"301: Master CPU servo input axis", "401: Master CPU command generation axis", "501: Master CPU synchronous encoder axis"

If device turns ON, the synchronous encoder axis is connected and is in counter enabling status.
If device turns OFF, the synchronous encoder axis is disconnected.

# Synchronous encoder axis monitor data (Word device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|
| Md.320 | Synchronous encoder axis current value | The current value for the synchronous encoder axis is stored. | -2147483648 to 2147483647 [Synchronous encoder axis position units][1] | Operation cycle | D38560+32n D38561+32n | D13240+20n D13241+20n |
| Md.321 | Synchronous encoder axis current value per cycle | The current value per cycle for a synchronous encoder axis is stored. | 0 to (Synchronous encoder axis length per cycle-1) [Synchronous encoder axis position units][1] | | D38562+32n D38563+32n | D13242+20n D13243+20n |
| Md.322 | Synchronous encoder axis speed | The speed for a synchronous encoder axis is stored. | -2147483648 to 2147483647 [Synchronous encoder axis speed units][2] | | D38564+32n D38565+32n | D13244+20n D13245+20n |
| Md.323 | Synchronous encoder axis phase compensation amount | The phase compensation amount is stored. | -2147483648 to 2147483647 [Synchronous encoder axis position units][1] | | D38566+32n D38567+32n | D13246+20n D13247+20n |
| Md.324 | Synchronous encoder axis rotation direction restriction amount | While the rotation direction is restricted, the accumulation for the input travel value in the opposite direction of the enable direction is stored. | -2147483648 to 2147483647 [Synchronous encoder axis position units][1] | | D38568+32n D38569+32n | D13248+20n D13249+20n |
| Md.327 | Synchronous encoder axis warning code | The warning code for the synchronous encoder axis is stored. | Warning code[3] | Immediate | D38570+32n | D13250+20n |
| Md.326 | Synchronous encoder axis error code | The error code for the synchronous encoder axis is stored. | Error code[3] | | D38571+32n | D13251+20n |

*1   Synchronous encoder axis position units (☞ Page 55 Synchronous encoder axis position units)
*2   Synchronous encoder axis speed units (☞ Page 55 Synchronous encoder axis speed units)
*3   Refer to the following for details.
     📖 MELSEC iQ-R Motion Controller Programming Manual (Common)

## [Md.320] Synchronous encoder axis current value (R: D38560L+32n/Q: D13240L+20n)

The current value for the synchronous encoder axis is stored in synchronous encoder axis position units. (☞ Page 55 Synchronous encoder axis position units)

The synchronous encoder position for an incremental synchronous encoder is "0" immediately after the Multiple CPU system power supply ON.

## [Md.321] Synchronous encoder axis current value per cycle (R: D38562L+32n/Q: D13242L+20n)

The current value per cycle for a synchronous encoder axis is stored in the range from "0 to ("[Pr.324] Synchronous encoder axis length per cycle"-1)".

The unit is synchronous encoder axis position units. (☞ Page 55 Synchronous encoder axis position units)

## [Md.322] Synchronous encoder axis speed (R: D38564L+32n/Q: D13244L+20n)

The speed for a synchronous encoder axis is stored in synchronous encoder axis speed units. ( ☞ Page 55 Synchronous encoder axis speed units)

If the speed for a synchronous encoder axis exceeds the monitor range (Refer to Section 4.3.1), warning (error code: 0BD2H) will occur. In this case, use a smaller number of decimal places for the speed in "[Pr.321] Synchronous encoder axis unit setting" or set the speed time units to "s".

> **Point**
>
> Even if an unintended input pulse is input from the synchronous encoder, an error does not occur and the input axis is driven by the input pulse from the synchronous encoder. In this case, check the input pulse from the synchronous encoder with "[Md.322] Synchronous encoder axis speed (R: D38564+32n, D38565+32n/Q: D13244+20n, D13245+20n)".

## [Md.323] Synchronous encoder axis phase compensation amount (R: D38566L+32n/Q: D13246L+20n)

The phase compensation amount for a synchronous encoder axis is stored in the synchronous encoder axis position units. ( ☞ Page 55 Synchronous encoder axis position units)

The phase compensation amount for a synchronous encoder axis is the value after smoothing processing and phase compensation processing.

## [Md.324] Synchronous encoder axis rotation direction restriction amount (R: D38568L+32n/Q: D13248L+20n)

While the rotation direction is restricted for a synchronous encoder axis, the accumulation for input travel in the opposite direction of the enabled direction is stored in synchronous encoder axis position units as follows. ( ☞ Page 55 Synchronous encoder axis position units)

| Setting value of "[Pr.328] Synchronous encoder axis rotation direction restriction" | Storage details |
|---|---|
| 1: Enable only for current value increase direction | A negative accumulation is stored during rotation direction restriction. 0 is stored if there is no restriction. |
| 2: Enable only for current value decrease direction | A positive accumulation is stored during rotation direction restriction. 0 is stored if there is no restriction. |

Rotation direction restriction is processed after phase compensation processing. Therefore, if undershoot occurs from phase compensation during deceleration stop, the rotation direction restriction amount might remain.

## [Md.327] Synchronous encoder axis warning code (R: D38570+32n/Q: D13250+20n)

- This register stores the corresponding warning code at the warning occurrence of synchronous encoder axis. If another warning occurs after warning code storing, the previous warning code is overwritten by the new warning code.
- Warning codes can be cleared by an "[Rq.323] Synchronous encoder axis error reset (R: M42240+8n/Q: M11600+4n)"

> **Point**
>
> Refer to the following for details of warning codes.
> 📖 MELSEC iQ-R Motion controller Programming Manual (Common)

## [Md.326] Synchronous encoder axis error code (R: D38571+32n/Q: D13251+20n)

- This register stores the corresponding error code at the error occurrence of synchronous encoder axis. If another error occurs after error code storing, the previous error code is overwritten by the new error code.
- Error codes can be cleared by an "[Rq.323] Synchronous encoder axis error reset (R: M42240+8n/Q: M11600+4n)".

> **Point**
>
> Refer to the following for details of error codes.
> 📖 MELSEC iQ-R Motion controller Programming Manual (Common)

# Synchronous encoder axis monitor data (Bit device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|
| St.320 | Synchronous encoder axis setting valid flag | This flag turns ON when the setting of the synchronous encoder axis is valid. | ON: Setting valid<br>OFF: Setting invalid | At power ON | M38640+16n | M10440+10n |
| St.321 | Synchronous encoder axis connecting valid flag | This flag turns ON when the synchronous encoder axis connection is valid. | ON: Connection valid<br>OFF: Connection invalid | Operation cycle | M38641+16n | M10441+10n |
| St.322 | Synchronous encoder axis counter enable flag | This flag turns ON when input from the synchronous encoder is enabled. | ON: Counter enable<br>OFF: Counter disable | | M38642+16n | M10442+10n |
| St.323 | Synchronous encoder axis current value setting request flag | This flag turns ON when the current value of synchronous encoder axis is not set. | ON: Current value setting request<br>OFF: Current value setting not requested | | M38643+16n | M10443+10n |
| St.324 | Synchronous encoder axis error detection flag | This flag turns ON when an error occurs for the synchronous encoder axis. | ON: Error occurred<br>OFF: No error | Immediate | M38644+16n | M10444+10n |
| St.325 | Synchronous encoder axis control complete flag | This flag turns ON at the completion of synchronous encoder axis control. | ON: Control completed<br>OFF: Control not completed | | M38646+16n | M10446+10n |

## [St.320] Synchronous encoder axis setting valid flag (R: M38640+16n/Q: M10440+10n)

At Multiple CPU system power supply ON, this flag turns ON when the setting of the synchronous encoder axis is valid. It is turned OFF when the setting is invalid.

## [St.321] Synchronous encoder axis connecting valid flag (R: M38641+16n/Q: M10441+10n)

At Multiple CPU system's power supply ON, this flag turns ON when the synchronous encoder connection is valid.

This flag turns OFF when the connection is invalid.

When setting an incremental synchronous encoder, this flag turns ON simultaneously the Multiple CPU system power supply turns ON regardless of the actual encoder connection.

## [St.322] Synchronous encoder axis counter enable flag (R: M38642+16n/Q: M10442+10n)

This flag turns ON when input from the synchronous encoder is enabled.

If the counter disable control is executed, it is turned OFF, and input from the synchronous encoder becomes invalid. If the counter enable control is executed, it is turned ON, and input from the synchronous encoder becomes valid. Just after the synchronous encoder is valid to connect, the status is ON (enable).

## [St.323] Synchronous encoder axis current value setting request flag (R: M38643+16n/ Q: M10443+10n)

This flag turns ON, when a synchronous encoder axis current value change is never executed or when the synchronous encoder current value is lost by the battery error, etc. in the serial absolute synchronous encoder.

If the current value setting request flag is ON for the synchronous encoder connection, the synchronous encoder axis current value starts counting with 0.

This flag turns OFF when a synchronous encoder axis current value change is executed.

> **Point**
>
> For a system that needs alignment of synchronous encoder, confirm that "[St.323] Synchronous encoder axis current value setting request flag (R: M38643+16n/Q: M10443+10n)" is OFF.

## [St.324] Synchronous encoder axis error detection flag (R: M38644+16n/Q: M10444+10n)

- This signal turns ON with detection of a warning or error of synchronous encoder axis, and can be used to judge whether there is a warning or error or not. The applicable warning code is stored in the "[Md.327] Synchronous encoder axis warning code (R: D38570+32n/Q: M13250+20n)" with detection of a warning. The applicable error code is stored in the "[Md.326] Synchronous encoder axis error code (R: D38571+32n/Q: M13251+20n)" with detection of an error.
- This signal turns off when the "[Rq.323] Synchronous encoder axis error reset (R: M42240+8n/Q: M11600+4n)" turns on.

> **Point**
>
> Refer to the following for the warning codes and error codes with detection of warning and errors.
> 📖MELSEC iQ-R Motion controller Programming Manual (Common)

## [St.325] Synchronous encoder axis control complete flag (R: M38646+16n/Q: M10446+10n)

This flag turns ON at the completion of synchronous encoder axis control.

This flag turns OFF when "[Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: M11601+4n)" is turned from ON to OFF.

# 5 CAM FUNCTION

## 5.1 Control Details for Cam Function

The output axis for synchronous control is operated with a cam.

The following operations can be performed with cam functions.

- Two-way operation: Reciprocating operation with a constant cam strokes range.
- Feed operation: Cam reference position is updated every cycle.
- Linear operation: Linear operation (cam No.0) in the cycle as the stroke ratio is 100%.

The output axis is controlled by a value (current feed value), which is converted from the input value (cam axis current value per cycle) by cam data.
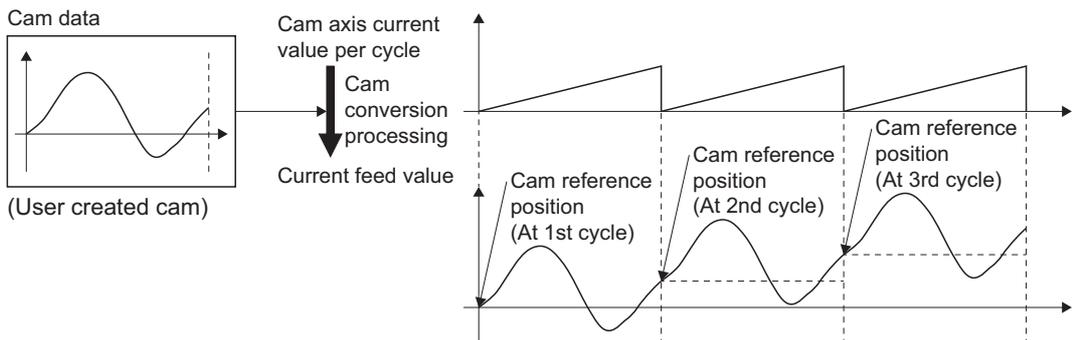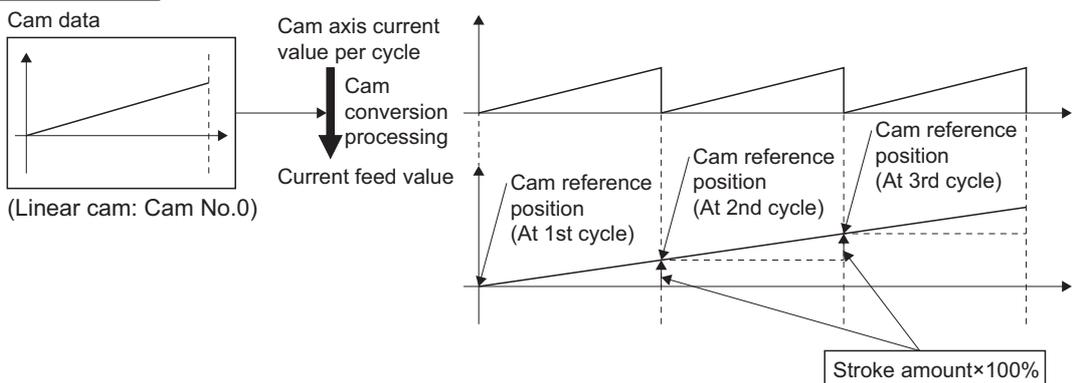
# Type of cam data

The cam data methods used in the cam function are linear cam, stroke ratio data format, coordinate data format, and auto-generation data format. Cam data is arranged in the "Cam storage area" and "Cam open area".

Refer to memory operation of cam data for details of each area. (☞ Page 89 Memory operation of cam data)

The following describes each type of cam data.

## Linear cam control

When "0" is set for "[Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)", the cam data operates as a straight line with a 100% stroke ratio at the last point. Linear cam data does not consume the cam open area. Also, linear cam data cannot be read/written as storage data.
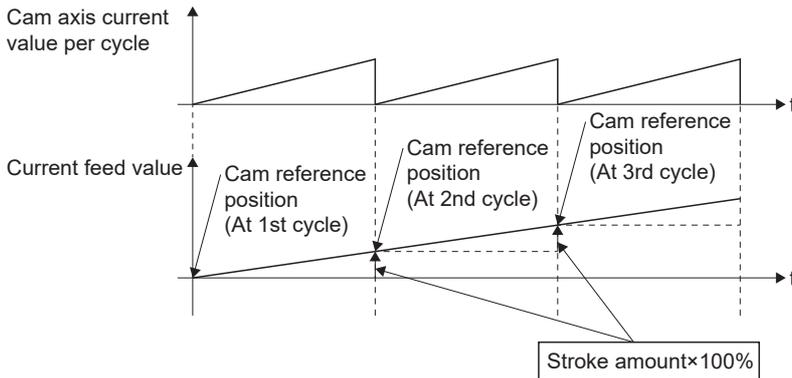


## Stroke ratio data format

The stroke ratio data format is defined in equal divisions for one cam cycle based on the cam resolution, and configured with stroke ratio data from points within the cam resolution.

Refer to create cam data for setting methods for cam data. (☞ Page 89 Create Cam Data)

| Setting item | Setting details | Setting range | Default value (MT Developer2) |
|---|---|---|---|
| Cam No. | Set the cam No. | 1 to 1024: User created cam | 1 |
| Cam resolution | Set the number of divisions for one cam cycle. | 256/512/1024/2048/4096/8192/16384/32768 | 256 |
| Cam data starting point | Set the cam data point corresponding to "Cam axis current value per cycle = 0". | 0 to (Cam resolution - 1) | 0 |
| Stroke ratio data | Set the stroke ratio from the 1st to the last point. (The 0th point setting is not required. It is always 0%.) | -2147483648 to 2147483647 [$\times 10^{-7}$ %][1] (-214.7483648 to 214.7483647%) | 0 |

[1] For setting the stroke ratio out of range ±100% with MT Developer2, check the "Display Advanced Cam Graph Stroke" by selecting the [Cam Data] on the options screen displayed by the menu bar [Tools] ⇨ [Options].

**Ex.**
Cam resolution: 512
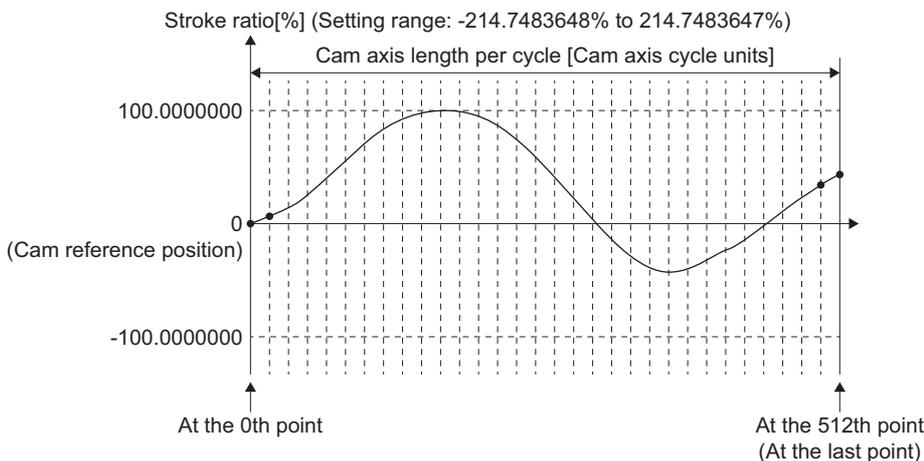
# Coordinate data format

The coordinate data format is defined in coordinates of more than 2 points for one cam cycle. The coordinate data is represented as input value and output value, with "input value = cam axis current value per cycle", and "output value = stroke position from cam reference position".

With this format, "[Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n)" of output axis parameter is ignored and output value of the coordinate data becomes cam stroke position.

Refer to create cam data for setting methods of cam data. ( ☞ Page 89 Create Cam Data)

| Setting item | Setting details | Setting range | Default value (MT Developer2) |
|---|---|---|---|
| Cam No. | Set the cam No. | 1 to 1024: User created cam | 1 |
| Coordinate number | Set the number of coordinate points in one cam cycle. The coordinates are included at the 0th point. | 2 to 65535 | 2 |
| Cam data starting point | Setting is not required with coordinate data format. | — | — |
| Coordinate data | Set all coordinate data (input value: $X_n$, output value: $Y_n$). Required to set the coordinate data $(X_0, Y_0)$ from the 0th point. The input value should be larger than the previous coordinate data $(X_n \leq X_{n+1})$. | Input value: 0 to 2147483647 [Cam axis cycle units] Output value: -2147483648 to 2147483647 [Output axis position units] | 0 |
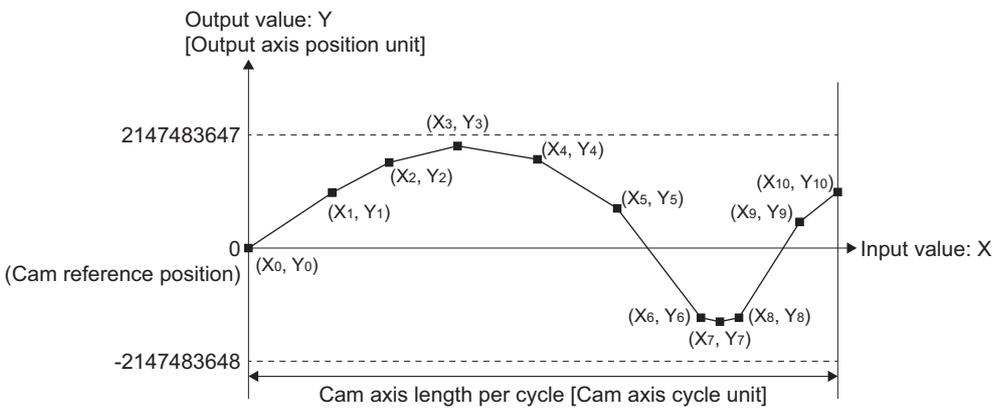


When the coordinate data corresponding to an input value that is 0 or when the cam axis length per cycle setting does not exist, the coordinate is calculated from the line segment between the nearest two coordinates.
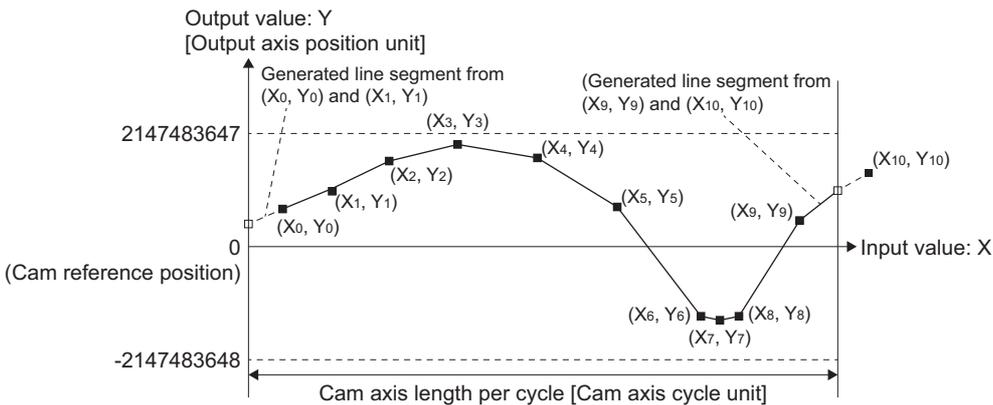
## Auto-generation data format

A cam pattern is created using the CAMMK instruction of Motion SFC program based on the specified parameter (data for auto-generation). Control cam data is created in the stroke ratio data format in the cam open area. Therefore, the operation during the control conforms to the cam operation in the stroke ratio data format.

The types of cam patterns for auto-generation data format are as follows.

| Auto-generation type | Details |
| --- | --- |
| Cam for rotary cutter | Set the auto-generation data, including the sheet length and the synchronization width of the cam data for rotary cutter. |
| Easy stroke ratio cam | Without using the MT Developer2 cam data, automatically generate cam data by setting the sections and the stroke amounts.<br>Setting of the detailed coefficients of the cam curve is omitted. A cam pattern is created using a limited number of curves and sections. |
| Advanced stroke ratio cam | Without using the MT Developer2 cam data, automatically generate cam data by setting the sections and the stroke amounts.<br>Create a detailed cam pattern by setting applicable range for curves, and compensation for the acceleration/deceleration range. |

## ⚠ CAUTION

• If the cam data is set incorrectly, such as simply setting a target value and command speed similar to positioning control, the position and speed command to the servo amplifier increases, and may cause machine interface and servo errors (AL.31, AL.35). When creating and changing cam data, execute a trial operation and provide the appropriate adjustments. Refer to "Safety precautions" for precautions on trial operations and adjustments. (☞ 2 SAFETY PRECAUTIONS)

# Overview of cam operation

## Current feed value of cam axis

The current feed value is calculated as shown below.

### ■Stroke ratio data format

Current feed value=Cam reference position + (Cam stroke amount × Stroke ratio corresponding to cam axis current value per cycle)

### ■Coordinate data format

Current feed value = Cam reference position + Output value corresponding to cam axis current value per cycle

When the cam axis current value per cycle is within the defined cam data (Stroke ratio data/Coordinate data), the value is calculated from the nearest cam data.
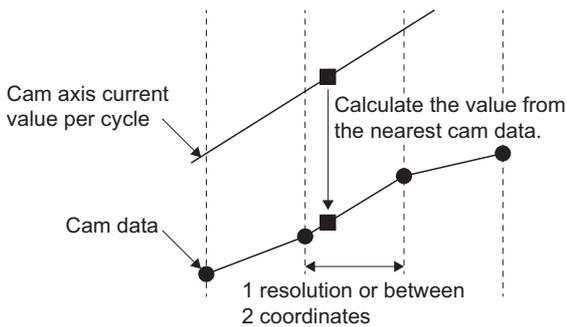


## Cam reference position

The cam reference position is calculated as shown below.

### ■Stroke ratio data format

Cam reference position = The preceding cam reference position + (Cam stroke amount × Stroke ratio at the last point)

### ■Coordinate data format

Cam reference position= The preceding cam reference position + Output value corresponding to "Input value = Cam axis length per cycle" - Output value corresponding to "Input value = 0"

Create cam data for two-way cam operation as shown below.

### ■Stroke ratio data format

Create cam data so that the stroke ratio is 0% at the last point.

### ■Coordinate data format

Create cam data with the same output value for the point where the input value is 0 and the input value is equal to the cam axis length per cycle.



Cam reference position
(Does not change because of the stroke ratio 0% and output value = 0.)
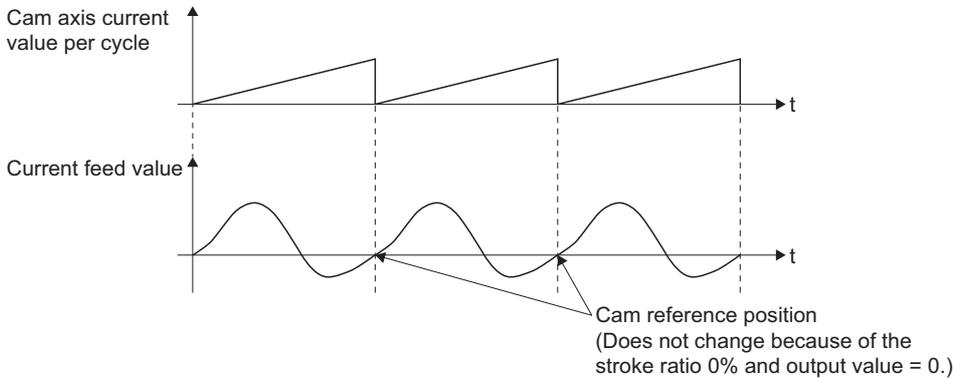
## Cam data starting point

This setting is only valid for cam data using the stroke ratio data format.

The cam data point corresponding to "Cam axis current value per cycle = 0" can be set as the cam data starting point.

The default value of the cam data starting point is 0. (The cam axis is controlled with cam data starting from the 0th point (stroke ratio 0%).)

When a value other than 0 is set for the cam data starting point, cam control is started from the point where the stroke ratio is not 0%.

The cam data starting point is set for each cam data. The setting range is from 0 to (cam resolution-1).
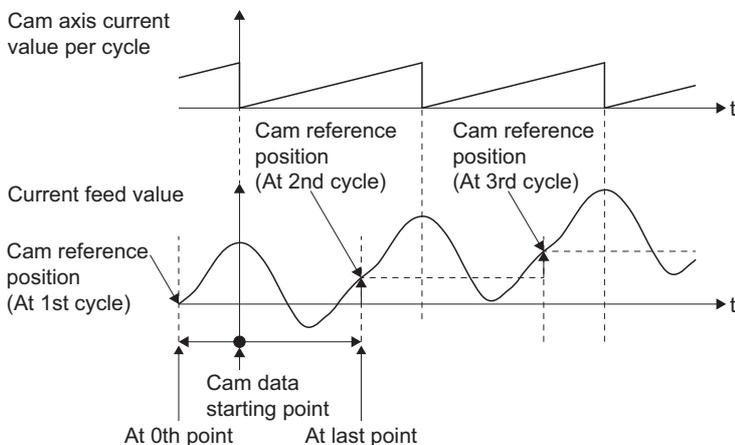


## Timing of applying cam control data

### ■Stroke ratio data format

If any one of "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)", "[Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)", or "[Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n)" is changed during synchronous control, the new value is accepted and applied when the cam axis current value per cycle passes through the 0th point of cam data, or is on the 0th point.

The cam reference position is updated when the cam axis current value per cycle passes through the 0th point of cam data.

### ■Coordinate data format

If "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)" or "[Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)" is changed during synchronous control, the new value is accepted and applied when the cam axis current value per cycle passes through 0, or is on 0.

The cam reference position is updated when the cam axis current value per cycle passes through 0.

5 CAM FUNCTION
5.1 Control Details for Cam Function

# 5.2 Create Cam Data

## Memory operation of cam data

Cam data is arranged in the following 2 areas.

| Area | Storage item | Details | Remark |
|---|---|---|---|
| Cam storage area (Standard ROM/ SD memory card) | Cam storage data (Cam file) | Data is written by the following operations.<br>• Write with MT Developer2<br>• When specifying a cam file for writing data and executing the CAMWR/CAMMK instruction of Motion SFC program. | Data is preserved even when turning the Multiple CPU system power supply OFF. |
| Cam open area | Cam open data | • Cam data is transmitted from the cam file, when turning the Multiple CPU system power supply ON.<br>• Writing to the cam open area is also possible using the CAMWR/CAMMK instruction or "File transmission request (SD820)". | • Data is lost when turning OFF or resetting the Multiple CPU system power supply.<br>• The cam data that is used in cam control is stored. |

Previously written cam data can be used after turning the Multiple CPU system power supply OFF by writing data in the cam file. Cam data should be written in the cam file for normal use.

It is possible to write the cam data to the cam open area via the device specified by Motion SFC program when fine adjusting cam data during cam control etc.

The cam file must also be updated as appropriate because the contents of the cam file are transmitted to the cam open area when turning the Multiple CPU system power supply ON again.

When the cam file is updated, the contents of the cam open area can be updated using "File transmission request (SD820)".
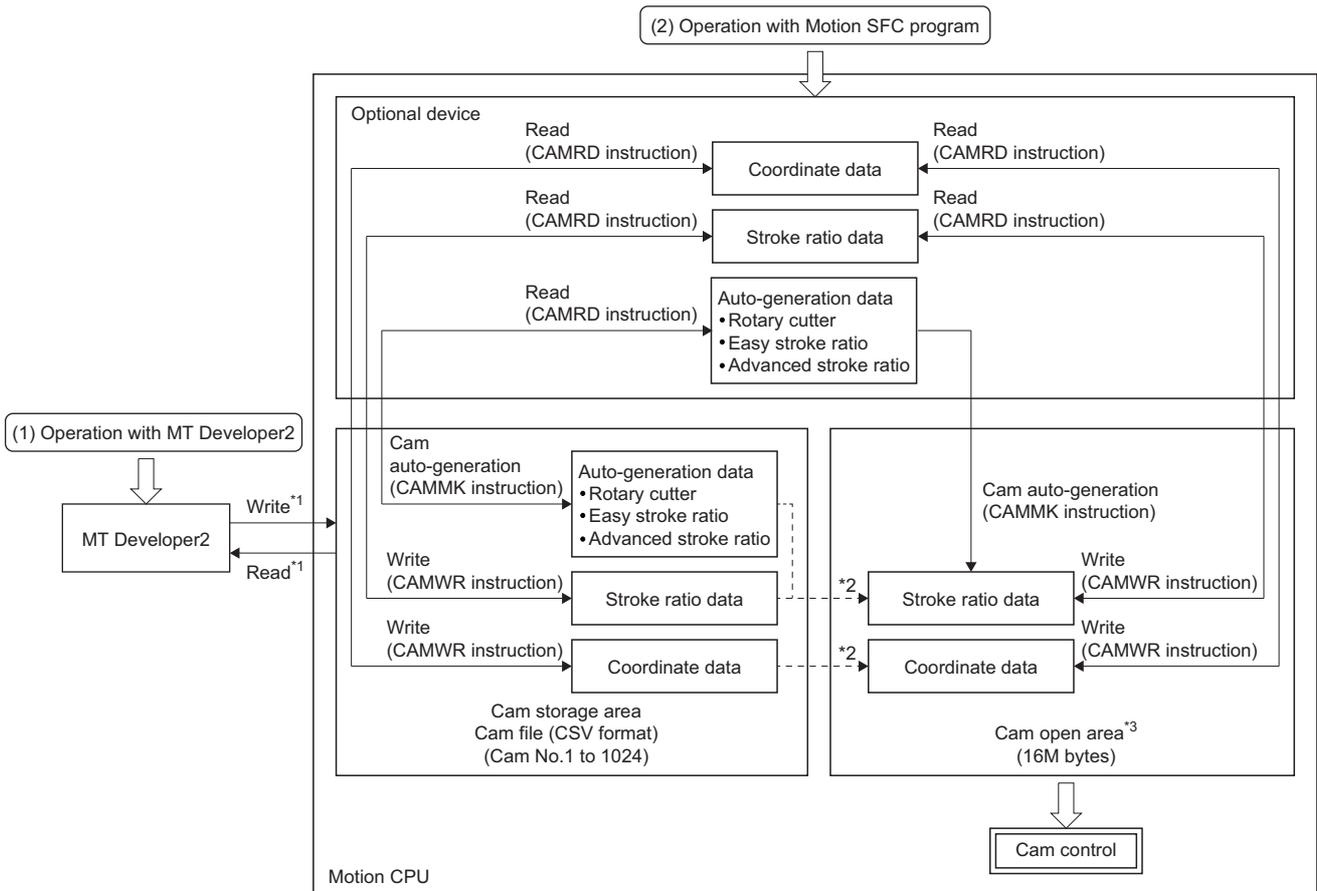


*1   The operations from MT Developer2 are for the cam file.
*2   Cam data is written to the cam open area at Multiple CPU system power supply ON, or by "File transmission request(SD820)".
*3   The contents of the cam open area are cleared by turning the Multiple CPU system power supply OFF and ON again, or by reset.
      The cam files in the cam storage area can also be sent to the cam open area by *2.

## Cam data operation with MT Developer2

Cam data can be modified while viewing the waveform with MT Developer2.

The cam data is written/read to the cam file with MT Developer2, however it cannot be executed to the cam open area.

The waveform generated by the cam auto-generation function can be confirmed on the "Cam graph" of the "Cam data window" through reading with MT Developer2.

## Cam data operation with Motion SFC program

Cam data read/write operation, cam auto-generation and cam position calculation can be executed with the Motion SFC program. (☞ Page 91 Cam data operation by Motion SFC program)

## Cam data capacity

The size of the created cam data is shown below for the cam open area.

| Operation method | Data method/Auto-generation type | Cam open area (16M bytes) |
|---|---|---|
| Create with MT Developer2 | Stroke ratio data format | Cam resolution × 4 bytes |
| | Coordinate data format | Coordinate number × 8 bytes |
| Create with Motion SFC program (CAMWR instruction) | Stroke ratio data format | Cam resolution × 4 bytes |
| | Coordinate data format | Coordinate number × 8 bytes |
| Create with cam auto-generation in Motion SFC program (CAMMK instruction) | For a rotary cutter | Cam resolution × 4 bytes |
| | Easy stroke ratio cam | |
| | Advanced stroke ratio CAM | |

## Delete method of cam data

Delete the cam file with MT Developer2 to delete only cam data.

## Password protection for cam file

The cam file can be protected as shown below by file password setting. Depending on the registration condition that has been set, the cam file is protected as follows.

| Registration condition | Cam data operation with MT Developer2 | Cam data operation with Motion SFC program |
|---|---|---|
| Write protection | Cam data cannot be written without unlocking the password. | Cam file with a password can be created by writing cam data and cam data auto-generation. |
| Read protection | Cam data cannot be read/written without unlocking the password. | A cam data read with the cam file as target cannot be executed. |

Refer to the following for details of the file password protection.

📖 MELSEC iQ-R Motion controller Programming Manual (Common)

# Cam data operation by Motion SFC program

Cam data read/write operation and cam auto-generation can be executed with the synchronous control dedicated function of Motion SFC program.

Refer to the following for details.

📖 MELSEC iQ-R Motion controller Programming Manual (Program Design)

| Classification | Symbol | Instruction | Description |
|---|---|---|---|
| Synchronous control dedicated function | CAMRD | Cam data read | This is used to read cam data.<br>Cam data can be read from a cam file by setting the destination reading. The upper amount of data for each operation is 32768 points (2 words are used per point) with the stroke ratio data format, and 16384 points (4 words are used per point) with the coordinate data format.<br>If the read is not completed in one time, the operation should be separated in multiple times. |
| | CAMWR | Cam data write | This is used to write cam data to the CAM open area.<br>Cam data can be saved in a cam file by setting the destination for writing.<br>The upper amount of data for each operation is 32768 points (2 words are used per point) with the stroke ratio data format, and 16384 points (4 words are used per point) with the coordinate data format.<br>If the write is not completed in one time, the operation should be separated in multiple times. |
| | CAMMK | Cam auto-generation function | This function is used to automatically generate cam data for specific purposes by setting data for auto-generation.<br>Auto-generation cam data is generated in the stroke ratio format in the cam open area, and the data for auto-generation can be saved in a cam file by setting the destination for writing.<br>It is possible to generate up to 16Mbytes including the regular cam data.<br>(Example)<br>1024 cam data (with the stroke ratio format, resolution is 4096) can be automatically generated. |

# Cam data operation by file transmission function

Cam data can be written from a cam file to the cam open area by specifying cam data using "File transmission request (SD820)".

Refer to the following for details of the file transmission function.

📖 MELSEC iQ-R Motion controller Programming Manual (Common)
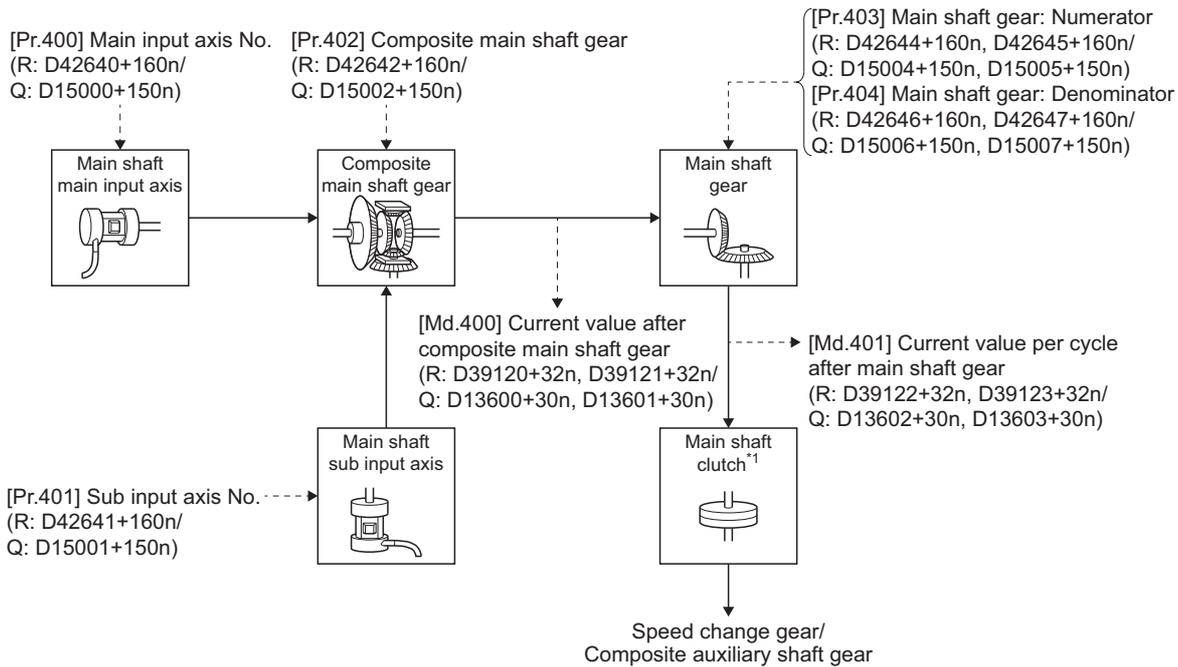
# 6 SYNCHRONOUS CONTROL

## 6.1 Main Shaft Module

### Overview of main shaft module

For the main shaft module, the input value is generated as a composite value from two input axes (the main and sub input axis) through the composite main shaft gear. The composite input value can be converted by the main shaft gear that provides the deceleration ratio and the rotation direction for the machine system, etc.

Refer to the following for details on setting for the main shaft module.

- Main shaft parameters ( Page 93 Main shaft parameters)
- Main shaft clutch parameters ( Page 95 Main shaft clutch parameters)

[Pr.400] Main input axis No.
(R: D42640+160n/
Q: D15000+150n)

[Pr.402] Composite main shaft gear
(R: D42642+160n/
Q: D15002+150n)

[Pr.403] Main shaft gear: Numerator
(R: D42644+160n, D42645+160n/
Q: D15004+150n, D15005+150n)

[Pr.404] Main shaft gear: Denominator
(R: D42646+160n, D42647+160n/
Q: D15006+150n, D15007+150n)

Main shaft main input axis

Composite main shaft gear

Main shaft gear

[Md.400] Current value after composite main shaft gear
(R: D39120+32n, D39121+32n/
Q: D13600+30n, D13601+30n)

[Md.401] Current value per cycle after main shaft gear
(R: D39122+32n, D39123+32n/
Q: D13602+30n, D13603+30n)

Main shaft sub input axis

Main shaft clutch[*1]

[Pr.401] Sub input axis No.
(R: D42641+160n/
Q: D15001+150n)

Speed change gear/
Composite auxiliary shaft gear

*1 Clutch ( Page 111 Clutch)

# Main shaft parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|--------|--------------|-----------------|---------------|-------------|---------------|---------------------------------------------|---------------------------------------------|
| Pr.400 | Main input axis No. | Set the input axis No. on the main input side for the main shaft. | 0: Invalid<br>1 to 64: Servo input axis[*1]<br>201 to 264: Command generation axis[*2]<br>801 to 812: Synchronous encoder axis | At start of synchronous control | 0 | D42640+160n | D15000+150n |
| Pr.401 | Sub input axis No. | Set the input axis No. on the sub input side for the main shaft. | 0: Invalid<br>1 to 64: Servo input axis[*1]<br>201 to 264: Command generation axis[*2]<br>801 to 812: Synchronous encoder axis | | 0 | D42641+160n | D15001+150n |
| Pr.402 | Composite main shaft gear | Select the composite method for input values from the main input axis and sub input axis. | • Set in hexadecimal.<br>H□□□□<br>→ Main input method<br>0: No input<br>1: Input +<br>2: Input -<br>→ Sub input method<br>0: No input<br>1: Input +<br>2: Input - | Operation cycle | 0001H | D42642+160n | D15002+150n |
| Pr.403 | Main shaft gear: Numerator | Set the numerator for the main shaft gear. | -2147483648 to 2147483647 | At start of synchronous control | 1 | D42644+160n<br>D42645+160n | D15004+150n<br>D15005+150n |
| Pr.404 | Main shaft gear: Denominator | Set the denominator for the main shaft gear. | 1 to 2147483647 | | 1 | D42646+160n<br>D62647+160n | D15006+150n<br>D15007+150n |

*1 The following range is valid. R16MTCPU: 1 to 16, R32MTCPU: 1 to 32.
*2 The following range is valid. R16MTCPU: 201 to 216, R32MTCPU: 201 to 232.

## [Pr.400] Main input axis No. (R: D42640+160n/Q: D15000+150n)

Set the main input axis No. for the main shaft.

| Setting value | Description |
|---------------|-------------|
| 0: Invalid | The input value is always 0. |
| 1 to 64: Servo input axis[*1] | Set the servo input axis (axis 1 to 64).<br>When the servo input axis is not set in the servo network setting, the input value is always 0.<br>If the number is set to the same value as the output axis, the minor error (error code: 1BE0H, 1BE1H) occurs and synchronous control cannot be started. |
| 201 to 264: Command generation axis[*2] | Set the command generation axis (axis 1 to 64).<br>When the command generation axis is invalid in the command generation axis parameter setting, the input value is always 0.<br>As the command generation axis is used only for command generation, it is possible to set the same number as the output axis. |
| 801 to 812: Synchronous encoder axis | Set the synchronous encoder axis (axis 1 to 12).<br>When synchronous encoder axis is invalid, the input value is always 0. |

*1 The following range is valid. R16MTCPU: 1 to 16, R32MTCPU: 1 to 32.
*2 The following range is valid. R16MTCPU: 201 to 216, R32MTCPU: 201 to 232.

## [Pr.401] Sub input axis No. (R: D42641+160n/Q: D15001+150n)

Set the sub input axis No. for the main shaft.

| Setting value | Description |
|---|---|
| 0: Invalid | The input value is always 0. |
| 1 to 64: Servo input axis[*1] | Set the servo input axis (axis 1 to 64).<br>When the servo input axis is not set in the servo network setting, the input value is always 0.<br>If the number is set to the same value as the output axis, the minor error (error code: 1BE0H, 1BE1H) occurs and synchronous control cannot be started. |
| 201 to 264: Command generation axis[*2] | Set the command generation axis (axis 1 to 64).<br>When the command generation axis is invalid in the command generation axis parameter setting, the input value is always 0.<br>As the command generation axis is used only for command generation, it is possible to set the same number as the output axis. |
| 801 to 812: Synchronous encoder axis | Set the synchronous encoder axis (axis 1 to 12).<br>When synchronous encoder axis is invalid, the input value is always 0. |

*1 The following range is valid. R16MTCPU: 1 to 16, R32MTCPU: 1 to 32.
*2 The following range is valid. R16MTCPU: 201 to 216, R32MTCPU: 201 to 232.

## [Pr.402] Composite main shaft gear (R: D42642+160n/Q: D15002+150n)

Set the composite method for input values from the main and sub input axes.

The setting values for each axis are shown as follows.

| Setting value | Description |
|---|---|
| 0: No input | The input value from the input axis is calculated as 0. |
| 1: Input+ | The input value from the input axis is calculated as it is. |
| 2: Input- | The input value from the input axis is calculated with its opposite sign. |

Operation assumes "0: No input" if the value is set out of the range from 0 to 2.

> **Point**
>
> The composite method for the composite main shaft gear can be changed during synchronous control. It is used as a clutch to switch input values between the main and the sub input axes.

## [Pr.403] Main shaft gear: Numerator (R: D42644L+160n/Q: D15004L+150n)

Set the numerator for the main shaft gear to convert the input value.

The input value is converted as follows.

$$\text{Input value after conversion} = \text{Input value before conversion} \times \frac{\text{Main shaft gear: Numerator}}{\text{Main shaft gear: Denominator}}$$

The input value direction can be reversed by setting a negative value in the numerator of the main shaft gear.
Set the denominator of the main shaft gear to a value within the range from 1 to 2147483647.

**Ex.**
Convert the cam axis per cycle to be controlled in intervals of 0.1[mm] (0.00394[inch]). The cam axis synchronizes with a conveyer that moves 100[mm] (3.937[inch]) for every (360.00000[degree]) of the main shaft.
Main shaft gear: Numerator: 1000[×0.1mm]
Main shaft gear: Denominator: 36000000[×$10^{-5}$degree]

## [Pr.404] Main shaft gear: Denominator (R: D42646L+160n/Q: D15006L+150n)

Set the denominator for the main shaft gear to convert the input value.
Set together with the main shaft gear numerator. (☞ Page 94 [Pr.403] Main shaft gear: Numerator (R: D42644L+160n/Q: D15004L+150n))

# Main shaft clutch parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.405 | Main shaft clutch control setting | Set the control method for the clutch. | • Set in hexadecimal.<br>H□□□□<br>→ ON control mode<br>  0: No clutch<br>  1: Clutch command ON/OFF<br>  2: Clutch command leading edge<br>  3: Clutch command trailing edge<br>  4: Address mode<br>  5: High speed input request<br>→ OFF control mode<br>  0: OFF control invalid<br>  1: One-shot OFF<br>  2: Clutch command leading edge<br>  3: Clutch command trailing edge<br>  4: Address mode<br>  5: High speed input request<br>→ High speed input request signal<br>  00 to 3F: High speed input request signal from signal 1 to 64 | Operation cycle | 0000H | D42648+160n | D15008+150n |
| Pr.406 | Main shaft clutch reference address setting | Set the reference address for the clutch. | 0: Current value after composite main shaft gear<br>1: Current value per cycle after main shaft gear | At start of synchronous control | 0 | D42649+160n | D15009+150n |
| Pr.407 | Main shaft clutch ON address | • Set the clutch ON address for address mode. (This setting is invalid except during address mode.)<br>• If the address is out of the range from 0 to (Cam axis length per cycle-1), the address is converted to a value within range. | -2147483648 to 2147483647<br>[Main input axis position units[*1], or cam axis cycle units[*2]] | Operation cycle | 0 | D42650+160n<br>D42651+160n | D15010+150n<br>D15011+150n |
| Pr.408 | Travel value before main shaft clutch ON | • Set the travel value for the distance between the clutch ON condition completing and the clutch closing.<br>• Set a positive value when the reference address is increasing, and a negative value when it is decreasing. | -2147483648 to 2147483647<br>[Main input axis position units[*1], or cam axis cycle units[*2]] | At completing clutch ON condition | 0 | D42652+160n<br>D42653+160n | D15012+150n<br>D15013+150n |

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| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.409 | Main shaft clutch OFF address | • Set the clutch OFF address for the address mode. (This setting is invalid except during address mode.)<br>• If the address is out of the range from 0 to (Cam axis length per cycle - 1), the setting address is converted to a value within range. | -2147483648 to 2147483647 [Main input axis position units[*1], or cam axis cycle units[*2]] | Operation cycle | 0 | D42654+160n D42655+160n | D15014+150n D15015+150n |
| Pr.410 | Travel value before main shaft clutch OFF | • Set the travel value for the distance between the clutch OFF condition completing and the clutch opening.<br>• Set a positive value when the reference address is increasing, and a negative value when it is decreasing. | -2147483648 to 2147483647 [Main input axis position units[*1], or cam axis cycle units[*2]] | At completing clutch OFF condition | 0 | D42656+160n D42657+160n | D15016+150n D15017+150n |
| Pr.411 | Main shaft clutch smoothing method | Set the clutch smoothing method. | 0: Direct<br>1: Time constant method (Exponent)<br>2: Time constant method (Linear)<br>3: Slippage method (Exponent)<br>4: Slippage method (Linear)<br>5: Slippage method (Linear: Input value follow up) | At start of synchronous control | 0 | D42658+160n | D15018+150n |
| Pr.412 | Main shaft clutch smoothing time constant | For smoothing with a time constant method, set the smoothing time constant. | 0 to 5000[ms] | | 0[ms] | D42659+160n | D15019+150n |
| Pr.413 | Slippage amount at main shaft clutch ON | For smoothing with a slippage method, set the slippage amount at clutch ON. | 0 to 2147483647 [Main input axis position units[*1], or cam axis cycle units[*2]] | At turning clutch ON | 0 | D42660+160n D42661+160n | D15020+150n D15021+150n |
| Pr.414 | Slippage amount at main shaft clutch OFF | For smoothing with a slippage method, set the slippage amount at clutch OFF. | 0 to 2147483647 [Main input axis position units[*1], or cam axis cycle units[*2]] | At turning clutch OFF | 0 | D42662+160n D42663+160n | D15022+150n D15023+150n |

*1 Main input axis position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

*2 Cam axis cycle units (☞ Page 126 Cam axis cycle units)

## [Pr.405] Main shaft clutch control setting (R: D42648+160n/Q: D15008+150n)

Set the ON and OFF control methods separately for the main shaft clutch.

The clutch control setting can be changed during synchronous control, however, the setting "No clutch" (Direct coupled operation) cannot be selected during synchronous control after already selecting another setting.

Refer to control method for clutch for details on the clutch control. ( )

### ■ON control mode

| Setting value | Description |
|---|---|
| 0: No clutch (Direct coupled operation)) | Execute direct coupled operation without clutch control. |
| 1: Clutch command ON/OFF | The clutch is turned ON/OFF by the operation of "[Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)" ON/OFF. (Setting in the OFF control mode are not applicable in the clutch command ON/OFF mode.) |
| 2: Clutch command leading edge | The clutch turned ON when "[Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)" passes the leading edge (from OFF to ON). |
| 3: Clutch command trailing edge | The clutch is turned ON when "[Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)" passes the trailing edge (from ON to OFF). |
| 4: Address mode | The clutch is turned ON when the reference address (the current value after composite main shaft gear or the current value per cycle after main shaft gear) reaches "[Pr.407] Main shaft clutch ON address (R: D42650+160n, D42651+160n/Q: D15010+150n, D15011+150n)". The travel value after passing through the ON address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value. |
| 5: High speed input request | The clutch is turned ON when the high speed input request signal turns ON. |

> **Point**
>
> Other clutch parameters are not applicable during direct coupled operation by setting "0: No clutch". "[Rq.402] Main shaft clutch forced OFF command (R: M42402+16n/Q: M11682+10n)" and the change of the clutch control setting are ignored during direct coupled operation.

### ■OFF control mode

| Setting value | Description |
|---|---|
| 0: OFF control invalid | Clutch OFF control is not used. This setting is applicable only for execution with clutch ON control. |
| 1: One-shot OFF | The clutch turned OFF after moving the distance "[Pr.410] Travel value before main shaft clutch OFF (R: D42656+160n, D42657+160n/Q: D15016+150n, D15107+150n)" (One-shot operation) after the clutch command turns from OFF to ON. If "[Pr.410] Travel value before main shaft clutch OFF (R: D42656+160n, D42657+160n/Q: D15016+150n, D15107+150n)" is 0, "[St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n)" does not turn ON in order to turn back OFF immediately. |
| 2: Clutch command leading edge | The clutch is turned OFF when "[Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)" passes the leading edge (from OFF to ON). |
| 3: Clutch command trailing edge | The clutch is turned OFF when "[Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)" passes the trailing edge (from ON to OFF). |
| 4: Address mode | The clutch is turned OFF when the reference address (the current value after composite main shaft gear or the current value per cycle after main shaft gear) reaches "[Pr.409] Main shaft clutch OFF address (R: D42654+160n, D42655+160n/Q: D15014+150n, D15015+150n)". The travel value before passing through the OFF address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value. |
| 5: High speed input request | The clutch is turned OFF when the high speed input request signal turns ON. |

## ■High speed input request signal

Set the high speed input request signal No. for the "(a) ON control mode" and the "(b) OFF control mode" when using the setting "5: High speed input request".

| Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) |
|---|---|---|---|---|---|---|---|
| 1 | 00 | 17 | 10 | 33 | 20 | 49 | 30 |
| 2 | 01 | 18 | 11 | 34 | 21 | 50 | 31 |
| 3 | 02 | 19 | 12 | 35 | 22 | 51 | 32 |
| 4 | 03 | 20 | 13 | 36 | 23 | 52 | 33 |
| 5 | 04 | 21 | 14 | 37 | 24 | 53 | 34 |
| 6 | 05 | 22 | 15 | 38 | 25 | 54 | 35 |
| 7 | 06 | 23 | 16 | 39 | 26 | 55 | 36 |
| 8 | 07 | 24 | 17 | 40 | 27 | 56 | 37 |
| 9 | 08 | 25 | 18 | 41 | 28 | 57 | 38 |
| 10 | 09 | 26 | 19 | 42 | 29 | 58 | 39 |
| 11 | 0A | 27 | 1A | 43 | 2A | 59 | 3A |
| 12 | 0B | 28 | 1B | 44 | 2B | 60 | 3B |
| 13 | 0C | 29 | 1C | 45 | 2C | 61 | 3C |
| 14 | 0D | 30 | 1D | 46 | 2D | 62 | 3D |
| 15 | 0E | 31 | 1E | 47 | 2E | 63 | 3E |
| 16 | 0F | 32 | 1F | 48 | 2F | 64 | 3F |

## [Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n)

Select the address type to be used as the reference address for clutch control.

| Setting value | Description |
|---|---|
| 0: Current value after composite main shaft gear | The clutch is controlled by using the current value after composite main shaft gear. Output after the clutch control is a converted travel value through the main shaft gear. |
| 1: Current value per cycle after main shaft gear | The clutch is controlled by using the current value per cycle after main shaft gear. Output after the clutch control is a travel value without conversion. |

The setting units for the following parameters are in units based on the reference address setting.
- [Pr.407] Main shaft clutch ON address (R: D42650+160n, D42651+160n/Q: D15010+150n, D15011+150n)
- [Pr.409] Main shaft clutch OFF address (R: D42654+160n, D42655+160n/Q: D15014+150n, D15015+150n)
- [Pr.408] Travel value before main shaft clutch ON (R: D42652+160n, D42653+160n/Q: D15012+150n, D15013+150n), [Pr.410] Travel value before main shaft clutch OFF (R: D42656+160n, D42657+160n/Q: D15016+150n, D15017+150n)
- [Pr.413] Slippage amount at main shaft clutch ON (R: D42660+160n, D42661+160n/Q: D15020+150n, D15021+150n), [Pr.414] Slippage amount at main shaft clutch OFF (R: D42662+160n, D42663+160n/Q: D15022+150n, D15023+150n)

## [Pr.407] Main shaft clutch ON address (R: D42650L+160n/Q: D15010L+150n)

Set the clutch ON address when address mode is configured for the ON control mode of the main shaft clutch.
When the reference address is the current value per cycle after main shaft gear, the setting address is converted for control within the range from 0 to (Cam axis length per cycle-1).

Ex.

Cam axis length per cycle: 20000[pulse]

The ON address is controlled as 19000[pulse] when the setting value is -1000.

## [Pr.408] Travel value before main shaft clutch ON (R: D42652L+160n/Q: D15012L+150n)

Set the travel value for the reference address with a signed number for the distance between the clutch ON condition completing and the clutch closing.

| Setting value | Description |
|---|---|
| 1 to 2147483647(Positive value) | Used when the reference address is increasing in direction. |
| 0 | No movement (The clutch is immediately turned ON with the clutch ON condition completing.) |
| -2147483648 to -1(Negative value) | Used when the reference address is decreasing in direction. |

Clutch ON condition is completed
(Example: [Rq.400] Main shaft clutch command
(R: M42400+16n/Q: M11680+10n) ON)

[St.420] Main shaft clutch ON/OFF status
(R: M38960+16n/Q: M10560+10n)

[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/ Q: D13600+30n, D13601+30n)
or
[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/ Q: D13602+30n, D13603+30n)

Travel value after clutch
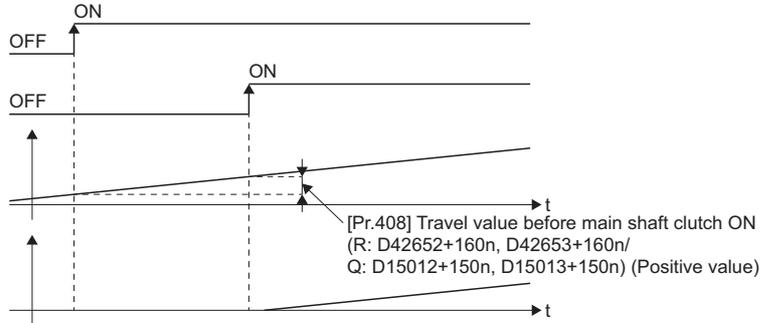


## [Pr.409] Main shaft clutch OFF address (R: D42654L+160n/Q: D15014L+150n)

Set the clutch OFF address when address mode is configured for the OFF control mode of the main shaft clutch.

When the reference address is the current value per cycle after main shaft gear, the setting address is converted for control within the range from 0 to (Cam axis length per cycle-1).

Ex.

Cam axis length per cycle: 20000[pulse]

The OFF address is controlled as 60[pulse] when the setting value is 40060.

## [Pr.410] Travel value before main shaft clutch OFF (R: D42656L+160n/Q: D15016L+150n)

Set the travel value for the reference address with a signed number for the distance between the clutch OFF condition completing and the clutch opening.

| Setting value | Description |
|---|---|
| 1 to 2147483647(Positive value) | Used when the reference address is increasing in direction. |
| 0 | No movement. (The clutch is immediately turned OFF with the clutch OFF condition completing.) |
| -2147483648 to -1(Negative value) | Used when the reference address is decreasing in direction. |

Clutch OFF condition is completed
(Example: [Rq.400] Main shaft clutch command
(R: M42400+16n/Q: M11680+10n) OFF)

[St.420] Main shaft clutch ON/OFF status
(R: M38960+16n/Q: M10560+10n)

[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/ Q: D13600+30n, D13601+30n)
or
[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/ Q: D13602+30n, D13603+30n)

Travel value after clutch
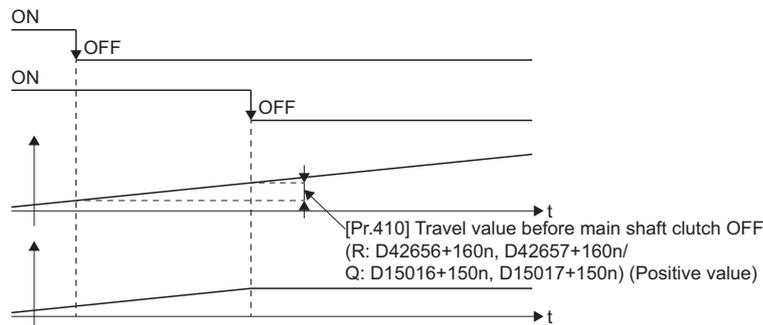
## [Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n)

Set the smoothing method for clutch ON/OFF. (☞ Page 116 Smoothing method for clutch)

| Setting value | Description |
|---|---|
| 0: Direct | No smoothing. |
| 1: Time constant method (Exponent) | Smoothing with an exponential curve based on the time constant setting. |
| 2: Time constant method (Linear) | Smoothing with linear acceleration/deceleration based on the time constant setting. |
| 3: Slippage method (Exponent) | Smoothing with an exponential curve based on the slippage amount setting. |
| 4: Slippage method (Linear) | Smoothing with linear acceleration/deceleration based on the slippage amount setting. |
| 5: Slippage method (Linear: Input value follow up) | Smoothing with linear acceleration/deceleration based on the slippage amount setting. |

## [Pr.412] Main shaft clutch smoothing time constant (R: D42659+160n/Q: D15019+150n)

Set a time constant when the time constant method is set in "[Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n)".

The time constant setting applies for both clutch ON/OFF.

## [Pr.413] Slippage amount at main shaft clutch ON (R: D42660L+160n/Q: D15020L+150n)

Set the slippage amount at clutch ON when the slippage method is set in "[Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n)".

The slippage amount is set in units based on the current value selected in "[Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n)".

If the set amount is negative, slippage amount at clutch ON is controlled as 0 (direct).

## [Pr.414] Slippage amount at main shaft clutch OFF (R: D42662L+160n/Q: D15022L+150n)

Set the slippage amount at clutch OFF when the slippage method is set in "[Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n)".

The slippage amount is set in units based on the current value selected in "[Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n)".

If the set amount is negative, slippage amount at clutch OFF is controlled as 0 (direct).

# Main shaft clutch control data

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Rq.400 | Main shaft clutch command | Set the clutch command ON/OFF. | OFF: Main shaft clutch command OFF<br>ON: Main shaft clutch command ON | Operation cycle | OFF | M42400+16n | M11680+10n |
| Rq.401 | Main shaft clutch control invalid command | Set the command disable the clutch control temporarily. | OFF: Main shaft clutch control valid<br>ON: Main shaft clutch control invalid | | OFF | M42401+16n | M11681+10n |
| Rq.402 | Main shaft clutch forced OFF command | Set the command to force the clutch OFF. | OFF: Main shaft clutch normal control<br>ON: Main shaft clutch forced OFF | | OFF | M42402+16n | M11682+10n |

## [Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n)

Use ON/OFF for the main shaft clutch command. This command is used when the clutch ON control mode is "1: Clutch command ON/OFF", "2: Clutch command leading edge" or "3: Clutch command trailing edge", and the clutch OFF control mode is either "2: Clutch command leading edge" or "3: Clutch command trailing edge".

Status is considered as clutch command OFF just before starting synchronous control. If synchronous control is started while the clutch command is ON, the condition is established just after starting synchronous control, by setting "2: Clutch command leading edge". The condition is not established just after starting, by setting "3: Clutch command trailing edge".

## [Rq.401] Main shaft clutch control invalid command (R: M42401+16n/Q: M11681+10n)

The main shaft clutch control is invalid if ON is set. The previous clutch ON/OFF status remains before clutch control becomes invalid.

Clutch control will not become invalid during movement before clutch ON and during movement before clutch OFF. Instead, clutch control will become invalid after movement is completed.

## [Rq.402] Main shaft clutch forced OFF command (R: M42402+16n/Q: M11682+10n)

Set ON to force the clutch OFF. The output value from the clutch becomes 0 immediately, even during clutch smoothing. The slippage (accumulative) amount is set to 0 if smoothing with a slippage method.

Reset to OFF to restart the clutch control from the clutch OFF status after using the clutch forced OFF command.

# 6.2 Auxiliary Shaft Module

## Overview of auxiliary shaft module

For the auxiliary shaft module, the input value is generated from the auxiliary shaft. The input value can be converted by the auxiliary shaft gear that provides the deceleration ratio and the rotation direction for the machine system etc.

Refer to the following for details on setting for the auxiliary shaft module.

- Auxiliary shaft parameters (☞ Page 102 Auxiliary shaft parameters)
- Auxiliary shaft clutch parameters (☞ Page 104 Auxiliary shaft clutch parameters)



*1 Clutch (☞ Page 111 Clutch)

## Auxiliary shaft parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Pr.418 | Auxiliary shaft axis No. | Set the input axis No. for the auxiliary shaft. | 0: Invalid<br>1 to 64: Servo input axis[1]<br>201 to 264: Command generation axis[2]<br>801 to 812: Synchronous encoder axis | At start of synchronous control | 0 | D42664+160n | D15024+150n |
| Pr.419 | Composite auxiliary shaft gear | Select the composite method for input values from the main shaft and the auxiliary shaft. | • Set in hexadecimal.<br>H□□□□<br>↳ Main shaft input method<br>0: No input<br>1: Input +<br>2: Input -<br>↳ Auxiliary shaft input method<br>0: No input<br>1: Input +<br>2: Input - | Operation cycle | 0001H | D42665+160n | D15025+150n |
| Pr.420 | Auxiliary shaft gear: Numerator | Set the numerator for the auxiliary shaft gear. | -2147483648 to 2147483647 | At start of synchronous control | 1 | D42666+160n<br>D42667+160n | D15026+150n<br>D15027+150n |
| Pr.421 | Auxiliary shaft gear: Denominator | Set the denominator for the auxiliary shaft gear. | 1 to 2147483647 | | 1 | D42668+160n<br>D42669+160n | D15028+150n<br>D15029+150n |

*1 The following range is valid. R16MTCPU: 1 to 16, R32MTCPU: 1 to 32.
*2 The following range is valid. R16MTCPU: 201 to 216, R32MTCPU: 201 to 232.

## [Pr.418] Auxiliary shaft axis No. (R: D42664+160n/Q: D15024+150n)

Set the input axis No. for the auxiliary shaft.

| Setting value | Description |
|---|---|
| 0: Invalid | The input value is always 0. |
| 1 to 64: Servo input axis[*1] | Set the servo input axis (axis 1 to 64).<br>When the servo input axis is not set in the servo network setting, the input value is always 0.<br>If the number is set to the same value as the output axis, minor error (error code: 1BF0H) occurs and synchronous control cannot be started. |
| 201 to 264: Command generation axis[*2] | Set the command generation axis (axis 1 to 64).<br>When the command generation axis is invalid in the command generation axis parameter setting, the input value is always 0.<br>As the command generation axis is used only for command generation, it is possible to set the same number as the output axis. |
| 801 to 812: Synchronous encoder axis | Set the synchronous encoder axis (axis 1 to 12).<br>When synchronous encoder axis is invalid, the input value is always 0. |

*1 The following range is valid. R16MTCPU: 1 to 16, R32MTCPU: 1 to 32.
*2 The following range is valid. R16MTCPU: 201 to 216, R32MTCPU: 201 to 232.

## [Pr.419] Composite auxiliary shaft gear (R: D42665+160n/Q: D15025+150n)

Set the composite method for input values from the main and auxiliary shafts. The setting values for each axis are shown as follows.

| Setting value | Description |
|---|---|
| 0: No input | The input value from the input axis is calculated as 0. |
| 1: Input+ | The input value from the input axis is calculated as it is. |
| 2: Input- | The input value from the input axis is calculated with its opposite sign. |

Operation assumes "0: No input" if the value is set out of the range from 0 to 2.

> **Point**
>
> The composite method for the composite auxiliary shaft gear can be changed during synchronous control. It is used as a clutch to switch input values between the main and the auxiliary shafts.

## [Pr.420] Auxiliary shaft gear: Numerator (R: D42666L+160n/Q: D15026L+150n)

Set the numerator for auxiliary shaft gear to convert the input value. The input value is converted as follows.

$$\text{Input value after conversion} = \text{Input value before conversion} \times \frac{\text{Auxiliary shaft gear: Numerator}}{\text{Auxiliary shaft gear: Denominator}}$$

The input value direction can be reversed by setting a negative value in the numerator of the auxiliary shaft gear.
Set the denominator of the auxiliary shaft gear to a value within the range from 1 to 2147483647.

## [Pr.421] Auxiliary shaft gear: Denominator (R: D42668L+160n/Q: D15028L+150n)

Set the denominator for auxiliary shaft gear to convert the input value.
Set together with the main shaft gear numerator. (☞ Page 103 [Pr.420] Auxiliary shaft gear: Numerator (R: D42666L+160n/ Q: D15026L+150n))

# Auxiliary shaft clutch parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Pr.422 | Auxiliary shaft clutch control setting | Set the control method for the clutch. | • Set in hexadecimal.<br>H□□□□<br>→ ON control mode<br>0: No clutch<br>1: Clutch command ON/OFF<br>2: Clutch command leading edge<br>3: Clutch command trailing edge<br>4: Address mode<br>5: High speed input request<br>→ OFF control mode<br>0: OFF control invalid<br>1: One-shot OFF<br>2: Clutch command leading edge<br>3: Clutch command trailing edge<br>4: Address mode<br>5: High speed input request<br>→ High speed input request signal<br>00 to 3F: High speed input request signal from signal 1 to 64 | Operation cycle | 0000H | D42670+160n | D15030+150n |
| Pr.423 | Auxiliary shaft clutch reference address setting | Set the reference address for the clutch. | 0: Current value after composite auxiliary shaft gear<br>1: Current value per cycle after auxiliary shaft gear | At start of synchronous control | 0 | D42671+160n | D15031+150n |
| Pr.424 | Auxiliary shaft clutch ON address | • Set the clutch ON address for address mode. (This setting is invalid except during address mode.)<br>• If the address is out of the range from 0 to (Cam axis length per cycle - 1), the address is converted to a value within range. | -2147483648 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | Operation cycle | 0 | D42672+160n<br>D42673+160n | D15032+150n<br>D15033+150n |
| Pr.425 | Travel value before auxiliary shaft clutch ON | • Set the travel value for the distance between the clutch ON condition completing and the clutch closing.<br>• Set a positive value when the reference address is increasing, and a negative value when it is decreasing. | -2147483648 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | At completing clutch ON condition | 0 | D42674+160n<br>D42675+160n | D15034+150n<br>D15035+150n |

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.426 | Auxiliary shaft clutch OFF address | • Set the clutch OFF address for the address mode. (This setting is invalid except during address mode.)<br>• If the address is out of the range from 0 to (Cam axis length per cycle - 1), the setting address is converted to a value within range. | -2147483648 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | Operation cycle | 0 | D42676+160n D42677+160n | D15036+150n D15037+150n |
| Pr.427 | Travel value before auxiliary shaft clutch OFF | • Set the travel value for the distance between the clutch OFF condition completing and the clutch opening.<br>• Set a positive value when the reference address is increasing, and a negative value when it is decreasing. | -2147483648 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | At completing clutch OFF condition | 0 | D42678+160n D42679+160n | D15038+150n D15039+150n |
| Pr.428 | Auxiliary shaft clutch smoothing method | Set the clutch smoothing method. | 0: Direct<br>1: Time constant method (Exponent)<br>2: Time constant method (Linear)<br>3: Slippage method (Exponent)<br>4: Slippage method (Linear)<br>5: Slippage method (Linear: Input value follow up) | At start of synchronous control | 0 | D42680+160n | D15040+150n |
| Pr.429 | Auxiliary shaft clutch smoothing time constant | For smoothing with a time constant method, set the smoothing time constant. | 0 to 5000[ms] | | 0[ms] | D42681+160n | D15041+150n |
| Pr.430 | Slippage amount at auxiliary shaft clutch ON | For smoothing with a slippage method, set the slippage amount at clutch ON. | 0 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | At turning clutch ON | 0 | D42682+160n D42683+160n | D15042+150n D15043+150n |
| Pr.431 | Slippage amount at auxiliary shaft clutch OFF | For smoothing with a slippage method, set the slippage amount at clutch OFF. | 0 to 2147483647 [Auxiliary shaft position units[*1], or cam axis cycle units[*2]] | At turning clutch OFF | 0 | D42684+160n D42685+160n | D15044+150n D15045+150n |

*1  Auxiliary shaft position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)
*2  Cam axis cycle units (☞ Page 126 Cam axis cycle units)

## [Pr.422] Auxiliary shaft clutch control setting (R: D42670+160n/Q: D15030+150n)

Set the ON and OFF control methods separately for the auxiliary shaft.

The clutch control setting can be changed during synchronous control, however the setting to "No clutch" (Direct coupled operation) cannot be selected during synchronous control after already selecting another setting.

Refer to control method for clutch for details on the clutch control. (☞ Page 111 Control method for clutch)

### ■ON control mode

| Setting value | Description |
|---|---|
| 0: No clutch (Direct coupled operation) | Execute direct coupled operation without clutch control. |
| 1: Clutch command ON/OFF | The clutch is turned ON/OFF by the operation of "[Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)" ON/OFF. (Setting in the OFF control mode are not applicable in the clutch command ON/OFF mode.) |
| 2: Clutch command leading edge | The clutch is turned ON when "[Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)" passes the leading edge (from OFF to ON). |
| 3: Clutch command trailing edge | The clutch is turned ON when "[Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)" passes the trailing edge (from ON to OFF). |
| 4: Address mode | The clutch is turned ON when the reference address (the auxiliary shaft current value or the current value per cycle after auxiliary shaft gear) reaches "[Pr.424] Auxiliary shaft clutch ON address (R: D42672+160n, D42673+160n/Q: D15032+150n, D15033+150n)".<br>The travel value after passing through the ON address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value. |
| 5: High speed input request | The clutch is turned ON when the high speed input request signal turns ON. |

> **Point** 🔎
>
> Other clutch parameters are not applicable during direct coupled operation by setting "0: No clutch". "[Rq.405] Auxiliary shaft clutch forced OFF command (R: M42406+16n/Q: M11686+10n)" and the change of the clutch control setting are ignored during direct coupled operation.

### ■OFF control mode

| Setting value | Description |
|---|---|
| 0: OFF control invalid | Clutch OFF control is not used. This setting is applicable only for execution with clutch ON control. |
| 1: One-shot OFF | The clutch turned OFF after moving the distance "[Pr.427] Travel value before auxiliary shaft clutch OFF (R: D42678+160n, D42679+160n/Q: D15038+150n, D15039+150n)" (One-shot operation) after the clutch command turns from OFF to ON.<br>If "[Pr.427] Travel value before auxiliary shaft clutch OFF (R: D42678+160n, D42679+160n/Q: D15038+150n, D15039+150n)" is 0, "[St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n)" does not turn ON in order to turn back OFF immediately. |
| 2: Clutch command leading edge | The clutch is turned OFF when "[Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)" passes the leading edge (from OFF to ON). |
| 3: Clutch command trailing edge | The clutch is turned OFF when "[Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)" passes the trailing edge (from ON to OFF). |
| 4: Address mode | The clutch is turned OFF when the reference address (the auxiliary shaft current value or the current value per cycle after auxiliary shaft gear) reaches "[Pr.426] Auxiliary shaft clutch OFF address (R: D42676+160n, D42677+160n/Q: D15036+150n, D15037+150n)".<br>The travel value before passing through the OFF address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value. |
| 5: High speed input request | The clutch is turned OFF when the high speed input request signal turns ON. |

## ■High speed input request signal

Set the high speed input request signal No. for the "ON control mode" and the "OFF control mode" when using the setting "5: High speed input request".

| Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) | Signal No. | Setting value (Hexadecimal) |
|---|---|---|---|---|---|---|---|
| 1 | 00 | 17 | 10 | 33 | 20 | 49 | 30 |
| 2 | 01 | 18 | 11 | 34 | 21 | 50 | 31 |
| 3 | 02 | 19 | 12 | 35 | 22 | 51 | 32 |
| 4 | 03 | 20 | 13 | 36 | 23 | 52 | 33 |
| 5 | 04 | 21 | 14 | 37 | 24 | 53 | 34 |
| 6 | 05 | 22 | 15 | 38 | 25 | 54 | 35 |
| 7 | 06 | 23 | 16 | 39 | 26 | 55 | 36 |
| 8 | 07 | 24 | 17 | 40 | 27 | 56 | 37 |
| 9 | 08 | 25 | 18 | 41 | 28 | 57 | 38 |
| 10 | 09 | 26 | 19 | 42 | 29 | 58 | 39 |
| 11 | 0A | 27 | 1A | 43 | 2A | 59 | 3A |
| 12 | 0B | 28 | 1B | 44 | 2B | 60 | 3B |
| 13 | 0C | 29 | 1C | 45 | 2C | 61 | 3C |
| 14 | 0D | 30 | 1D | 46 | 2D | 62 | 3D |
| 15 | 0E | 31 | 1E | 47 | 2E | 63 | 3E |
| 16 | 0F | 32 | 1F | 48 | 2F | 64 | 3F |

## [Pr.423] Auxiliary shaft clutch reference address setting (R: D42671+160n/Q: D15031+150n)

Select the address type to be used as the reference address for clutch control.

| Setting value | Description |
|---|---|
| 0: Auxiliary shaft current value | The clutch is controlled by using the current value for the servo input axis/command generation axis/synchronous encoder axis that is set for the auxiliary shaft.<br>Output after the clutch control is a converted travel value through the auxiliary shaft gear. |
| 1: Current value per cycle after auxiliary shaft gear | The clutch is controlled by using the current value per cycle after auxiliary shaft gear.<br>Output after the clutch control is a travel value without conversion. |

The setting units for the following parameters are in units based on the reference address setting.
- [Pr.424] Auxiliary shaft clutch ON address (R: D42672+160n, D42673+160n/Q: D15032+150n, D15033+150n)
- [Pr.426] Auxiliary shaft clutch OFF address (R: D42676+160n, D42677+160n/Q: D15036+150n, D15037+150n)
- [Pr.425] Travel value before auxiliary shaft clutch ON (R: D42674+160n, D42675+160n/Q: D15034+150n, D15035+150n), [Pr.427] Travel value before auxiliary shaft clutch OFF (R: D42678+160n, D42679+160n/Q: D15038+150n, D15039+150n)
- [Pr.430] Slippage amount at auxiliary shaft clutch ON (R: D42682+160n, D42683+160n/Q: D15042+150n, D15043+150n), [Pr.431] Slippage amount at auxiliary shaft clutch OFF (R: D42684+160n, D42685+160n/Q: D15044+150n, D15045+150n)

## [Pr.424] Auxiliary shaft clutch ON address (R: D42672L+160n/Q: D15032L+150n)

Set the clutch ON address when address mode is configured for the ON control mode of the auxiliary shaft clutch.

When the reference address is the current value per cycle after auxiliary shaft gear, the setting address is converted for control within the range from 0 to (Cam axis length per cycle - 1).

Ex.

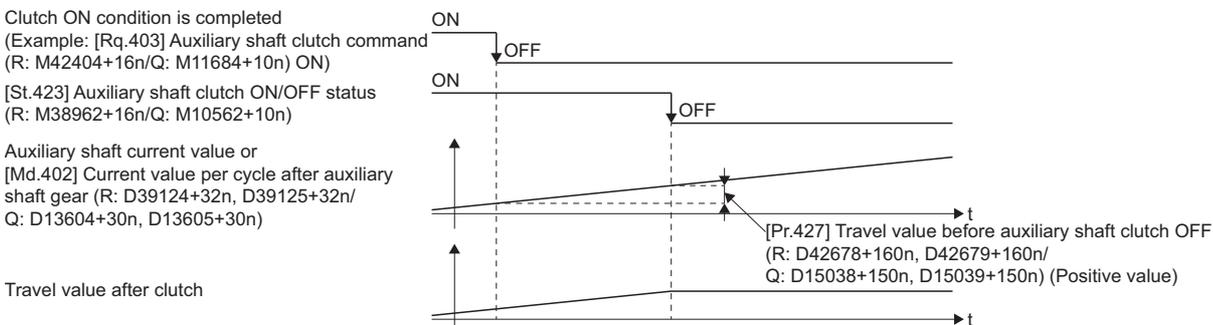Cam axis length per cycle: 20000[pulse]

The ON address is controlled as 19000[pulse] when the setting value is -1000.

## [Pr.425] Travel value before auxiliary shaft clutch ON (R: D42674L+160n/Q: D15034L+150n)

Set the travel value for the reference address with a signed numbers for the distance between the clutch ON condition completing and the clutch closing.

| Setting value | Description |
|---|---|
| 1 to 2147483647(Positive value) | Used when the reference address is increasing in direction. |
| 0 | No movement (The clutch is immediately turned ON with the clutch ON condition completing.) |
| -2147483648 to -1(Negative value) | Used when the reference address is decreasing in direction. |

Clutch ON condition is completed
(Example: [Rq.403] Auxiliary shaft clutch command
(R: M42404+16n/Q: M11684+10n) ON)

[St.423] Auxiliary shaft clutch ON/OFF status
(R: M38962+16n/Q: M10562+10n)

Auxiliary shaft current value or
[Md.402] Current value per cycle after auxiliary
shaft gear (R: D39124+32n, D39125+32n/
Q: D13604+30n, D13605+30n)

Travel value after clutch

[Pr.425] Travel value before auxiliary shaft clutch ON
(R: D42674+160n, D42675+160n/
Q: D15034+150n, D15035+150n) (Positive value)

## [Pr.426] Auxiliary shaft clutch OFF address (R: D42676L+160n/Q: D15036L+150n)

Set the clutch OFF address when address mode is configured for the OFF control mode of the auxiliary shaft clutch.

When the reference address is the current value per cycle after auxiliary shaft gear, the setting address is converted for control within the range from 0 to (Cam axis length per cycle - 1).

**Ex.**

Cam axis length per cycle: 20000[pulse]

The OFF address is controlled as 60[pulse] when the setting value is 40060.

## [Pr.427] Travel value before auxiliary shaft clutch OFF (R: D42678L+160n/Q: D15038L+150n)

Set the travel value for the reference address with a signed numbers for the distance between the clutch OFF condition completing and the clutch opening.

| Setting value | Description |
|---|---|
| 1 to 2147483647(Positive value) | Used when the reference address is increasing in direction. |
| 0 | No movement. (The clutch is immediately turned OFF with the clutch OFF condition completing.) |
| -2147483648 to -1(Negative value) | Used when the reference address is decreasing in direction. |

Clutch ON condition is completed
(Example: [Rq.403] Auxiliary shaft clutch command
(R: M42404+16n/Q: M11684+10n) ON)

[St.423] Auxiliary shaft clutch ON/OFF status
(R: M38962+16n/Q: M10562+10n)

Auxiliary shaft current value or
[Md.402] Current value per cycle after auxiliary
shaft gear (R: D39124+32n, D39125+32n/
Q: D13604+30n, D13605+30n)

Travel value after clutch

[Pr.427] Travel value before auxiliary shaft clutch OFF
(R: D42678+160n, D42679+160n/
Q: D15038+150n, D15039+150n) (Positive value)

## [Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n)

Set the smoothing method for clutch ON/OFF. (☞ Page 116 Smoothing method for clutch)

| Setting value | Description |
|---|---|
| 0: Direct | No smoothing. |
| 1: Time constant method (Exponent) | Smoothing with an exponential curve based on the time constant setting. |
| 2: Time constant method (Linear) | Smoothing with linear acceleration/deceleration based on the time constant setting. |
| 3: Slippage method (Exponent) | Smoothing with an exponential curve based on the slippage amount setting. |
| 4: Slippage method (Linear) | Smoothing with linear acceleration/deceleration based on the slippage amount setting. |
| 5: Slippage method (Linear: Input value follow up) | Smoothing with linear acceleration/deceleration based on the slippage amount setting. |

## [Pr.429] Auxiliary shaft clutch smoothing time constant (R: D42681+160n/Q: D15041+150n)

Set a time constant when the time constant method is set in "[Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n)".

The time constant setting applies for both clutch ON/OFF.

## [Pr.430] Slippage amount at auxiliary shaft clutch ON (R: D42682L+160n/Q: D15042L+150n)

Set the slippage amount at clutch ON when the slippage method is set in "[Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n)".

The slippage amount is set in units based on the current value selected in "[Pr.423] Auxiliary shaft clutch reference address setting (R: D42671+160n/Q: D15031+150n)".

If the set amount is negative, the slippage amount at clutch ON is controlled as 0 (direct).

## [Pr.431] Slippage amount at auxiliary shaft clutch OFF (R: D42684L+160n/Q: D15044L+150n)

Set the slippage amount at clutch OFF when the slippage method is set in "[Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n)".

The slippage amount is set in units based on the current value selected in "[Pr.423] Auxiliary shaft clutch reference address setting (R: D42671+160n/Q: D15031+150n)".

If the set amount is negative, the slippage amount at clutch OFF is controlled as 0 (direct).

# Auxiliary shaft clutch control data

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Rq.403 | Auxiliary shaft clutch command | Set the clutch command ON/OFF. | OFF: Auxiliary shaft clutch command OFF<br>ON: Auxiliary shaft clutch command ON | Operation cycle | OFF | M42404+16n | M11684+10n |
| Rq.404 | Auxiliary shaft clutch control invalid command | Set the command to disable the clutch control temporarily. | OFF: Auxiliary shaft clutch control valid<br>ON: Auxiliary shaft clutch control invalid | | OFF | M42405+16n | M11685+10n |
| Rq.405 | Auxiliary shaft clutch forced OFF command | Set the command to force the clutch OFF. | OFF: Auxiliary shaft clutch normal control<br>ON: Auxiliary shaft clutch forced OFF | | OFF | M42406+16n | M11686+10n |

## [Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n)

Use ON/OFF for the auxiliary shaft clutch command. This command is used when the clutch ON control mode is "1: Clutch command ON/OFF", "2: Clutch command leading edge" or "3: Clutch command trailing edge", and the clutch OFF control mode is either "2: Clutch command leading edge" or "3: Clutch command trailing edge".

Status is considered as clutch command OFF just before starting synchronous control. If synchronous control is started while the clutch command is ON, the condition is established just after starting synchronous control, by setting "2: Clutch command leading edge". The condition is not established just after starting, by setting "3: Clutch command trailing edge".

## [Rq.404] Auxiliary shaft clutch control invalid command (R: M42405+16n/Q: M11685+10n)

The auxiliary shaft clutch control is invalid if ON is set. The previous clutch ON/OFF status remains before clutch control becomes invalid.

Clutch control will not become invalid during movement before clutch ON and clutch OFF. Instead, clutch control will become invalid after movement is completed.

## [Rq.405] Auxiliary shaft clutch forced OFF command (R: M42406+16n/Q: M11686+10n)

Set ON to force the clutch OFF. The output value from the clutch becomes 0 immediately, even during clutch smoothing. The slippage (accumulative) amount is set to 0 if smoothing with a slippage method.

Reset to OFF to restart the clutch control from the clutch OFF status after using the clutch forced OFF command.

# 6.3 Clutch

## Overview of clutch

The clutch is used to transmit/disengage command pulses from the main/auxiliary shaft input side to the output module side through turning the clutch ON/OFF, which controls the operation/stop of the servo motor.

A clutch can be configured for the main and auxiliary shafts.

## Control method for clutch

Set the ON and OFF control methods separately in "[Pr.405] Main shaft clutch control setting (R: D42648+160n/Q: D15008+150n)" and "[Pr.422] Auxiliary shaft clutch control setting (R: D42670+160n/Q: D15030+150n)".

Although the clutch control setting can be changed during synchronous control, however, the setting "No clutch" (Direct coupled operation) cannot be selected during synchronous control after already selecting another setting.

| Item | Setting item | | Setting details | Setting value |
|---|---|---|---|---|
| | **Main shaft clutch** | **Auxiliary shaft clutch** | | |
| Clutch control setting | [Pr.405] Main shaft clutch control setting (R: D42648+160n/Q: D15008+150n) | [Pr.422] Auxiliary shaft clutch control setting (R: D42670+160n/ Q: D15030+150n) | Set the clutch control method. | • Set in hexadecimal.<br><br>H□□□□<br><br>→ ON control mode<br>　　0: No clutch<br>　　1: Clutch command ON/OFF<br>　　2: Clutch command leading edge<br>　　3: Clutch command trailing edge<br>　　4: Address mode<br>　　5: High speed input request<br>→ OFF control mode<br>　　0: OFF control invalid<br>　　1: One-shot OFF<br>　　2: Clutch command leading edge<br>　　3: Clutch command trailing edge<br>　　4: Address mode<br>　　5: High speed input request<br>→ High speed input request signal<br>　　00 to 3F: High speed input request signal from signal 1 to 64 |

When the clutch ON condition and the clutch OFF condition are completed simultaneously within one operation cycle, both clutch ON and OFF processing are executed within one operation cycle. Therefore, the clutch is from OFF to ON and again to OFF at the clutch OFF status, and it is from ON to OFF and again to ON at the clutch ON status.

The ON and OFF control mode setting for clutch ON/OFF are shown below.

## ON control mode

### ■No clutch (Direct coupled operation)

Execute direct coupled operation without clutch control.

> **Point**
>
> Other clutch parameters are not applicable during direct coupled operation by setting "0: No clutch". "Clutch forced OFF command" and the change of the clutch control setting are ignored during direct coupled operation.

### ■Clutch command ON/OFF

The clutch is turned ON/OFF by the operation of clutch command ON/OFF.

(Setting in the OFF control mode are not applicable in the clutch command ON/OFF mode.)

| Item | Main shaft clutch | Auxiliary shaft clutch |
|---|---|---|
| Clutch command | [Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n) | [Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n) |
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n) |

### ■Clutch command leading edge

The clutch is turned ON when the clutch command passes the leading edge (from OFF to ON).
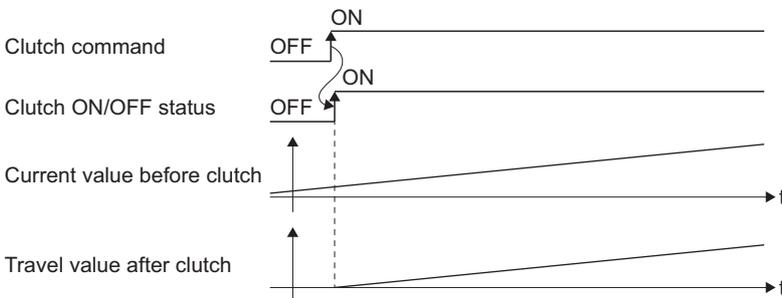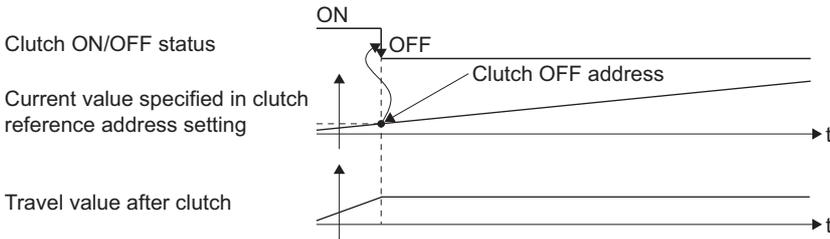
### ■Clutch command trailing edge

The clutch is turned ON when the clutch command passes the trailing edge (from ON to OFF).
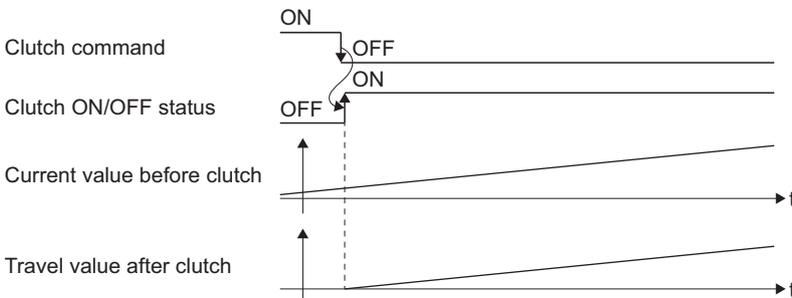
## ■Address mode

The clutch is turned ON when the reference address reaches "Clutch ON address".

The travel value after passing through the ON address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value.
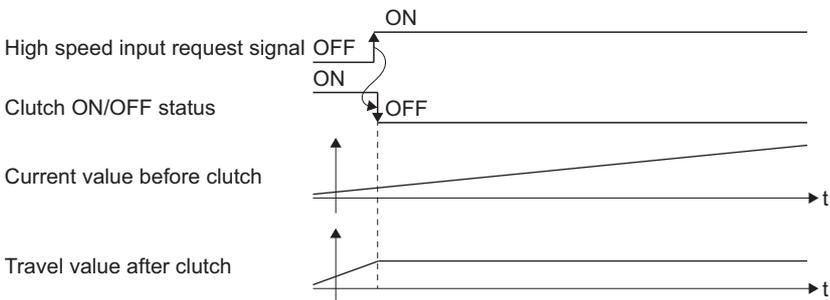


| Item | Main shaft clutch | Auxiliary shaft clutch |
|---|---|---|
| Reference address | The current value specified in "[Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n)"("[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)" or "[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/Q: D13602+30n, D13603+30n)") | The current value specified in "[Pr.423] Auxiliary shaft clutch reference address setting (R: D42671+160n/Q: M15031+150n)"(Auxiliary shaft current value (servo input axis current value/synchronous encoder axis current value) or "[Md.402] Current value per cycle after auxiliary shaft gear (R: D39124+32n, D39125+32n/Q: D13604+30n, D13605+30n)") |
| Clutch ON address | [Pr.407] Main shaft clutch ON address (R: D42650+160n, D42651+160n/Q: D15010+150n, D15011+150n) | [Pr.424] Auxiliary shaft clutch ON address (R: D42672+160n, D42673+160n/Q: D15032+150n, D15033+150n) |
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n) |

## ■High-speed input request

The clutch is turned ON when the high-speed input request signal turns ON.

The following actions are required when using the high-speed input request.

- Set the signal No. for the "High-speed input request signal" clutch control setting.
- Set the input signal to be used by [Motion CPU Common Parameter] ⇨ [High-speed input request signal].



*Point*

When the mixed operation cycle function is valid, set the setting No. of the high-speed input request signal that has a high-speed input request signal control cycle setting that matches the output axis control cycle.

## OFF control mode

### ■ OFF control invalid

Clutch OFF control is not used. This setting is applicable only for execution with clutch ON control.

### ■One-shot OFF

The clutch is turned OFF after moving the distance "Travel value before clutch OFF" (One-shot operation) after the clutch command turns from OFF to ON.

If "Travel value before clutch OFF" is 0, "Clutch ON/OFF status" does not turn ON in order to turn back OFF immediately.



| Item | Main shaft clutch | Auxiliary shaft clutch |
|---|---|---|
| Clutch command | [Rq.400] Main shaft clutch command (R: M42400+16n/Q: M11680+10n) | [Rq.403] Auxiliary shaft clutch command (R: M42404+16n/Q: M11684+10n) |
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n) |
| Travel value before clutch OFF | [Pr.410] Travel value before main shaft clutch OFF (R: M42656+160n, M42657+160n/Q: D15016+150n, D15017+150n) | [Pr.427] Travel value before auxiliary shaft clutch OFF (R: M42678+160n, M42679+160n/Q: D15038+150n, D15039+150n) |

### ■Clutch command leading edge

The clutch is turned OFF when the clutch command passes the leading edge (from OFF to ON).
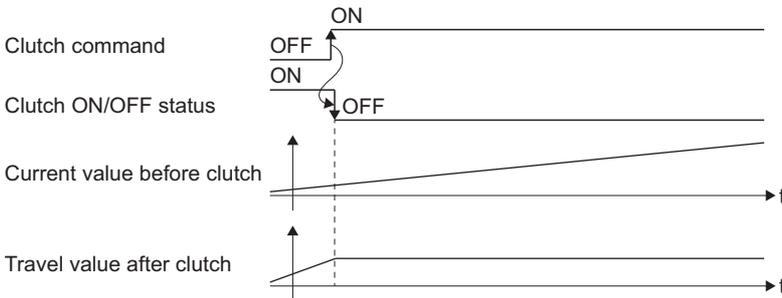


### ■Clutch command trailing edge

The clutch is turned OFF when the clutch command passes the trailing edge (from ON to OFF).
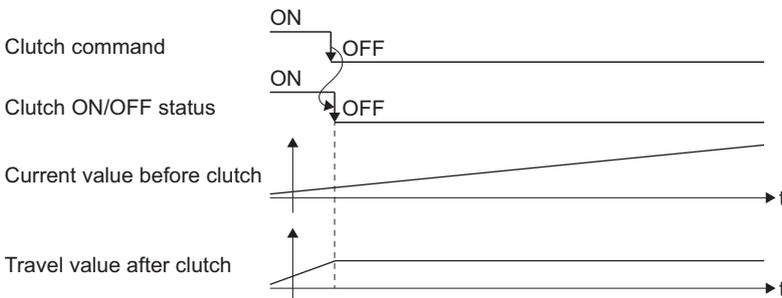
## ■Address mode

The clutch is turned OFF when the reference address reaches "Clutch OFF address".

The travel value before passing through the OFF address is calculated as the output travel value of the clutch based on the reference address passing through, thereby controlling the clutch with an accurate travel value.



| Item | Main shaft clutch | Auxiliary shaft clutch |
|---|---|---|
| Reference address | The current value specified in "[Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n)" ("[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)" or "[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/Q: D13602+30n, D13603+30n)") | The current value specified in "[Pr.423] Auxiliary shaft clutch reference address setting (R: D42671+160n/Q: D15031+150n)"(Auxiliary shaft current value (servo input axis current value/synchronous encoder axis current value) or "[Md.402] Current value per cycle after auxiliary shaft gear (R: D39124+32n, D39125+32n/Q: D13604+30n, D13605+30n)") |
| Clutch OFF address | [Pr.409] Main shaft clutch OFF address (R: D42654+160n, D42655+160n/Q: D15014+150n, D15015+150n) | [Pr.426] Auxiliary shaft clutch OFF address(R: D42676+160n, D42677+160n/Q: D15036+150n, D15037+150n) |
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/ Q: M10562+10n) |

## ■High-speed input request

The clutch is turned OFF when the high-speed input request signal turns ON.

The following actions are required when using the high-speed input request.

- Set the signal No. for the "High-speed input request signal" clutch control setting.
- Set the input signal to be used by [Motion CPU Common Parameter] ⇨ [High-speed input request signal].



**Point**

When the mixed operation cycle function is valid, set the setting No. of the high-speed input request signal that has a high-speed input request signal control cycle setting that matches the output axis control cycle.

# Smoothing method for clutch

Set the clutch smoothing method in "[Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n)" and "[Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n)".

The 2 types of clutch smoothing include the following.

- Time constant method smoothing
- Slippage method smoothing

When not using clutch smoothing, set "0: Direct" in the clutch smoothing method.

| Item | Setting item | | Setting details | Setting value |
| --- | --- | --- | --- | --- |
| | Main shaft clutch | Auxiliary shaft clutch | | |
| Clutch smoothing method | [Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n) | [Pr.428] Auxiliary shaft clutch smoothing method (R: D42680+160n/Q: D15040+150n) | Set the clutch smoothing method. | 0: Direct<br>1: Time constant method (Exponent)<br>2: Time constant method (Linear)<br>3: Slippage method (Exponent)<br>4: Slippage method (Linear)<br>5: Slippage method (Linear: Input value follow up) |

The operation of each smoothing method is shown below.

## Time constant method smoothing

Smoothing is processed with the time constant setting value in the smoothing time constant at clutch ON/OFF. After clutch ON smoothing is complete, smoothing is processed with the time constant setting value when the speed of the input values changes.

The travel value between the clutch turning ON and OFF is not changed with smoothing.

Travel value after clutch smoothing = Travel value before clutch smoothing

| Item | Setting item | | Setting details | Setting value |
| --- | --- | --- | --- | --- |
| | Main shaft clutch | Auxiliary shaft clutch | | |
| Clutch smoothing time constant | [Pr.412] Main shaft clutch smoothing time constant (R: D42659+160n/Q: D15019+150n) | [Pr.429] Auxiliary shaft clutch smoothing time constant (R: D42681+160n/Q: D15041+150n) | For smoothing with a time constant method, set the smoothing time constant. | 0 to 5000[ms] |

### ■Time constant method exponential curve smoothing

Set "1: Time constant method (Exponential)" in the clutch smoothing method.



| Item | Main shaft clutch | Auxiliary shaft clutch |
| --- | --- | --- |
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n) |
| Clutch smoothing status | [St.421] Main shaft clutch smoothing status (R: M38961+16n/Q: M10561+10n) | [St.424] Auxiliary shaft clutch smoothing status (R: M38963+16n/Q: M10563+10n) |

## ■Time constant method linear acceleration/deceleration smoothing

Set "2: Time constant method (Linear)" in the clutch smoothing method.
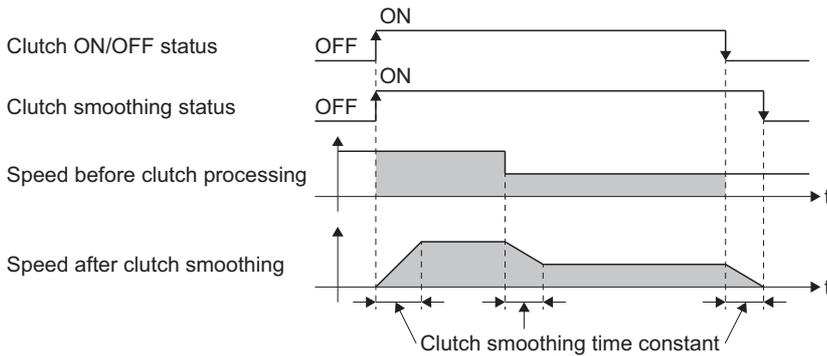


## Slippage method smoothing

Smoothing is processed with the value in slippage at clutch ON when the clutch turns ON, and with slippage at clutch OFF when the clutch turns OFF.

Smoothing is also processed with the slippage amount setting when the input speed to the clutch changes, therefore, positioning control at clutch ON/OFF is not affected by speed changes.

Processing proceeds with direct operation after completing clutch ON smoothing.

The travel value between the clutch turning ON and OFF is as follows after clutch smoothing.

Travel value after clutch smoothing=Travel value before clutch smoothing+(Slippage amount at OFF-Slippage amount at ON)

| Item | Setting item | | Setting details | Setting value |
|---|---|---|---|---|
| | Main shaft clutch | Auxiliary shaft clutch | | |
| Slippage amount at clutch ON | [Pr.413] Slippage amount at main shaft clutch ON (R: D42660+160n, D42661+160n/Q: D15020+150n, D15021+150n) | [Pr.430] Slippage amount at auxiliary shaft clutch ON (R: D42682+160n, D42683+160n/Q: D15042+150n, D15043+150n) | For smoothing with a slippage method, set the slippage amount at clutch ON. | 0 to 2147483647 [Main input axis position units[*1]/ auxiliary shaft position units[*2], or cam axis cycle units[*3]] |
| Slippage amount at clutch OFF | [Pr.414] Slippage amount at main shaft clutch OFF (R: D42662+160n, D42663+160n/Q: D15022+150n, D15023+150n) | [Pr.431] Slippage amount at auxiliary shaft clutch OFF (R: D42684+160n, D42685+160n/Q: D15044+150n, D15045+150n) | For smoothing with a slippage method, set the slippage amount at clutch OFF. | |

*1 Main input axis position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

*2 Auxiliary shaft position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

*3 Cam axis cycle units (☞ Page 126 Cam axis cycle units)

### ■Slippage method exponential curve smoothing

Set "3: Slippage (Exponential)" in the clutch smoothing method.



| Item | Main shaft clutch | Auxiliary shaft clutch |
|---|---|---|
| Clutch ON/OFF status | [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n) | [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/ Q: M10562+10n) |
| Clutch smoothing status | [St.421] Main shaft clutch smoothing status (R: M38961+16n/Q: M10561+10n) | [St.424] Auxiliary shaft clutch smoothing status (R: M38963+16n/Q: M10563+10n) |

## ■Slippage method linear acceleration/deceleration smoothing

Set "4: Slippage method (Linear)", or "5: Slippage method (Linear: Input value follow up)" in the clutch smoothing method. The difference between "4: Slippage method (Linear)" and "5: Slippage method (Linear: Input value follow up)" is shown below.

| Input speed during smoothing | Smoothing method | |
|---|---|---|
| | 4: Slippage method (Linear) | 5: Slippage method (Linear: Input value follow up) |
| When input speed is fixed | No difference | |
| When there is a continuous small oscillation in the input speed | The output speed (smoothing section) fluctuates according to the input speed when clutch is ON. | The output speed (smoothing section) is fixed regardless of the input speed when clutch is ON. |
| When input speed has a large fluctuation | The fluctuation in the output speed (smoothing section) is small. (The average speed may rise higher than before the start of smoothing) | The output speed (smoothing section) fluctuates with the input speed. (When reaccelerating after the input speed is dropped, a sudden acceleration may occur) |

- When input speed is fixed

    The operation for "4: Slippage method (Linear)" and "5: Slippage method (Linear: Input value follow up)" is the same.
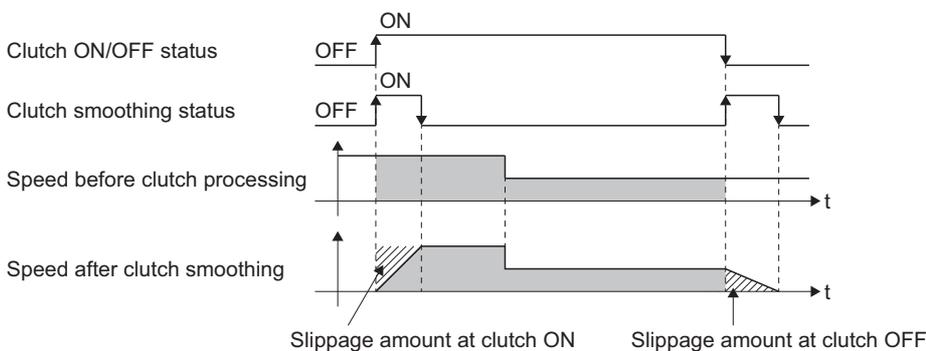


- When there is a continuous small oscillation in the input speed
    - When "4: Slippage method (Linear)" is set

    The clutch smoothing status ON section changes with the fluctuation of the input speed.

    - When the clutch smoothing status ON section is extended
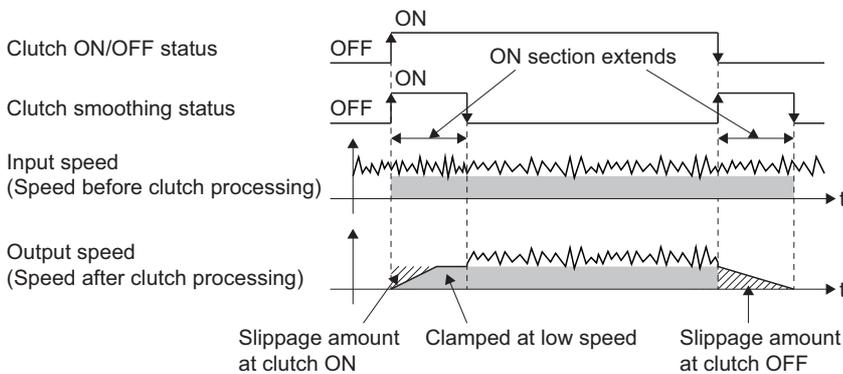


    - When the clutch smoothing status ON section is shortened
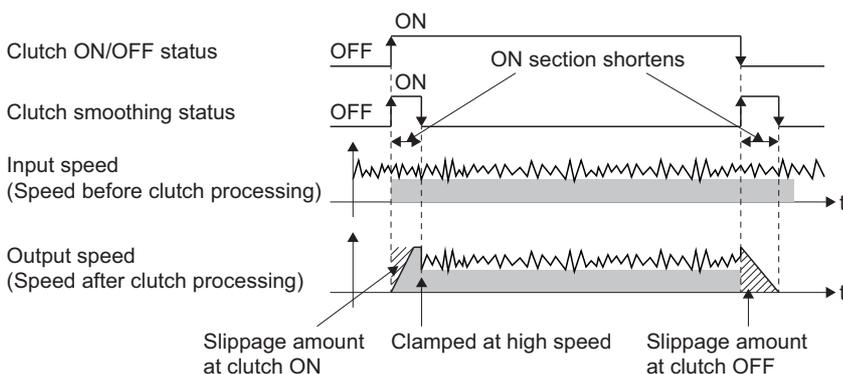
• When "5: Slippage method (Linear: Input value follow up)" is set

The clutch smoothing status ON section is fixed.
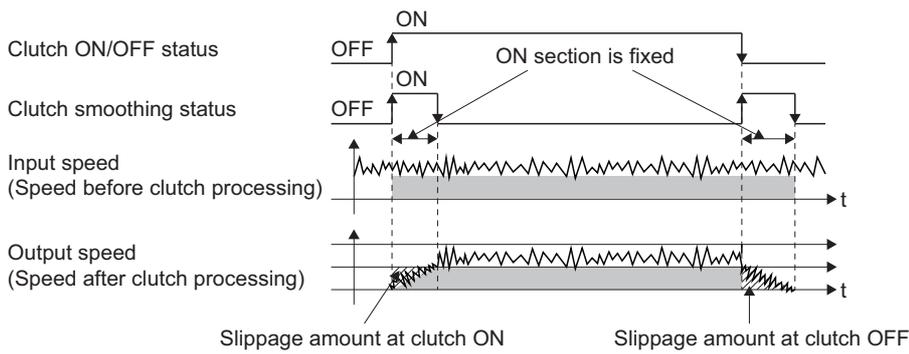


• When input speed has a large fluctuation

• When "4: Slippage method (Linear)" is set

The fluctuation in the output speed is smaller compared to the fluctuation in the input speed.
(The average speed may rise higher than before the start of smoothing)
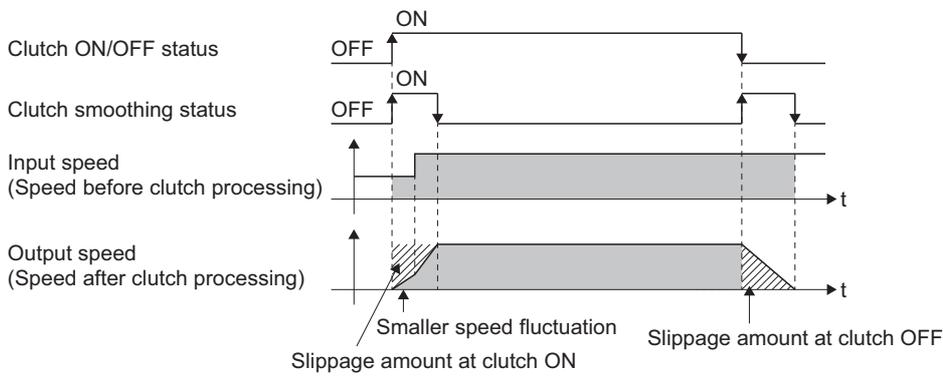


• When "5: Slippage method (Linear: Input value follow up)" is set

The output speed fluctuates with the input speed.
(When re-accelerating after the input speed is dropped, a sudden acceleration may occur)
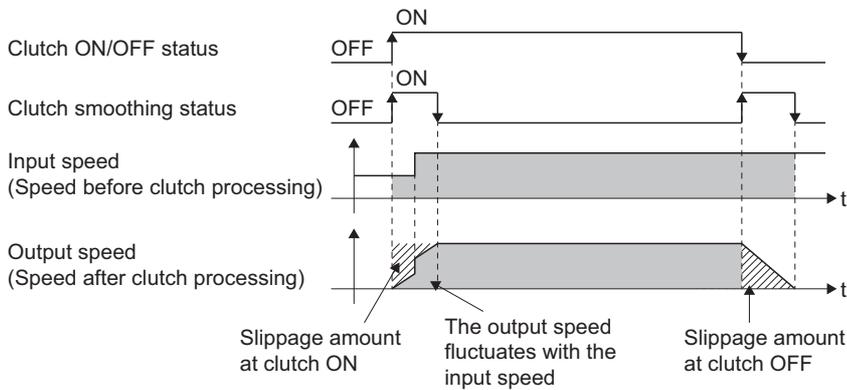
### ■Operation at input speed deceleration during slippage method smoothing

When the speed before clutch processing decreases, the speed after clutch smoothing is controlled without exceeding the speed before clutch processing.

If slippage amount remains when the speed before clutch processing becomes 0, the smoothing process will be continued. And when the speed before clutch processing gets faster than the speed after clutch smoothing, clutch smoothing takes place for the remainder slippage amount.
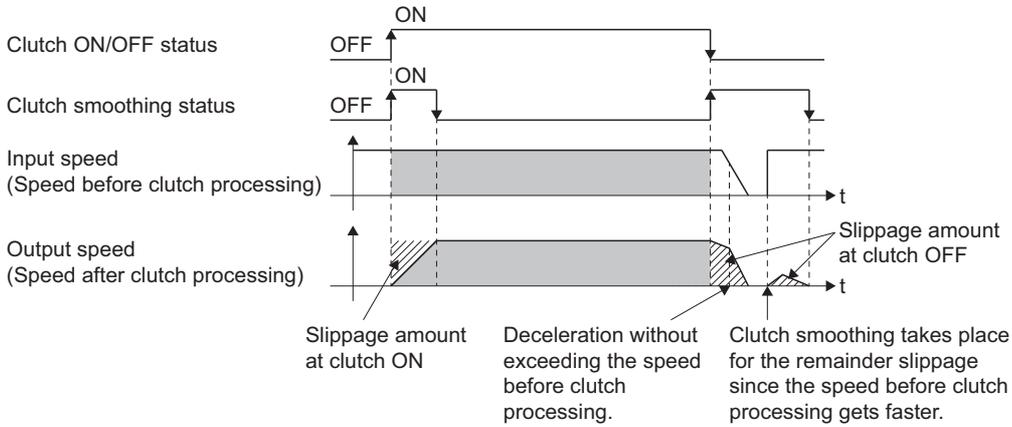
# Use example of clutch

The following machine shows an example using clutch control for a flying shear cutting system that synchronizes off a start signal from a sensor input.
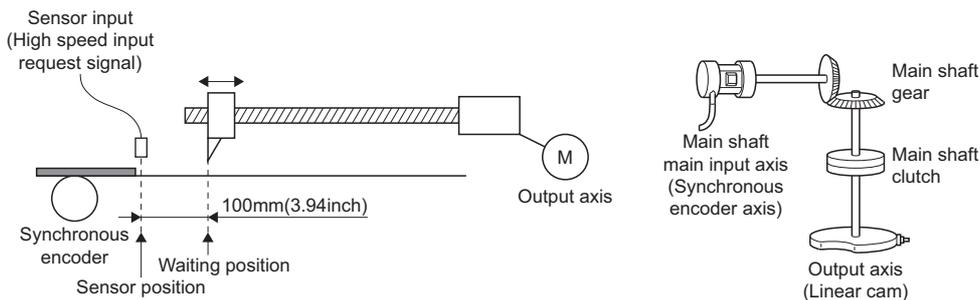


| Main shaft clutch setting item | | Setting value |
|---|---|---|
| [Pr.405] Main shaft clutch control setting (R: D42648+160n/Q: D15008+150n) | ON control mode | 5: High speed input request |
| | OFF control mode | 1: One-shot OFF |
| | High speed input request signal | (Specify the high speed input request signal No., used for sensor input.) |
| [Pr.406] Main shaft clutch reference address setting (R: D42649+160n/Q: D15009+150n) | | 0: Current value after composite main shaft gear |
| [Pr.408] Travel value before main shaft clutch ON (R: D42652+160n, D42653+160n/Q: D15012+150n, D15013+150n) | | 0[mm] (0[inch]) |
| [Pr.410] Travel value before main shaft clutch OFF (R: D42656+160n, D42657+160n/Q: D15016+150n, D15017+150n) | | 380[mm] (14.96[inch]) |
| [Pr.411] Main shaft clutch smoothing method (R: D42658+160n/Q: D15018+150n) | | 4: Slippage method (Linear) |
| [Pr.413] Slippage amount at main shaft clutch ON (R: D42660+160n, D42661+160n/Q: D15020+150n, D15021+150n) | | 100[mm] (3.94[inch]) (Distance between the sensor and the waiting position) |
| [Pr.414] Slippage amount at main shaft clutch OFF (R: D42662+160n, D42663+160n/Q: D15022+150n, D15023+150n) | | 20[mm] (0.79[inch]) |
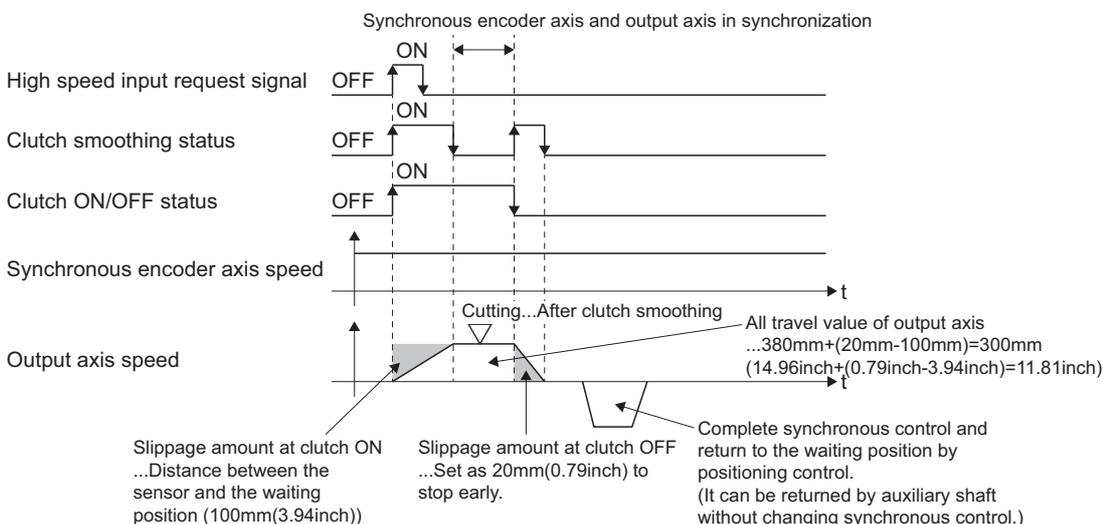
# 6.4 Speed Change Gear Module

## Overview of speed change gear module

A speed change gear module is used to change the input speed from the main shaft/auxiliary shaft/composite auxiliary shaft gear during operation. When not using a speed change gear module, set "0: No speed change gear" in "[Pr.434] Speed change gear1 (R: D42686+160n/Q: D15046+150n)" and "[Pr.490] Speed change gear2 (R: D42692+160n/Q: D15052+150n)".

With speed change from a speed change gear module, operation is executed with linear acceleration/deceleration based on the setting for the speed change gear smoothing time constant.

[Pr.434]Speed change gear 1
(R: D42686+160n/Q: D15046+150n)
[Pr.435]Speed change gear 1 smoothing time constant
(R: D42687+160n/Q: D15047+150n)
[Pr.436]Speed change ratio 1: Numerator
(R: D42688+160n, D42689+160n/
Q: D15048+150n, D15049+150n)
[Pr.437]Speed change ratio 1: Denominator
(R: D42690+160n, D42691+160n/
Q: D15050+150n, D15051+150n)

[Pr.490]Speed change gear 2
(R: D42692+160n/Q: D15052+150n)
[Pr.491]Speed change gear 2 smoothing time constant
(R: D42693+160n/Q: D15053+150n)
[Pr.492]Speed change ratio 2: Numerator
(R: D42694+160n, D42695+160n/
Q: D15054+150n, D15055+150n)
[Pr.493]Speed change ratio 2: Denominator
(R: D42696+160n, D42697+160n/
Q: D15056+150n, D15057+150n)

Input value

Speed change gear

Output value

[Arrangement the speed change gear]
Arranged on two of "Main shaft side", "Auxiliary shaft side" or "After composite auxiliary shaft gear".

Main shaft clutch
Speed change gear
Auxiliary shaft clutch
Speed change gear
Composite auxiliary shaft gear
Speed change gear
Cam
Output axis

Input value speed before speed change

[Pr.436] Speed change ratio 1: Numerator
(R: D42688+160n, D42689+160n/
Q: D15048+150n, D15049+150n)
[Pr.492] Speed change ratio 2: Numerator
(R: D42694+160n, D42695+160n/
Q: D15054+150n, D15055+150n)

100000 | 50000 | -50000

[Pr.437] Speed change ratio 1: Denominator
(R: D42690+160n, D42691+160n/
Q: D15050+150n, D15051+150n)
[Pr.493] Speed change ratio 2: Denominator
(R: D42696+160n, D42697+160n/
Q: D15056+150n, D15057+150n)

100000 | 100000 | 100000

Input value speed after speed change

[Pr.435] Speed change gear 1 smoothing time constant
(R: D42687+160n/Q: D15047+150n)
[Pr.491] Speed change gear 2 smoothing time constant
(R: D42693+160n/Q: D15053+150n)

[Pr.435] Speed change gear 1 smoothing time constant
(R: D42687+160n/Q: D15047+150n)
[Pr.491] Speed change gear 2 smoothing time constant
(R: D42693+160n/Q: D15053+150n)

# Speed change gear parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.434 | Speed change gear 1 | Set the arrangement for the speed change gear 1. | 0: No speed change gear<br>1: Main shaft side<br>2: Auxiliary shaft side<br>3: After composite auxiliary shaft gear | At start of synchronous control | 0 | D42686+160n | D15046+150n |
| Pr.435 | Speed change gear 1 smoothing time constant | Set the smoothing time constant for the speed change gear 1. | 0 to 5000[ms] | | 0[ms] | D42687+160n | D15047+150n |
| Pr.436 | Speed change ratio 1: Numerator | Set the numerator for the speed change ratio 1. | -2147483648 to 2147483647 | Operation cycle | 1 | D42688+160n D42689+160n | D15048+150n D15049+150n |
| Pr.437 | Speed change ratio 1: Denominator | Set the denominator for the speed change ratio 1. | 1 to 2147483647 | | 1 | D42690+160n D42691+160n | D15050+150n D15051+150n |
| Pr.490 | Speed change gear 2 | Set the arrangement for the speed change gear 2. | 0: No speed change gear<br>1: Main shaft side<br>2: Auxiliary shaft side<br>3: After composite auxiliary shaft gear | At start of synchronous control | 0 | D42692+160n | D15052+150n |
| Pr.491 | Speed change gear 2 smoothing time constant | Set the smoothing time constant for the speed change gear 2. | 0 to 5000[ms] | | 0[ms] | D42693+160n | D15053+150n |
| Pr.492 | Speed change ratio 2: Numerator | Set the numerator for the speed change ratio 2. | -2147483648 to 2147483647 | Operation cycle | 1 | D42694+160n D42695+160n | D15054+150n D15055+150n |
| Pr.493 | Speed change ratio 2: Denominator | Set the denominator for the speed change ratio 2. | 1 to 2147483647 | | 1 | D42696+160n D42697+160n | D15056+150n D15057+150n |

## [Pr.434] Speed change gear 1 (R: D42686+160n/Q: D15046+150n)

Set the arrangement for the speed change gear 1. The speed change gear 1 and speed change gear 2 cannot be set in the same arrangement. If they are set in the same arrangement, the minor error (error code: 1C08H) occurs and the synchronous control cannot be started.

| Setting value | Description |
|---|---|
| 0: No speed change gear | Speed change is not processed, and the input value is transmitted as is. |
| 1: Main shaft side | Speed change is processed for input value after main shaft clutch based on the speed change ratio settings. |
| 2: Auxiliary shaft side | Speed change is processed for input value after auxiliary shaft clutch based on the speed change ratio settings. |
| 3: After composite auxiliary shaft gear | Speed change is processed for input value after composite auxiliary shaft gear based on the speed change ratio settings. |

## [Pr.435] Speed change gear 1 smoothing time constant (R: D42687+160n/Q: D15047+150n)

Set the averaging time to execute a smoothing process for the speed change for the speed change gear.
The input response is delayed depending on the time corresponding the speed change gear smoothing time constant.
Speed is changed directly when "0" is set.

## [Pr.436] Speed change ratio 1: Numerator (R: D42688L+160n/Q: D15048L+150n)

Set the numerator for the speed change ratio 1.

Speed change ratio 1: Numerator can be changed during synchronous control.

Input values for speed change are processed as follows.

$$\text{Input value after change} = \text{Input value before change} \times \frac{\text{Speed change ratio: Numerator}}{\text{Speed change ratio: Denominator}}$$

The input speed can be reversed by setting a negative value in Speed change ratio 1: Numerator.

Speed change ratio: Denominator is set within the range from 1 to 2147483647.

## [Pr.437] Speed change ratio 1: Denominator (R: D42690+L+160n/Q: D15050L+150n)

Set the denominator for the speed change ratio 1.

Speed change ratio 1: Denominator can be changed during synchronous control.

Set together with the speed change ratio 1: Numerator. (☞ Page 124 [Pr.436] Speed change ratio 1: Numerator (R: D42688L+160n/Q: D15048L+150n))

## [Pr.490] Speed change gear 2 (R: D42692+160n/Q: D15052+150n)

Set the arrangement for the speed change gear 2. The speed change gear 1 and speed change gear 2 cannot be set in the same arrangement. If they are set in the same arrangement, the minor error (error code: 1C08H) occurs and the synchronous control cannot be started.

| Setting value | Description |
|---|---|
| 0: No speed change gear | Speed change is not processed, and the input value is transmitted as is. |
| 1: Main shaft side | Speed change is processed for input value after main shaft clutch based on the speed change ratio settings. |
| 2: Auxiliary shaft side | Speed change is processed for input value after auxiliary shaft clutch based on the speed change ratio settings. |
| 3: After composite auxiliary shaft gear | Speed change is processed for input value after composite auxiliary shaft gear based on the speed change ratio settings. |

## [Pr.491] Speed change gear 2 smoothing time constant (R: D42693+160n/Q: D15053+150n)

Set the averaging time to execute a smoothing process for the speed change for the speed change gear.

The input response is delayed depending on the time corresponding the speed change gear smoothing time constant.

Speed is changed directly when "0" is set.

## [Pr.492] Speed change ratio 2: Numerator (R: D42694L+160n/Q: D15054L+150n)

Set the numerator for the speed change ratio 2.

Speed change ratio 2: Numerator can be changed during synchronous control.

Input values for speed change are processed as follows.

$$\text{Input value after change} = \text{Input value before change} \times \frac{\text{Speed change ratio: Numerator}}{\text{Speed change ratio: Denominator}}$$

The input speed can be reversed by setting a negative value in Speed change ratio 2: Numerator.

Speed change ratio 2: Denominator is set within the range from 1 to 2147483647.

## [Pr.493] Speed change ratio 2: Denominator (R: D42696L+160n/Q: D15056L+150n)

Set the denominator for the speed change ratio 2.

Speed change ratio 2: Denominator can be changed during synchronous control.

Set together with the Speed change ratio 2: Numerator. (☞ Page 124 [Pr.492] Speed change ratio 2: Numerator (R: D42694L+160n/Q: D15054L+150n))

# 6.5 Output Axis Module

## Overview of output axis module

For the output axis module, the cam axis current value per cycle is calculated based on the input value (the output value from a speed change gear), and is converted based on the cam data settings as output commands to the servo amplifier.



[Pr.438] Cam axis cycle unit setting
(R: D42698+160n/Q: D15058+150n)
(No influence on control)
[Pr.448] Synchronous control parameter block No.
(R: D42709+160n/Q: D15069+150n)

[Pr.444] Cam axis phase compensation advance time
(R: D42706+160n, D42707+160n/ Q: D15066+150n, D15067+150n)
[Pr.445] Cam axis phase compensation time constant
(R: D42708+160n/Q: D15068+150n)

[Pr.439] Cam axis length per cycle
(R: D42700+160n, D42701+160n/ Q: D15060+150n, D1561+150n)
[Pr.440] Cam No.
(R: D42702+160n/Q: D15062+150n)
[Pr.441] Cam stroke amount
(R: D42704+160n, D42705+160n/ Q: D15064+150n, D1565+150n)
Cam data

[Pr.447] Output axis smoothing time constant
(R: D42710+160n/Q: D15070+150n)

Input value

Cam axis phase compensation processing

[Md.406] Cam axis phase compensation amount
(R: D39130+32n, D39131+32n/ Q: D13610+30n, D13611+30n)

Cam conversion processing

[Md.410] Execute cam No.
(R: D39138+32n/Q: D13618+30n)
[Md.411] Execute cam stroke amount
(R: D39140+32n, D39141+32n/ Q: D13620+30n, D13621+30n)

[Md.407] Cam axis current value per cycle
(R: D39132+32n, D39133+32n/ Q: D13612+30n, D13613+30n)
[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/ Q: D13614+30n, D13615+30n)
[Md.409] Cam axis current feed value
(R: D39136+32n, D39137+32n/ Q: D13616+30n, D13617+30n)

Output axis smoothing processing

[Md.20] Feed current value
(R: D32000+48n, D32001+48n/ Q: D0+20n, D1+20n)

# Units for the output axis

## ■Output axis position units

The position units for the output axis are shown below based on the setting "Unit setting" of fixed parameter.

| Setting value of Unit setting | Output axis position unit | Range |
|---|---|---|
| 0: mm | $\times 10^{-1}$μm | -214748364.8 to 214748364.7[μm] |
| 1: inch | $\times 10^{-5}$inch | -21474.83648 to 21474.83647[inch] |
| 2: degree | $\times 10^{-5}$degree | -21474.83648 to 21474.83647[degree] |
| 3: pulse | pulse | -2147483648 to 2147483647[pulse] |

## ■Cam axis cycle units

Cam axis cycle units are shown below based on the setting "[Pr.438] Cam axis cycle unit setting (R: D42698+160n/Q: D15058+150n)".

| Setting value of "[Pr.438] Cam axis cycle unit setting (D15058+150n)" | | | Cam axis cycle unit | Range |
|---|---|---|---|---|
| Unit setting selection | Control unit | Number of decimal places | | |
| 0: Use units of main input axis | — | — | Servo input axis position unit (☞ Page 31 Servo input axis position units) Command generation axis position unit (☞ Page 39 Command generation axis position units) Synchronous encoder axis position unit (☞ Page 55 Synchronous encoder axis position units) | |
| 1: Use units of this setting | 0: mm | 0 | mm | -2147483648 to 2147483647[mm] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$mm | -2.147483648 to 2.147483647[mm] |
| | 1: inch | 0 | inch | -2147483648 to 2147483647[inch] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$inch | -2.147483648 to 2.147483647[inch] |
| | 2: degree | 0 | degree | -2147483648 to 2147483647[degree] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$degree | -2.147483648 to 2.147483647[degree] |
| | 3: pulse | 0 | pulse | -2147483648 to 2147483647[pulse] |
| | | ⋮ | ⋮ | ⋮ |
| | | 9 | $\times 10^{-9}$pulse | -2.147483648 to 2.147483647[pulse] |

# Output axis parameters

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| | | | | | | **Device No.** | |
| Pr.438 | Cam axis cycle unit setting | • Set the units for the cam axis length per cycle.<br>• There is no influence on the control for the parameter for monitor display. | • Set in hexadecimal.<br>H☐☐☐☐<br>↳ Control unit<br>  0: mm<br>  1: inch<br>  2: degree<br>  3: pulse<br>↳ Number of decimal places<br>  0 to 9<br>↳ b0: Unit setting selection<br>  0: Use units of main input axis<br>  1: Use units of this setting<br>  b1 to 3: Not used | At start of synchronous control | 0000H | D42698+160n | D15058+150n |
| Pr.439 | Cam axis length per cycle | Set the required input amount with the cam per cycle. | 1 to 2147483647 [Cam axis cycle units][*1] | At start of synchronous control, At passing through the 0th point of cam data | 4194304 | D42700+160n<br>D42701+160n | D15060+150n<br>D15061+150n |
| Pr.440 | Cam No. | Set the cam No. | 0:  Linear cam (Preset)<br>1 to 1024: User created cam | | 0 | D42702+160n | D15062+150n |
| Pr.441 | Cam stroke amount | • Set the cam stroke amount corresponding to the stroke ratio 100% for cam with stroke ratio data format.<br>• This is ignored for cams using the coordinate data format. | -2147483648 to 2147483647 [Output axis position units][*2] | | 4194304 | D42704+160n<br>D42705+160n | D15064+150n<br>D15065+150n |
| Pr.442 | Cam axis length per cycle change setting | Set when changing [Pr. 439] Cam axis length per cycle (D15060+150n, D15061+150n) during synchronous control. | 0:  Invalid<br>1:  Valid | At start of synchronous control | 0 | D42699+160n | D15059+150n |
| Pr.444 | Cam axis phase compensation advance time | Set the time to advance or delay the phase of the cam axis. | -2147483648 to 2147483647[μs] | Operation cycle | 0[μs] | D42706+160n<br>D42707+160n | D15066+150n<br>D15067+150n |
| Pr.445 | Cam axis phase compensation time constant | Set the time constant to affect the phase compensation of the cam axis. | 0 to 65535[ms] | At start of synchronous control | 10[ms] | D42708+160n | D15068+150n |
| Pr.448 | Synchronous control parameter block No. | Set the parameter block No. for the synchronous control. | 1 to 64 | | 1 | D42710+160n | D15069+150n |
| Pr.447 | Output axis smoothing time constant | Set to smooth the output axis. | 0 to 5000[ms] | | 0[ms] | D42709+160n | D15070+150n |

*1  Cam axis cycle units ( ☞ Page 126 Cam axis cycle units)
*2  Output axis position units ( ☞ Page 126 Output axis position units)

## [Pr.438] Cam axis cycle unit setting (R: D42698+160n/Q: D15058+150n)

Set the command units for the cam axis input per cycle to be used for cam control.

These units are used for setting the cam axis length per cycle and the cam axis current value per cycle.

There is no influence on the control for the parameter for monitor display. (☞ Page 126 Units for the output axis)

## [Pr.439] Cam axis length per cycle (R: D42700L+160n/Q: D15060L+150n)

Set the length per cycle of the cam axis to generate the cam axis current value per cycle.

The unit settings are in the cam axis cycle units. (☞ Page 126 Cam axis cycle units)

Set a value within the range from 1 to 2147483647.

The cam axis length per cycle can be changed during synchronous control by setting "1: Valid" in "[Pr. 442] Cam axis length per cycle change setting (R: D42699+160n/Q: D15059+150n)". When the cam axis current value per cycle passes through the 0th point of cam data, or is at the 0th point of cam data, the value of "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)" is loaded.

For a cam using the coordinate data format, if the input value of the final coordinate is less than "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)", it is controlled using a line segment calculated from the nearest two coordinates.

An example of a cam using coordinate data format, and changing "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)" to a value that exceeds the input value of cam data final coordinate during synchronous control is shown below.

### ■Coordinate data format

- Cam axis length per cycle : 4194304[pulse]
- Cam stroke amount : ± 4194304[pulse]
- Coordinate data

| Point | Input value | Output value |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 2097152 | 4194304 |
| 3 | 4194304 | 0 |
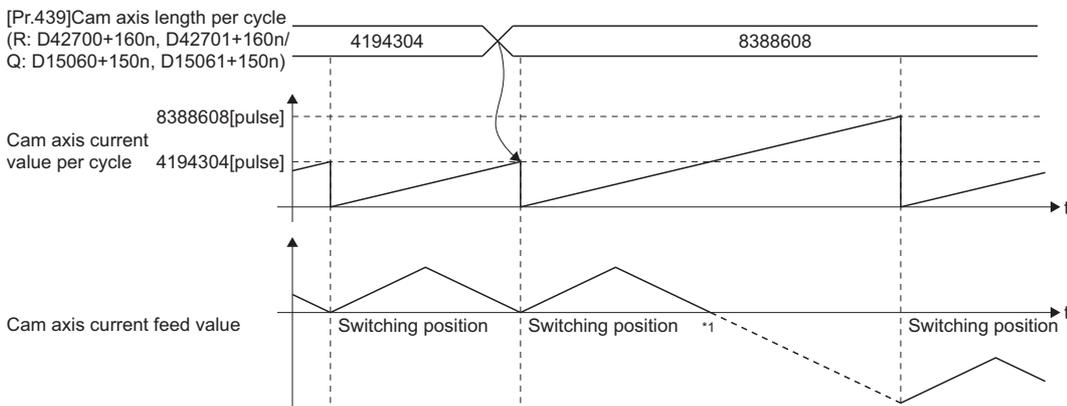


*1 Because the coordinate where "input value = cam axis length per cycle" does not exist, the final coordinate is calculated from the line segment between the nearest two coordinates.

## [Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)

Set the cam No. for cam control.

Cam No.0 is preset in the Motion CPU, and it operates as a linear cam for 100% of its stroke ratio along the cam axis length per cycle.

The cam No. can be changed during synchronous control.

The value set in "[Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)" is valid when the cam axis current value per cycle passes through the 0th point of cam data, or is on the 0th point.

## [Pr.441] Cam stroke amount (R: D42704L+160n/Q: D15064L+150n)

Set the cam stroke amount corresponding to a 100% stroke ratio in output axis position units for cam control using the stroke ratio data format. ( Page 126 Output axis position units)

The cam stroke amount can be changed during synchronous control.

The value set in "[Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n)" is valid when the cam axis current value per cycle passes through the 0th point of cam data, or is on the 0th point.

The setting value is ignored for a cam using the coordinate data format.

## [Pr.442] Cam axis length per cycle change setting (R: D42699+160n/Q: D15059+150n)

Set when changing "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160/Q: D15060+150n, D15061+150n)" during synchronous control.

Can change in cam No.0 (linear cam), stroke ratio data format, or coordinate data format. However, this cannot change [Pr.439] Cam axis length per cycle (D15060+150n, D15061+150n) in stroke ratio data format, when using cam data with starting point other than 0.

| Setting value | Description |
|---|---|
| 0: Invalid | Cannot change cam axis length per cycle during synchronous control. |
| 1: Valid | Loads the value of "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160/Q: D15060+150n, D15061+150n)" when the cam axis current value per cycle passes through the 0th point of cam data, or is at the 0th point of cam data. |

## [Pr.444] Cam axis phase compensation advance time (R: D42706L+160n/Q: D15066L+150n)

Set the time to advance or delay the phase of the cam axis current value per cycle in the cam control.

| Setting value | Description |
|---|---|
| 1 to 2147483647[μs] | Advance the phase according to the setting time. |
| 0[μs] | Do not execute phase compensation. |
| -2147483648 to -1[μs] | Delay the phase according to the setting time. |

If the setting time is too long, the system experiences overshoot or undershoot at acceleration/deceleration of the input speed. In this case, set a longer time to affect the phase compensation amount in "[Pr.445] Cam axis phase compensation time constant (R: D42708+160n/Q: D15068+150n)".

## [Pr.445] Cam axis phase compensation time constant (R: D42708+160n/Q: D15068+150n)

Set the time constant to affect the phase compensation amount for the first order delay.

63 [%] of the phase compensation amount is reflected in the time constant setting.
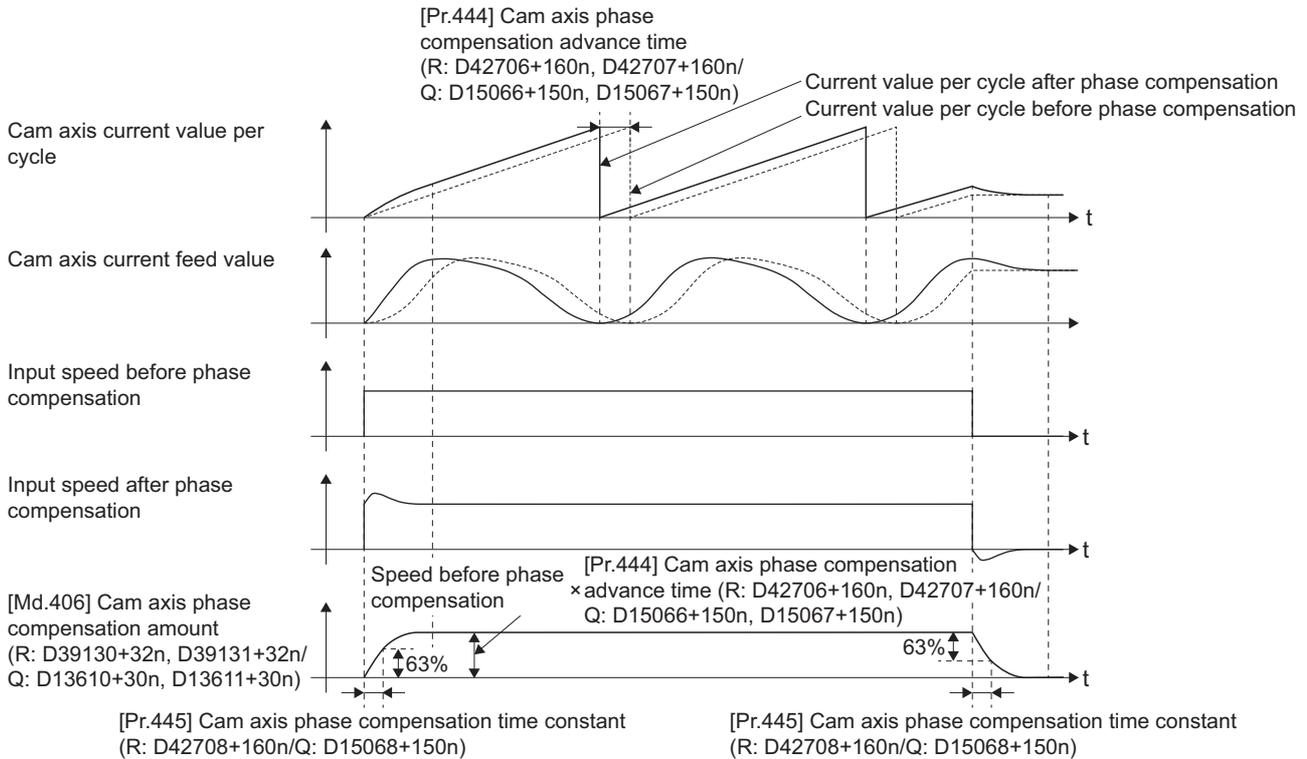


## [Pr.447] Output axis smoothing time constant (R: D42710+160n/Q: D15070+150n)

Set the averaging time to execute a smoothing process for the travel value of the output axis after cam data conversion.

The smoothing process can moderate sudden speed fluctuation for cams using the coordinate data format, etc.

The input response is delayed depending on the time corresponding to the setting by smoothing process setting.
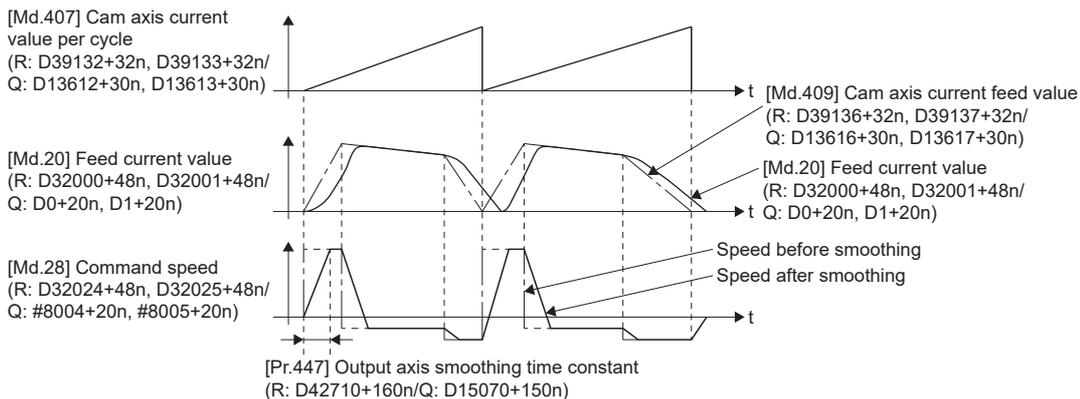
## [Pr.448] Synchronous control parameter block No. (R: D42709+160n/Q: D15069+150n)

Set the parameter block number to be used by output axis of during synchronous control.

Used item for the parameter block is shown below.

○: Valid, ×: Invalid

| Item | | Valid/invalid of setting value | Remarks |
|---|---|---|---|
| Interpolation control unit | | × | |
| Speed limit value[1] | | ○ | The setting value is valid only at the synchronous control stop. |
| Acceleration time | | × | |
| Deceleration time[1] | | ○ | The setting value is valid only at the synchronous control stop. |
| Rapid stop deceleration time[1] | | ○ | |
| S-curve ratio[2] | | × | |
| Torque limit value | | ○ | The setting value is changed to the torque limit value of output axis at the synchronous control start. |
| Deceleration processing on STOP input[1] | | ○ | The setting value is valid only at the synchronous control stop. |
| Allowable error range for circular interpolation | | × | |
| Bias speed at start | | × | |
| Acceleration/deceleration system[1][3] | | ○ | Only "0: Trapezoid/S-curve" is valid. |
| Advanced S-curve acceleration/ deceleration | Acceleration section 1 ratio | × | |
| | Acceleration section 2 ratio | × | |
| | Deceleration section 1 ratio | × | |
| | Deceleration section 2 ratio | × | |

*1 The output axis during synchronous control synchronizes with the input axis. Therefore, the output axis depends on the input axis operation and synchronous control parameter, and the setting value is invalid during the synchronous control.
However, at synchronous control stop during output axis operation, the setting value is valid since the stop is processed after the synchronous control completion, and the output axis decelerates to stop with the following slope of deceleration.
Slope of deceleration = Speed limit value ÷ Deceleration time (Rapid stop deceleration time)

*2 The setting of S-curve ratio is invalid. If a value other than 0% is set to the S-curve ratio, the stop processing is performed with trapezoidal acceleration/deceleration (S-curve ratio=0[%]).

*3 When "1: Adv. S-curve" is selected, the setting is invalid, and the stop processing is performed with trapezoidal acceleration/ deceleration (S-curve ratio=0[%]).

**Point**

The actual deceleration time is longer than the set deceleration time if the output axis speed is larger than the speed limit value.

• "Output axis speed>Speed limit value"
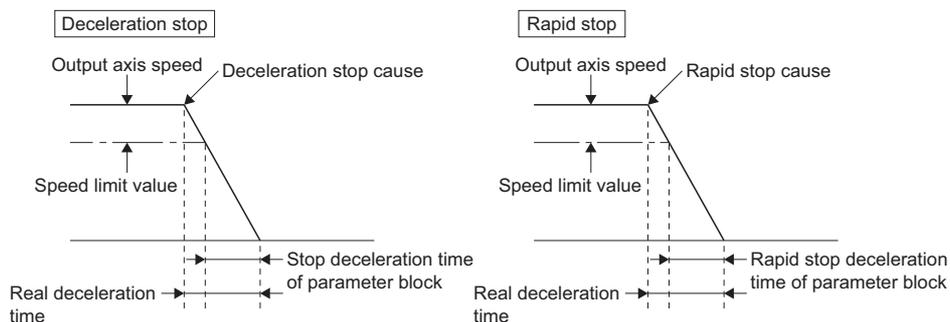
# 6.6 Synchronous Control Change Function

## Overview of synchronous control change function

This function can be used to change the cam reference position, the cam axis current value per cycle and the current value per cycle after the main/auxiliary shaft gear during the synchronous control.

The following 5 methods exist for the synchronous control change function. ( ☞ Page 133 [Cd.407] Synchronous control change command (R: D42770+160n/Q: D15130+150n))

| Synchronous control change command | Application | Output axis operation |
|---|---|---|
| Cam reference position movement | Adjust the cam reference position by travel value. | Operated |
| Change cam axis current value per cycle | Change the cam axis current value per cycle. | None |
| Change current value per cycle after main shaft gear | Change the current value per cycle after main shaft gear. | None |
| Change current value per cycle after auxiliary shaft gear | Change the current value per cycle after auxiliary shaft gear. | None |
| Cam axis current value per cycle movement | Adjust the phase of the cam axis by travel value. | Operated |

## Synchronous control change control data (Bit device)

### Control data

| Symbol | Setting item | Setting details | Setting value | Refresh cycle | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Rq.406 | Control change request command | Set the control change command request command. | OFF: Control change not requested<br>ON: Control change requested | — | Operation cycle | OFF | M42408+16n | M11688+10n |

#### ■[Rq.406] Control change request command (R: M42408+16n/Q: M11688+10n)

Set ON to initiate "[Cd.407] Synchronous control change command (R: D42770+160n/Q: D15130+150n)". The "[St.426] Control change complete (R: M38966+16n/Q: M10566+10n)" turns ON at the after completion of the synchronous control change. "[Rq.406] Control change request command (R: M42408+16n/Q: M11688+10n)" turns OFF at the synchronous control start.

### Monitor data

| Symbol | Setting item | Setting details | Setting value | Refresh cycle | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| St.426 | Control change complete | The complete signal of control change request command processing is stored | OFF: Control change incomplete<br>ON: Control change complete | Operation cycle | — | — | M38966+16n | M10566+10n |

#### ■[St.426] Control change complete (R: M38966+16n/Q: M10566+10n)

This signal turns ON with the completion of control change.

If the control change processing is stopped midway, the signal remains to be OFF.

# Synchronous control change control data (Word device)

| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. | |
|---|---|---|---|---|---|---|---|
| | | | | | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| Cd.407 | Synchronous control change command | Set the synchronous control change command. | 0: Cam reference position movement<br>1: Change cam axis current value per cycle<br>2: Change current value per cycle after main shaft gear<br>3: Change current value per cycle after auxiliary shaft gear<br>4: Cam axis current value per cycle movement | At requesting synchronous control change | 0 | D42770+160n | D15130+150n |
| Cd.408 | Synchronous control change value | Set the change value for synchronous control change processing. | -2147483648 to 2147483647 (Refer to the detailed explanation on the next page for units.) | | 0 | D42772+160n<br>D42773+160n | D15132+150n<br>D15133+150n |
| Cd.409 | Synchronous control reflection time | Set the reflection time for synchronous control change processing. | 0 to 65535[ms] | | 0[ms] | D42771+160n | D15131+150n |

## [Cd.407] Synchronous control change command (R: D42770+160n/Q: D15130+150n)

Set the synchronous control change command.

| Setting value | Description | Reference |
|---|---|---|
| 0 | Cam reference position movement | ☞ Page 134 Cam reference position movement |
| 1 | Change cam axis current value per cycle | ☞ Page 134 Change cam axis current value per cycle |
| 2 | Change current value per cycle after main shaft gear | ☞ Page 134 Change current value per cycle after main shaft gear |
| 3 | Change current value per cycle after auxiliary shaft gear | ☞ Page 135 Change current value per cycle after auxiliary shaft gear |
| 4 | Cam axis current value per cycle movement | ☞ Page 135 Cam axis current value per cycle movement |

## ■Cam reference position movement

This command is executed to move the cam reference position through adding the setting travel value of "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n, D15133+150n)". The travel value to be added is averaged in "[Cd.409] Synchronous control reflection time (R: D42771+160n/Q: D15131+150n)" for its output. Set a long reflection time when a large travel value is used since the cam axis current feed value moves with the travel value.

[Md.407] Cam axis current value per cycle
(R: D39132+32n, D39133+32n/
Q: D13612+30n, D13613+30n)

[Cd.408] Synchronous control change value
(R: D42772+160n, D42773+160n/
Q: D15132+150n, D15133+150n)

[Md.409] Cam axis current feed value
(R: D39136+32n, D39137+32n/
Q: D13616+30n, D13617+30n)
(Current feed value)

[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/
Q: D13614+30n, D13615+30n)

[Cd.409] Synchronous control reflection time
(R: D42771+160n/Q: D15131+150n)

[Rq.406] Control change request command
(R: M42408+16n/Q: M11688+10n)
OFF / ON

[St.426] Control change complete
(R: M38966+16n/Q: M10566+10n)
OFF / ON

[Cd.407] Synchronous control change command
(R: D42770+160n/Q: D15130+150n)
0: Cam reference position movement
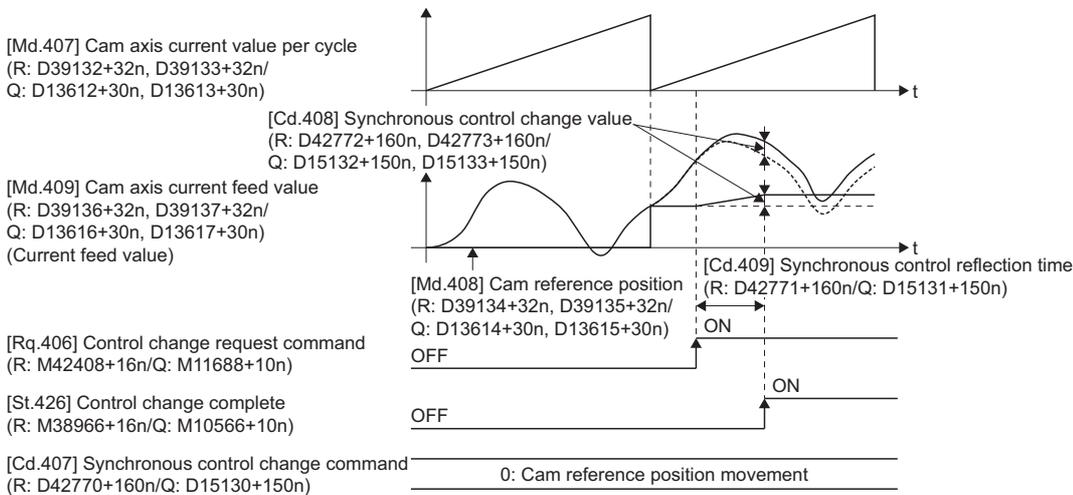
When "[Rq.406] Control change request command (R: M42408+16n/Q: M11688+10n)" is reset to OFF while executing the cam reference position movement command, operation is stopped midway. If the cam reference position movement command is executed again, the remainder travel value is not reflected, and the operation starts with "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n,D15133+150n)" to be used again.

If synchronous control is stopped while the cam reference position movement command is being executed, operation also stops midway. If synchronous control is restarted, the remainder travel value is not reflected.

## ■Change cam axis current value per cycle

The cam axis current value per cycle is changed to "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n, D15133+150n)". The cam reference position will be also changed to correspond to the changed cam axis current value per cycle.

This operation is completed within one operation cycle.

[Cd.408] Synchronous control change value
(R: D42772+160n, D42773+160n/
Q: D15132+150n, D15133+150n)

[Md.407] Cam axis current value per cycle
(R: D39132+32n, D39133+32n/
Q: D13612+30n, D13613+30n)

[Md.409] Cam axis current feed value
(R: D39136+32n, D39137+32n/
Q: D13616+30n, D13617+30n)
(Current feed value)

[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/
Q: D13614+30n, D13615+30n)

(before being changed)
(After being changed)
Changed to new reference position

[Rq.406] Control change request command
(R: M42408+16n/Q: M11688+10n)
OFF / ON

[St.426] Control change complete
(R: M38966+16n/Q: M10566+10n)
OFF / ON

[Cd.407] Synchronous control change command
(R: D42770+160n/Q: D15130+150n)
1: Change cam axis current value per cycle

## ■Change current value per cycle after main shaft gear

The current value per cycle after main shaft gear is changed to the value set in "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n, D15133+150n)". This operation is completed within one operation cycle.

Clutch control is not executed if the current value per cycle after main shaft gear (the value before being changed and after being changed) has already passed through the ON/OFF address in address mode.

## ■Change current value per cycle after auxiliary shaft gear

The current value per cycle after auxiliary shaft gear is changed to the value set in "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+10n, D15133+150n)".

This operation is completed within one operation cycle.

Clutch control is not executed if the current value per cycle after the auxiliary shaft gear (the value before being changed and after being changed) has already passed through the ON/OFF address in address mode.

## ■Cam axis current value per cycle movement

This command is executed to move the cam axis current value per cycle through adding the setting travel value of "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+20n, D1533+150n)".

The travel value to be added is averaged in "[Cd.409] Synchronous control reflection time (R: D42771+160n/Q: D15131+150n)" for its output.

Set a long reflection time when a large travel value is used since the cam axis current feed value moves with the travel value.
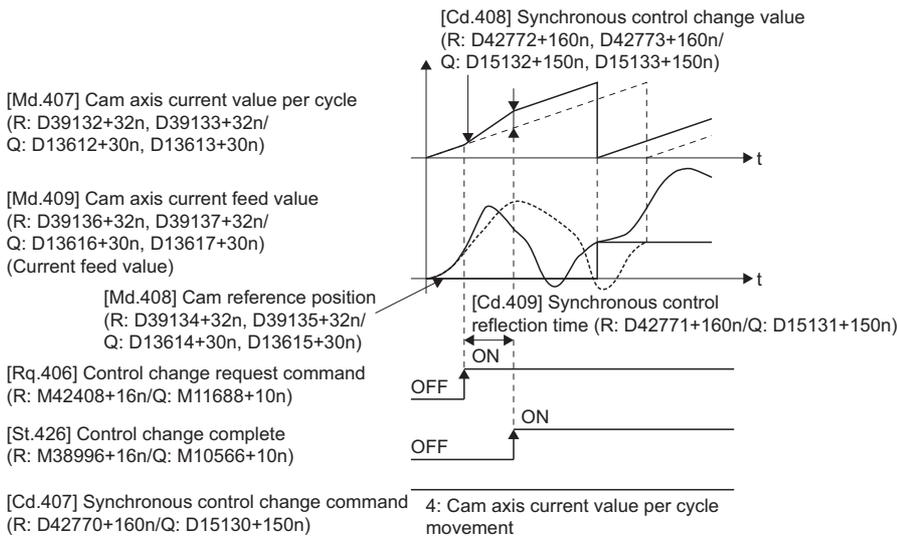


When "[Rq.406] Control change request command (R: M42408+16n/Q: M11688+10n)" is reset to OFF while executing the cam axis current value per cycle movement, operation is stopped midway. If the cam axis current value per cycle movement is executed again, the remainder travel value is not reflected, and the operation starts with "[Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n, D15133+150n)" to be used again.

If synchronous control is stopped while the cam axis current value per cycle movement is being executed, operation also stops midway. If synchronous control is restarted, the remainder travel value is not reflected.

## [Cd.408] Synchronous control change value (R: D42772L+160n/Q: D15132L+150n)

Set the change value for synchronous control change processing as follows.

| [Cd.407] Synchronous control change command (R: D42770+160n/Q: D15130+150n) | [Cd.408] Synchronous control change value (R: D42772+160n, D42773+160n/Q: D15132+150n, D15133+150n) | | |
|---|---|---|---|
| | Setting range | Unit | Setting details |
| 0: Cam reference position movement | -2147483648 to 2147483647 | Output axis position unit Cam axis cycle unit | • Set the travel value of the cam reference position.<br>• It moves within the range from -2147483648 to 2147483647. |
| 1: Change cam axis current value per cycle | | | • Set the change current value per cycle.<br>• The setting value is converted within the range from "0 to (Cam axis length per cycle-1)". |
| 2: Change current value per cycle after main shaft gear | | | |
| 3: Change current value per cycle after auxiliary shaft gear | | | |
| 4: Cam axis current value per cycle movement | | | • Set the travel value of the cam axis current value per cycle.<br>• It moves within the range from -2147483648 to 2147483647. |

## [Cd.409] Synchronous control reflection time (R: D42771+160n/Q: D15131+150n)

Set the reflection time for synchronous control change processing as follows.

| [Cd.407] Synchronous control change command (R: D42770+160n/Q: D15130+150n) | Setting details for "[Cd.409] Synchronous control reflection time (R: D42771+160n/Q: D15131+150n)" |
|---|---|
| 0: Cam reference position movement | The time to reflect the travel value to the cam reference position. |
| 1: Change cam axis current value per cycle | Setting not required. |
| 2: Change current value per cycle after main shaft gear | |
| 3: Change current value per cycle after auxiliary shaft gear | |
| 4: Cam axis current value per cycle movement | The time to reflect the travel value to the cam axis current value per cycle. |

# 6.7    Synchronous Control Monitor Data

Synchronous control monitor data is updated only during synchronous control.

The monitor values ("[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)", "[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/Q: D13602+30n, D13603+30n)", "[Md.402] Current value per cycle after auxiliary shaft gear (R: D39124+32n, D39125+32n/Q: D13604+30n, D13605+30n)", "[Md.407] Cam axis current value per cycle (R: D39132+32n, D39133+32n/Q: D13612+30n, D13613+30n)", "[Md.408] Cam reference position (R: D39134+32n, D39135+32n/Q: D13614+30n, D13615+30n)", and "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)") from the last synchronous control session are restored the next time the Multiple CPU system power supply turns ON. Restarting operation status from the last synchronous control session is possible through returning to the last position via positioning control. (☞ Page 143 Synchronous Control Initial Position)

"The last synchronous control session" indicates status just before the last synchronous control session was stopped as follows. These are listed with the last synchronization status.

- Just before "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" turns from ON to OFF.
- Just before deceleration stop by a stop command or an error, etc.
- Just before the Multiple CPU system power supply turned OFF.

**6**

# Synchronous Control Monitor Data (Word device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. | |
|---|---|---|---|---|---|---|
| | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| Md.400 | Current value after composite main shaft gear | • The current value after combining the main input and sub input values from the main shaft is stored.<br>• Value is stored even after Multiple CPU system power supply OFF. | -2147483648 to 2147483647 [Main input axis position units][1] | Operation cycle (During synchronous control only) | D39120+32n<br>D39121+32n | D13600+30n<br>D13601+30n |
| Md.401 | Current value per cycle after main shaft gear | • The current value per cycle after the main shaft gear is stored.<br>• One cycle is considered the cam axis length per cycle.<br>• Value is stored even after Multiple CPU system power supply OFF. | 0 to (Cam axis length per cycle-1) [Cam axis cycle units][2] | | D39122+32n<br>D39123+32n | D13602+30n<br>D13603+30n |
| Md.402 | Current value per cycle after auxiliary shaft gear | • The current value per cycle after the auxiliary shaft gear is stored.<br>• One cycle is considered the cam axis length per cycle.<br>• Value is stored even after Multiple CPU system power supply OFF. | 0 to (Cam axis length per cycle-1) [Cam axis cycle units][2] | | D39124+32n<br>D39125+32n | D13604+30n<br>D13605+30n |
| Md.406 | Cam axis phase compensation amount | The current phase compensation amount is stored. | -2147483648 to 2147483647 [Cam axis cycle units][2] | | D39130+32n<br>D39131+32n | D13610+30n<br>D13611+30n |
| Md.407 | Cam axis current value per cycle | • The current value per cycle is stored, which is calculated from the input travel value to the cam axis. (The value after phase compensation)<br>• Value is stored even after Multiple CPU system power supply OFF. | 0 to (Cam axis length per cycle-1) [Cam axis cycle units][2] | | D39132+32n<br>D39133+32n | D13612+30n<br>D13613+30n |
| Md.408 | Cam reference position | • The current feed value as the cam reference position is stored.<br>• Value is stored even after system's power supply OFF. | -2147483648 to 2147483647 [Output axis position units][3] | | D39134+32n<br>D39135+32n | D13614+30n<br>D13615+30n |
| Md.409 | Cam axis current feed value | • The current feed value while controlling the cam axis is stored.<br>• Value is stored even after system's power supply OFF. | -2147483648 to 2147483647 [Output axis position units][3] | | D39136+32n<br>D39137+32n | D13616+30n<br>D13617+30n |
| Md.410 | Execute cam No. | The executing cam No. is stored. | 0 to 1024 | | D39138+32n | D13618+30n |
| Md.411 | Execute cam stroke amount | The executing cam stroke amount is stored. | -2147483648 to 2147483647 [Output axis position units][3] | | D39140+32n<br>D39141+32n | D13620+30n<br>D13621+30n |
| Md.412 | Execute cam axis length per cycle | The executing cam axis length per cycle is stored. | 1 to 2147483647 [Cam axis cycle units][2] | | D39142+32n<br>D39143+32n | D13622+30n<br>D13623+30n |
| Md.422 | Main shaft clutch slippage (accumulative) | The accumulative slippage of the main shaft clutch smoothing with slippage method is stored as a signed value. | -2147483648 to 2147483647 [Main input axis position units][1], or [Cam axis cycle units][2] | | D39126+32n<br>D39127+32n | D13606+30n<br>D13607+30n |
| Md.425 | Auxiliary shaft clutch slippage (accumulative) | The accumulative slippage on the auxiliary shaft clutch smoothing with slippage method is stored as a signed value. | -2147483648 to 2147483647 [Main input axis position units][4], or [Cam axis cycle units][2] | | D39128+32n<br>D39129+32n | D13608+30n<br>D13609+30n |

*1 Main input axis position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

*2 Cam axis cycle units (☞ Page 126 Cam axis cycle units)

*3 Output axis position units (☞ Page 126 Output axis position units)

*4 Auxiliary shaft position units (☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

## [Md.400] Current value after composite main shaft gear (R: D39120L+32n/Q: D13600L+30n)

The current value after combining the main input and the sub input values going into the composite main shaft gear is stored as an accumulative value.

Units are in position units of the main input axis. The unit is pulse if the main input axis is invalid. ( ☞ Page 31 Servo input axis position units, ☞ Page 39 Command generation axis position units, ☞ Page 55 Synchronous encoder axis position units)

The current value after composite main shaft gear will be changed when the following operations are executed in the main input axis during synchronous control.

| Operation of main input axis (During synchronous control start) | Servo input axis | | Command generation axis | Synchronous encoder axis | | | |
|---|---|---|---|---|---|---|---|
| | Absolute position detection system valid | Absolute position detection system invalid | | Incremental synchronous encoder | Absolute synchronous encoder | Synchronous encoder via device | Multiple CPU advanced synchronous control[*3] |
| Home position return | Change method (1) | | — | — | | | |
| Current value change | Change method (1) | | Change method (1) | Change method (1) | | | |
| Speed control (I)[*1] | Change method (1) | | Change method (1) | — | | | |
| Fixed-pitch feed control | Change method (1) | | Change method (1) | — | | | |
| Speed/position switching control[*2] | Change method (1) | | — | — | | | |
| Connection to servo amplifier | Change method (2) | Change method (1) | — | — | | | |
| Connection to synchronous encoder | — | | — | Change method (1) | Change method (2) | | Change method (1) |

*1 When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)" or "[Rq.347] Feed current value update request command (R: M40172+32n/Q: M10972+20n)".

*2 When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)".

*3 When setting as a slave CPU synchronous encoder axis type (master CPU servo input axis, master CPU command generation axis, master CPU synchronous encoder axis) in a Multiple CPU advanced synchronous control configuration.

### ■Change method (1)

The new current value after composite main shaft gear is calculated based on the current value of the main input axis.

Current value after composite main shaft gear=Main input direction of composite main shaft gear (Input +/Input -/No input (0))×Main input axis current value

### ■Change method (2)

The travel value of the main input axis from the last synchronous control session is reflected to the current value after composite main shaft gear.

Current value after composite main shaft gear=Current value after composite main shaft gear at the last synchronous control session+Main input direction of composite main shaft gear (Input +/Input -/No input (0))×Amount of change of travel value of main input axis from the last synchronous control session

## [Md.401] Current value per cycle after main shaft gear (R: D39122L+32n/Q: D13602L+30n)

The input travel value after the main shaft gear is stored within the range from 0 to (Cam axis length per cycle - 1). The unit is in cam axis cycle units. ( ☞ Page 126 Cam axis cycle units)

The value is restored according to "[Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)" when starting synchronous control. ( ☞ Page 145 Current value per cycle after main/auxiliary shaft gear at synchronous control start)

## [Md.402] Current value per cycle after auxiliary shaft gear (R: D39124L+32n/Q: D13604L+30n)

The input travel value after the auxiliary shaft gear is stored within the range from 0 to (Cam axis length per cycle - 1). The unit is in cam axis cycle units. ($\square$ Page 126 Cam axis cycle units)

The value is restored according to "[Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)" when starting synchronous control. ($\square$ Page 145 Current value per cycle after main/auxiliary shaft gear at synchronous control start)

## [Md.406] Cam axis phase compensation amount (R: D39130L+32n/Q: D13610L+30n)

The phase compensation amount for the cam axis is stored with cam axis cycle units. ($\square$ Page 126 Cam axis cycle units)

The phase compensation amount after smoothing processing with "[Pr.445] Cam axis phase compensation time constant (R: D42708+160n/Q: D15068+150n)" is stored.

## [Md.407] Cam axis current value per cycle (R: D39132L+32n/Q: D13612L+30n)

The cam axis current value per cycle is stored within the range from 0 to (Cam axis length per cycle-1).

The current value after cam axis phase compensation processing can be monitored. The unit is in cam axis cycle units. ($\square$ Page 126 Cam axis cycle units)

The value is restored according to "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" when starting synchronous control. ($\square$ Page 146 Cam axis position at synchronous control start)

## [Md.408] Cam reference position (R: D39134L+32n/Q: D13614L+30n)

The current feed value is stored as the cam reference position. The unit is in output axis position units. When the unit is in [degree], a range from "0 to 35999999" is used. ($\square$ Page 126 Output axis position units)

The value is restored according to "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" when starting synchronous control. ($\square$ Page 146 Cam axis position at synchronous control start)

## [Md.409] Cam axis current feed value (R: D39136L+32n/Q: D13616L+30n)

The current feed value of the cam axis is stored. The value is the same as "[Md.20] Feed current value (R: D32000+48n, D32001+48n/Q: D0+20n, D1+20n)" during synchronous control.

## [Md.410] Execute cam No. (R: D39138+32n/Q: D13618+30n)

The executing cam No. is stored.

When "[Pr.440] Cam No. (R: D42702+160n/Q: D15062+150n)" is changed during synchronous control, this is updated when the controlling cam No. switches.

## [Md.411] Execute cam stroke amount (R: D39140L+32n/Q: D13620L+30n)

The executing cam stroke amount is stored.

When "[Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n)" is changed during synchronous control, this is updated when the controlling cam stroke amount switches.

## [Md.412] Execute cam axis length per cycle (R: D39142L+32n/Q: D13622L+30n)

The executing cam axis length per cycle is stored.

When "[Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n)" is changed during synchronous control, this is updated when the controlling cam axis length per cycle switches.

## [Md.422] Main shaft clutch slippage (accumulative) (R: D39126L+32n/Q: D13606L+30n)

The accumulative slippage amount with the slippage method is stored as a signed value.

The absolute value of the accumulative slippage increases to reach the slippage at clutch ON during clutch ON.

The absolute value of the accumulative slippage decreases to reach 0 during clutch OFF.

Monitoring of the accumulative slippage is used to check the smoothing progress with the slippage method.

## [Md.425] Auxiliary shaft clutch slippage (accumulative) (R: D39128L+32n/Q: D13608L+30n)

The accumulative slippage amount with the slippage method is stored as a signed value.

The absolute value of the accumulative slippage increases to reach the slippage at clutch ON during clutch ON.

The absolute value of the accumulative slippage decreases to reach 0 during clutch OFF.

Monitoring of the accumulative slippage is used to check the smoothing progress with the slippage method.

**6**

# Synchronous Control Monitor Data (Bit device)

| Symbol | Monitor item | Storage details | Monitor value | Refresh cycle | Device No. | |
|---|---|---|---|---|---|---|
| | | | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| St.420 | Main shaft clutch ON/OFF status | The ON/OFF status of main shaft clutch is stored. | OFF: Clutch OFF status ON:  Clutch ON status | Operation cycle (During synchronous control only) | M38960+16n | M10560+10n |
| St.421 | Main shaft clutch smoothing status | The smoothing status of main shaft clutch is stored. | OFF: Not on clutch smoothing ON:  On clutch smoothing | | M38961+16n | M10561+10n |
| St.423 | Auxiliary shaft clutch ON/OFF status | The ON/OFF status of the auxiliary shaft clutch is stored. | OFF: Clutch OFF status ON:  Clutch ON status | | M38962+16n | M10562+10n |
| St.424 | Auxiliary shaft clutch smoothing status | The smoothing status of the auxiliary shaft clutch is stored. | OFF: Not on clutch smoothing ON:  On clutch smoothing | | M38963+16n | M10563+10n |

## [St.420] Main shaft clutch ON/OFF status (R: M38960+16n/Q: M10560+10n)

The clutch ON/OFF status is stored.

## [St.421] Main shaft clutch smoothing status (R: M38961+16n/Q: M10561+10n)

The smoothing status of the main shaft clutch is stored. The status is updated by the clutch smoothing method as follows.

| Method | Description |
|---|---|
| Time constant method | The status is always "ON: On clutch smoothing" during the clutch ON status. The status will be "OFF: Not on clutch smoothing" when the clutch is turned OFF and smoothing is completed. |
| Slippage method | The status is "ON: On clutch smoothing" till the clutch accumulative slippage amount reaches the slippage at clutch ON when the clutch is turned ON. The status will change to "OFF: Not on clutch smoothing" when the clutch accumulative slippage amount reaches the slippage at clutch ON. The status is "ON: On clutch smoothing" till the clutch accumulative slippage amount reaches 0 when the clutch is turned OFF. The status will change to "OFF: Not on clutch smoothing" when the clutch accumulative slippage amount reaches 0. |

## [St.423] Auxiliary shaft clutch ON/OFF status (R: M38962+16n/Q: M10562+10n)

The clutch ON/OFF status is stored.

## [St.424] Auxiliary shaft clutch smoothing status (R: M38963+16n/Q: M10563+10n)

The smoothing status of the auxiliary shaft clutch is stored. The status is updated by the clutch smoothing method as follows.

| Method | Description |
|---|---|
| Time constant method | The status is always "ON: On clutch smoothing" during the clutch ON status. The status will be "OFF: Not on clutch smoothing" when the clutch is turned OFF and smoothing is completed. |
| Slippage method | The status is "ON: On clutch smoothing" till the clutch accumulative slippage amount reaches the slippage at clutch ON when the clutch is turned ON. The status will change to "OFF: Not on clutch smoothing" when the clutch accumulative slippage amount reaches the slippage at clutch ON. The status is "ON: On clutch smoothing" till the clutch accumulative slippage amount reaches 0 when the clutch is turned OFF. The status will change to "OFF: Not on clutch smoothing" when the clutch accumulative slippage amount reaches 0. |

# 7 SYNCHRONOUS CONTROL INITIAL POSITION

## 7.1 Synchronous Control Initial Position

The following synchronous control monitor data can be aligned to a set position when starting synchronous control, as the initial position for synchronous control.

The alignment to a synchronous control initial position is useful for restoring a system based on the last control status along with restarting synchronous control after cancelling midway.

| Synchronous control monitor data | The position when starting synchronous control |
|---|---|
| [Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n) | Restored to a position based on the main input axis of the main shaft. |
| [Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/Q: D13602+30n, D13603+30n) | Restored according to "[Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)". |
| [Md.402] Current value per cycle after auxiliary shaft gear (R: D39124+32n, D39125+32n/Q: D13604+30n, D13605+30n) | Restored according to "[Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)". |
| [Md.407] Cam axis current value per cycle (R: D39132+32n, D39133+32n/Q: D13612+30n, D13613+30n) | Restored according to "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)". |
| [Md.408] Cam reference position (R: D39134+32n, D39135+32n/Q: D13614+30n, D13615+30n) | |
| [Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n) | |
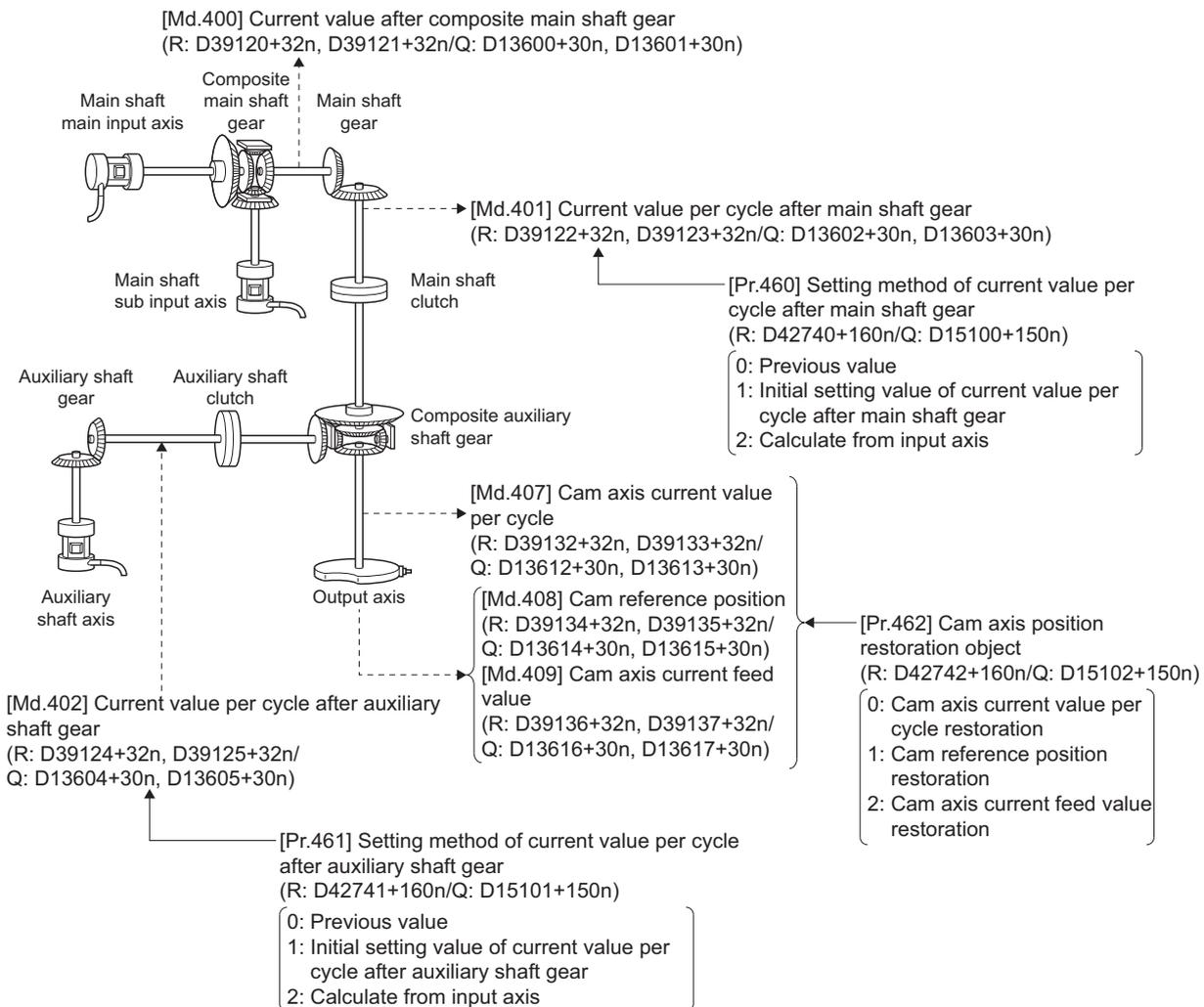
## Current value after composite main shaft gear when starting synchronous control

The current value after composite main shaft gear is restored as follows according to the main input axis operation executed before starting synchronous control.

| Operation of main input axis (Before synchronous control start) | Servo input axis | | Command generation axis | Synchronous encoder axis | | | |
|---|---|---|---|---|---|---|---|
| | Absolute position detection system valid | Absolute position detection system invalid | | Incremental synchronous encoder | Absolute synchronous encoder | Synchronous encoder via device | Multiple CPU advanced synchronous control[*3] |
| Home position return | Restoration method (1) | | — | — | | | |
| Current value change | Restoration method (1) | | Restoration method (1) | Restoration method (1) | | | |
| Speed control (I)[*1] | Restoration method (1) | | Restoration method (1) | — | | | |
| Fixed-pitch feed control | Restoration method (1) | | Restoration method (1) | — | | | |
| Speed/position switching control[*2] | Restoration method (1) | | — | — | | | |
| Connection to servo amplifier | Restoration method (2)[*4*5] | Restoration method (1) | — | — | | | |
| Connection to synchronous encoder | — | | — | Restoration method (1) | Restoration method (2) | Restoration method (2)[*6] | Restoration method (1) |
| Others | Restoration method (2) | | Restoration method (2) | Restoration method (2) | | | |

*1   When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)" or "[Rq.347] Feed current value update request command (R: M40172+32n/Q: M10972+20n)".

*2   When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)".

*3   When setting as a slave CPU synchronous encoder axis type (master CPU servo input axis, master CPU command generation axis, master CPU synchronous encoder axis) in a Multiple CPU advanced synchronous control configuration.

*4   When the unit setting of the servo input axis is set to [degree], the servo input axis value is rounded to a value within the range of "0 to 359.99999°", and the difference between this value and the current value of the servo input axis when synchronous control was last conducted is used as the change amount in "Restoration method (2)" below.

*5   When the servo input axis movement since synchronous control was last conducted exceeds "±2147483647 (input axis unit)" before synchronous control starts, the change amount cannot be calculated correctly.

*6   When the synchronous encoder axis via device since synchronous control was last conducted exceeds "Resolution of synchronous encoder via device" before synchronous control starts, the change amount cannot be calculated correctly.

### ■Restoration method (1)

The new current value after composite main shaft gear is calculated based on the current value of the main input axis.

Current value after composite main shaft gear=Main input direction of composite main shaft gear (Input +/Input -/No input (0))×Main input axis current value

### ■Restoration method (2)

The travel value of the main input axis from the last synchronous control session is reflected to the current value after composite main shaft gear.

Current value after composite main shaft gear=Current value after composite main shaft gear at the last synchronous control session+Main input direction of composite main shaft gear (Input +/Input -/No input (0))×Amount of change of main input axis current value from the last synchronous control session

The current value after composite main shaft gear at the last synchronous control session is restored when "0: Invalid" is set in "[Pr.400] Main input axis No. (R: D42640+160n/Q: D15000+150n)", or when a servo input axis or a synchronous encoder axis as the main input axis is not connected.

## Current value per cycle after main/auxiliary shaft gear at synchronous control start

The current value per cycle after main shaft gear/current value per cycle after auxiliary shaft gear is restored as follows according to the main input axis/auxiliary shaft operation executed before starting synchronous control.

| Operation of main input axis/ auxiliary shaft (Before synchronous control start) | Servo input axis | | Command generation axis | Synchronous encoder axis | | | |
|---|---|---|---|---|---|---|---|
| | Absolute position detection system valid | Absolute position detection system invalid | | Incremental synchronous encoder | Absolute synchronous encoder | Synchronous encoder via device | Multiple CPU advanced synchronous control[*3] |
| Home position return | Restoration method (1) | | — | — | | | |
| Current value change | Restoration method (1) | | Restoration method (1) | Restoration method (1) | | | |
| Speed control (I)[*1] | Restoration method (1) | | Restoration method (1) | — | | | |
| Fixed-pitch feed control | Restoration method (1) | | Restoration method (1) | — | | | |
| Speed/position switching control[*2] | Restoration method (1) | | — | — | | | |
| Connection to servo amplifier | Restoration method (2)[*4*5] | Restoration method (1) | — | — | | | |
| Connection to synchronous encoder | — | | — | Restoration method (1) | Restoration method (2)[*5] | Restoration method (2) | Restoration method (1) |
| Others | Restoration method (2)[*5] | | Restoration method (2)[*5] | Restoration method (2)[*5] | | | |

*1 When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)" or "[Rq.347] Feed current value update request command (R: M40172+32n/Q: M10972+20n)".

*2 When it starts by turning OFF the "[Rq.1152] Feed current value update command (R: M34492+32n/Q: M3212+20n)".

*3 When setting as a slave CPU synchronous encoder axis type (master CPU servo input axis, master CPU command generation axis, master CPU synchronous encoder axis) in a Multiple CPU advanced synchronous control configuration.

*4 When the unit setting of the servo input axis is set to [degree], the servo input axis value is rounded to a value within the range of "0 to 359.99999°", and the difference between this value and the current value of the servo input axis when synchronous control was last conducted is used as the change amount in "Restoration method (2)" below. For that reason, if positioning exceeds "360[degree]", the current value per cycle after main shaft gear and the current value per cycle after auxiliary shaft gear may not be restored correctly. In that case, set "[Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)" and "[Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)" to the following settings.

| Synchronous control initial position parameter | Setting value |
|---|---|
| [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n) | 0: Previous value, or 1: Initial setting value of current value per cycle after main shaft gear |
| [Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n) | 0: Previous value, or 1: Initial setting value of current value per cycle after auxiliary shaft gear |

*5 When the main input axis movement since synchronous control was last conducted exceeds "±2147483647 (input axis unit)" before synchronous control starts, the change amount cannot be calculated correctly. In that case, set "[Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)" and "[Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)" to the following settings.

| Synchronous control initial position parameter | Setting value |
|---|---|
| [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n) | 0: Previous value, or 1: Initial setting value of current value per cycle after main shaft gear |
| [Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n) | 0: Previous value, or 1: Initial setting value of current value per cycle after auxiliary shaft gear |

## ■Restoration method (1)

The new value of the current value per cycle after main shaft gear/current value per cycle after auxiliary shaft gear is calculated based on the current value after composite main shaft gear/auxiliary shaft current value.

- Main shaft

  Current value per cycle after main shaft gear=Main shaft gear ratio×Current value after composite main shaft gear

- Auxiliary shaft

  Current value per cycle after auxiliary shaft gear=Auxiliary shaft gear ratio×Auxiliary shaft current value

## ■Restoration method (2)

The travel value from the last synchronous control session is reflected to the current value per cycle after main shaft gear/current value per cycle after auxiliary shaft gear.

- Main shaft

  Current value per cycle after main shaft gear=Current value per cycle after main shaft gear at the last synchronous control session+Main shaft gear ratio×Amount of change of current value after composite main shaft gear from the last synchronous control session

- Auxiliary shaft

  Current value per cycle after auxiliary shaft gear=Current value per cycle after auxiliary shaft gear at the last synchronous control session+Auxiliary shaft gear ratio×Amount of change of auxiliary shaft current value from the last synchronous control session

The current value per cycle after main shaft gear/current value per cycle after auxiliary shaft gear at the last synchronous control session is restored when "0: Invalid" is set in "[Pr.400] Main input axis No. (R: D42640+160n/Q: D15000+150n)" / "[Pr.418] Auxiliary shaft axis No. (R: D42664+160n/Q: D15024+150n)", or when a servo input axis or a synchronous encoder axis as the main input axis/auxiliary shaft is not connected.

## Cam axis position at synchronous control start

The cam axis position is composed of the relationship of 3 positions "Cam axis current value per cycle", "Cam reference position" and "Cam axis current feed value". One of positions can be restored by defining 2 positions when starting synchronous control.
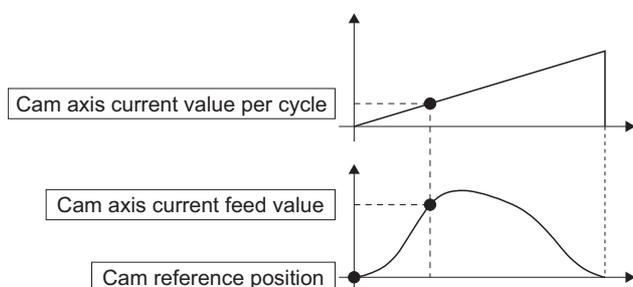


Select from 3 objects as follows in "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" which position is to be restored. ()

- Cam axis current value per cycle restoration
- Cam reference position restoration
- Cam axis current feed value restoration

Various parameters need to be set for the cam axis position restoration as shown in the table below. Refer to synchronous control initial position parameters for details of the settings. ()

○: Required, △: Required for initial setting value, ─: Not required

| [Pr.462]Cam axis position restoration object (R: D42742+160n/ Q: D15102+150n) | [Pr.463]Setting method of cam reference position (R: D42743+160n/ Q: D15103+150n) | [Pr.467]Cam reference position (Initial setting) (R: D42750+160n, D42751+160n/Q: D15110+150n, D15111+150n) | [Pr.464]Setting method of cam axis current value per cycle (R: D42744+160n/ Q: D15104+150n) | [Pr.468]Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n) | Restoration processing details |
|---|---|---|---|---|---|
| 0: Cam axis current value per cycle restoration | ○ | △ | ─ | ○ (Used as search starting point) | Restore "Cam axis current value per cycle" based on "Cam reference position" and "Cam axis current feed value". |
| 1: Cam reference position restoration | ─ | ─ | ○ | △ | Restore "Cam reference position" based on "Cam axis current value per cycle" and "Cam axis current feed value". |
| 2: Cam axis current feed value restoration | ○ | △ | ○ | △ | Restore "Cam axis current feed value" based on "Cam axis current value per cycle" and "Cam reference position". |

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| Symbol | Setting item | Setting details | Setting value | Fetch cycle | Default value | Device No. MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
|---|---|---|---|---|---|---|---|
| Pr.460 | Setting method of current value per cycle after main shaft gear | Select the setting method for the current value per cycle after main shaft gear. | 0: Previous value<br>1: Initial setting value of current value per cycle after main shaft gear ([Pr.465])<br>2: Calculate from input axis | At start of synchronous control | 0 | D42740+160n | D15100+150n |
| Pr.461 | Setting method of current value per cycle after auxiliary shaft gear | Select the setting method for the current value per cycle after auxiliary shaft gear. | 0: Previous value<br>1: Initial setting value of current value per cycle after auxiliary shaft gear ([Pr.466])<br>2: Calculate from input axis | | 0 | D42741+160n | D15101+150n |
| Pr.462 | Cam axis position restoration object | Select the object to restore the cam axis position. | 0: Cam axis current value per cycle restoration<br>1: Cam reference position restoration<br>2: Cam axis current feed value restoration | | 0 | D42742+160n | D15102+150n |
| Pr.463 | Setting method of cam reference position | • Select the setting method for the cam reference position.<br>• Set for the cam axis current value per cycle restoration or the cam axis current feed value restoration. | 0: Previous value<br>1: Initial setting value of cam reference position<br>2: Current feed value | | 2 | D42743+160n | D15103+150n |
| Pr.464 | Setting method of cam axis current value per cycle | • Select the setting method for the cam axis current value per cycle.<br>• Set for the cam reference position restoration or the cam axis current feed value restoration. | 0: Previous value<br>1: Initial setting value of cam axis current value per cycle<br>2: Current value per cycle after main shaft gear<br>3: Current value per cycle after auxiliary shaft gear | | 0 | D42744+160n | D15104+150n |
| Pr.465 | Current value per cycle after main shaft gear (Initial setting) | Set the initial value of the current value per cycle after main shaft gear. | 0 to (Cam axis length per cycle-1)<br>[Cam axis cycle units[*1]] | | 0 | D42746+160n<br>D42747+160n | D15106+150n<br>D15107+150n |
| Pr.466 | Current value per cycle after auxiliary shaft gear (Initial setting) | Set the initial value of the current value per cycle after auxiliary shaft gear. | 0 to (Cam axis length per cycle-1)<br>[Cam axis cycle units[*1]] | | 0 | D42748+160n<br>D42749+160n | D15108+150n<br>D15109+150n |
| Pr.467 | Cam reference position (Initial setting) | Set the initial value of the cam reference position. | -2147483648 to 2147483647<br>[Output axis position units[*2]] | | 0 | D42750+160n<br>D42751+160n | D15110+150n<br>D15111+150n |
| Pr.468 | Cam axis current value per cycle (Initial setting) | • Set the initial value for the cam axis current value per cycle.<br>• The restoration value for the cam axis current value per cycle is searched from the setting value with the cam axis current value per cycle restoration. | 0 to (Cam axis length per cycle-1)<br>[Cam axis cycle units[*1]] | | 0 | D42752+160n<br>D42753+160n | D15112+150n<br>D15113+150n |

*1 Cam axis cycle units ( ☞ Page 126 Cam axis cycle units)

*2 Output axis position units ( ☞ Page 126 Output axis position units)

## [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)

Select the setting method of "[Md.401] Current value per cycle after main shaft gear (R: D39122+32n, D39123+32n/Q: D13602+30n, D13603+30n)" when starting synchronous control.

| Setting value | Description |
|---|---|
| 0: Previous value | The current value per cycle after main shaft gear from the last synchronous control session is stored. |
| 1: Initial setting value of current value per cycle after main shaft gear | The value set in "[Pr.465] Current value per cycle after main shaft gear (Initial setting) (R: D42746+160n, D42747+160n/Q: D15106+150n, D15107+150n)" is stored. |
| 2: Calculate from input axis | The value calculated based on the current value after composite main shaft gear is stored. |

## [Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)

Select the setting method of "[Md.402] Current value per cycle after auxiliary shaft gear (R: D39124+32n, D39125+32n/Q: D13604+30n, D13605+30n)" when starting synchronous control.

| Setting value | Description |
|---|---|
| 0: Previous value | The current value per cycle after auxiliary shaft gear from the last synchronous control session is stored. |
| 1: Initial setting value of current value per cycle after auxiliary shaft gear | The value set in "[Pr.466] Current value per cycle after auxiliary shaft gear (Initial setting) (R: D42748+160n, D42749+160n/Q: D15108+150n, D15109+150n)" is stored. |
| 2: Calculate from input axis | The value calculated based on the auxiliary shaft current value is stored. |

## [Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)

Select the object to be restored from "Cam axis current value per cycle", "Cam reference position" or "Cam axis current feed value" when starting synchronous control.

| Setting value | Description |
|---|---|
| 0: Cam axis current value per cycle restoration | Restore the cam axis current value per cycle from "Cam reference position" and "Cam axis current feed value". |
| 1: Cam reference position restoration | Restore the cam reference position from "Cam axis current value per cycle" and "Cam axis current feed value". |
| 2: Cam axis current feed value restoration | Restore the cam axis current feed value from "Cam axis current value per cycle" and "Cam reference position". |

## [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n)

Select the method for the cam reference position to be restored when "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" is set to "0: Cam axis current value per cycle restoration" or "2: Cam axis current feed value restoration".
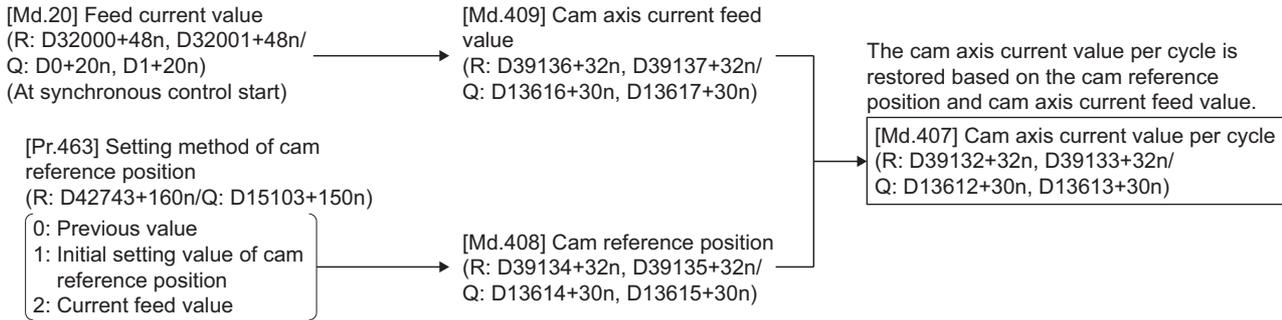
| Setting value | Description |
|---|---|
| 0: Previous value | The cam reference position from the last synchronous control session is stored. The current feed value is stored when the cam reference position from the last synchronous control session is not saved. |
| 1: Initial setting value of cam reference position | The value set in "[Pr.467] Cam reference position (Initial setting) (R: D42750+160n, D42751+160n/Q: D15110+150n, D15111+150n)" is stored. |
| 2: Current feed value | The value set in "[Md.20] Feed current value (R: D32000+48n, D32001+48n/Q: D0+20n, D1+20n)" is stored. |

## [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n)

Select the method for the cam axis current value per cycle to be restored when "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" is set to "1: Cam reference position restoration" or "2: Cam axis current feed value restoration".

| Setting value | Description |
|---|---|
| 0: Previous value | The cam axis current value per cycle from the last synchronous control session is stored as is. |
| 1: Initial setting value of cam axis current value per cycle | The value set in "[Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/ Q: D15112+150n, D15113+150n)" is stored. |
| 2: Current value per cycle after main shaft gear | The current value per cycle after main shaft gear is stored. |
| 3: Current value per cycle after auxiliary shaft gear | The current value per cycle after auxiliary shaft gear is stored. |

## [Pr.465] Current value per cycle after main shaft gear (Initial setting) (R: D42746L+160n/ Q: D15106L+150n)

Set the initial setting value of the current value per cycle after main shaft gear when "[Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n)" is set to "1: Current value per cycle after main shaft gear (Initial setting)".

The unit settings are in cam axis cycle units. (☞ Page 126 Cam axis cycle units)

Set within the range from 0 to (Cam axis length per cycle-1).

## [Pr.466] Current value per cycle after auxiliary shaft gear (Initial setting) (R: D42748L+160n/Q: D15108L+150n)

Set the initial setting value of the current value per cycle after auxiliary shaft gear when "[Pr.461] Setting method of current value per cycle after auxiliary shaft gear (R: D42741+160n/Q: D15101+150n)" is set to "1: Current value per cycle after auxiliary shaft gear (Initial setting)".

The unit settings are in cam axis cycle units. (☞ Page 126 Cam axis cycle units)

Set within the range from 0 to (Cam axis length per cycle-1).

## [Pr.467] Cam reference position (Initial setting) (R: D42750L+160n/Q: D15110L+150n)

Set the initial setting value of the cam reference position in output axis position units when "[Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n)" is set to "1: Cam reference position (Initial setting)". (☞ Page 126 Output axis position units)

## [Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752L+160n/Q: D15112L+150n)

Set a value according to the setting for "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)".

The unit settings are in cam axis cycle units. (☞ Page 126 Cam axis cycle units)

Set within the range from 0 to (Cam axis length per cycle-1).

| [Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n) | Setting value |
|---|---|
| 0: Cam axis current value per cycle restoration | Set the starting point for search processing to restore the cam axis current value per cycle. Set to restore the position on the return path in two-way cam pattern operation. Refer to cam axis current value per cycle restoration for details on search processing. (☞ Page 151 Cam axis current value per cycle restoration) |
| 1: Cam reference position restoration | Set the initial setting value for the cam axis current value per cycle when "[Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n)" is set to "1: Cam axis current value per cycle (Initial setting)". |
| 2: Cam axis current feed value restoration | |

# 7.3 Cam Axis Position Restoration Method

## Cam axis current value per cycle restoration

If "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" is set to "0: Cam axis current value per cycle restoration" when starting synchronous control, the cam axis current value per cycle is restored based on the cam reference position and the cam axis current feed value.

Select the method for the cam reference position to be restored. The current feed value when starting synchronous control is used as the cam axis current feed value.

The cam axis current value per cycle is restored by searching for the corresponding value from the beginning to the end of the cam pattern. Set the starting point from where to search the cam pattern in "[Pr.468] Cam axis current value per cycle (Initial settin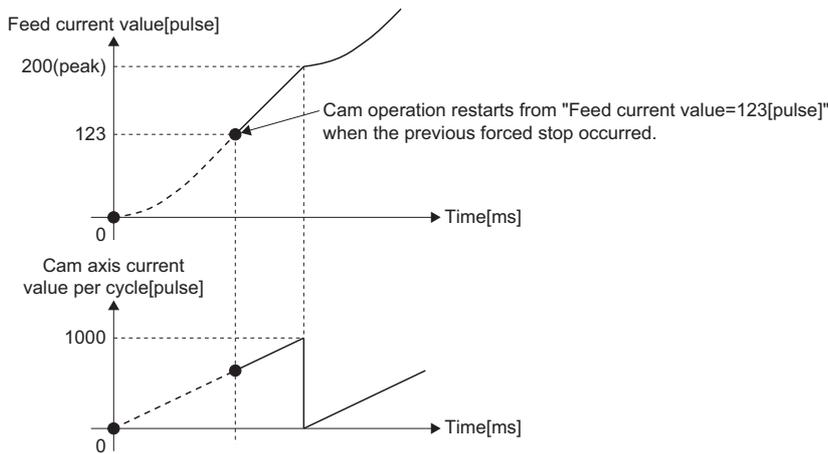g) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n)". (It is also possible to search the return path in a two-way cam pattern operation.)

[Md.20] Feed current value
(R: D32000+48n, D32001+48n/
Q: D0+20n, D1+20n)
(At synchronous control start)

[Md.409] Cam axis current feed value
(R: D39136+32n, D39137+32n/
Q: D13616+30n, D13617+30n)

The cam axis current value per cycle is restored based on the cam reference position and cam axis current feed value.

[Md.407] Cam axis current value per cycle
(R: D39132+32n, D39133+32n/
Q: D13612+30n, D13613+30n)

[Pr.463] Setting method of cam reference position
(R: D42743+160n/Q: D15103+150n)

0: Previous value
1: Initial setting value of cam reference position
2: Current feed value

[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/
Q: D13614+30n, D13615+30n)

Cam axis current value per cycle

Cam axis current feed value

Cam reference position

Search the cam pattern
(It is also possible to search from the middle of the cam axis current value per cycle.)

## Restrictions

- With two-way cam pattern operation, if the corresponding cam axis current value per cycle is not found, minor error (error code: 1C28H) will occur and synchronous control will not be started.
- When starting synchronous control, the current feed value may change slightly from its original position at starting synchronous control. This is due to the readjustment of the position based on the restored cam axis current value per cycle. This does not result in position displacement.
- With a feed operation cam pattern, if the corresponding cam axis current value per cycle is not found on the first cycle, the cam reference position is changed automatically and the pattern is searched again.
- If the cam resolution is large, or many axes are started at once, search processing may take a long time when starting synchronous control. When this occurs, change the operation cycle to a larger value.

| Number of axes | Cam resolution | |
| --- | --- | --- |
| | 256 | 32768 |
| 1 | 0.44[ms] | 12.2[ms] |
| 8 | 1.78[ms] | 94.4[ms] |
| 16 | 3.55[ms] | 249[ms] |
| 32 | 7.10[ms] | 483[ms] |
| 64 | 12.4[ms] | 831[ms] |

- If "degree" is the unit for the current feed value of the output axis, the current value is not restored in a cam stroke range that straddles 0[degree] and a minor error (error code: 1C28H) occurs. Execute cam axis current value per cycle restoration within a cam stroke range exceeding 0 and less than 360[degree].

## Cam axis current value per cycle restoration operation

### ■With a two-way cam pattern operation

- Search from "Cam axis current value per cycle = 0". (Cam data starting point = 0)

Cam axis current value per cycle

Search from "Cam axis current value per cycle=0".

Cam axis current feed value (Current feed value)

Restore to the first current feed value that matches. (Other values are not restored.)

Cam reference position

- Search from a value in the middle of the cam axis current value per cycle. (Cam data starting point = 0)

[Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n)

Cam axis current value per cycle

Search from the value in the middle. (Preceding values are searched later.)

Cam axis current feed value (Current feed value)

Restore to the first current value that matches. (The restoration is done on the second.)

Cam reference position

- Search from a value in the middle of the cam axis current value per cycle. (Cam data starting point ≠ 0)

[Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n)

Cam axis current value per cycle

Search from the value in the middle.

Cam axis current feed value (Current feed value)

Cam data starting point

Cam reference position

Restore to the first current feed value that matches.

• The search fails.

(1) When a matching current feed value is not found

Cam axis current value per cycle

Cam axis current feed value
(Current feed value)

Cam reference position

Restoration fails. No match is found
for the current feed value within1 cycle.
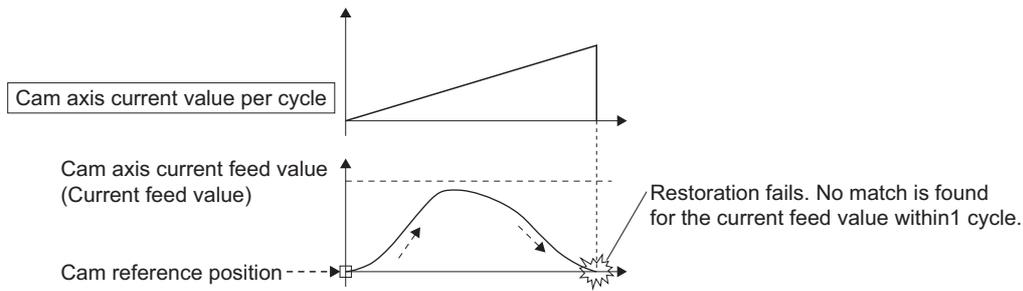
(2) When the unit is "degree" and cam axis current value per cycle restoration is executed in a cam stroke range that straddles 0
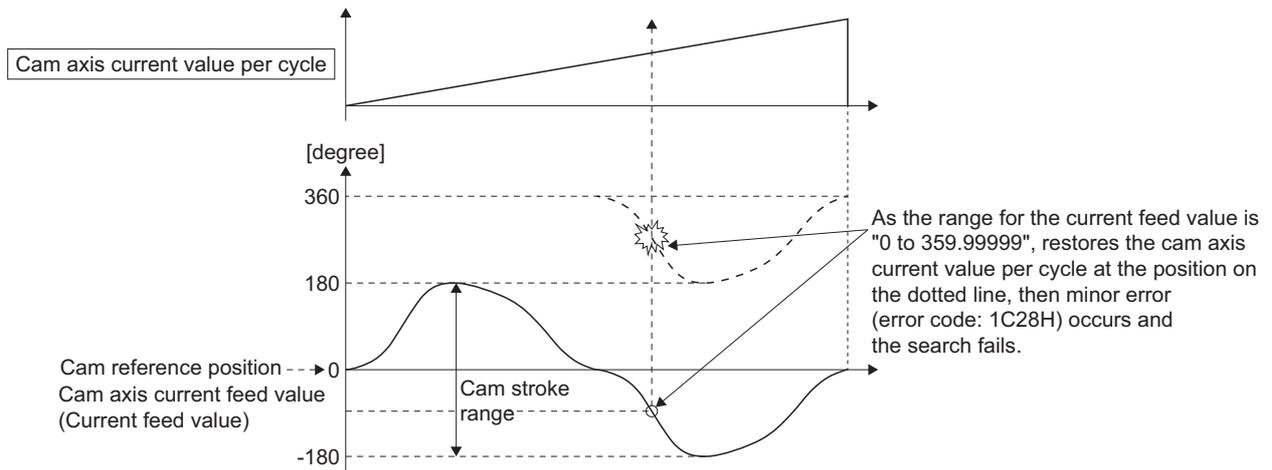
Cam axis current value per cycle

[degree]

360

180

Cam reference position 0
Cam axis current feed value
(Current feed value)

Cam stroke
range

-180

As the range for the current feed value is
"0 to 359.99999", restores the cam axis
current value per cycle at the position on
the dotted line, then minor error
(error code: 1C28H) occurs and
the search fails.

• In the case above, execute cam axis current value per cycle restoration within a cam stroke range exceeding 0 and less than 360[degree]

Cam axis current value per cycle

[degree]

360

180

Cam stroke
range

Cam axis current feed value
(Current feed value)

Cam reference position 0
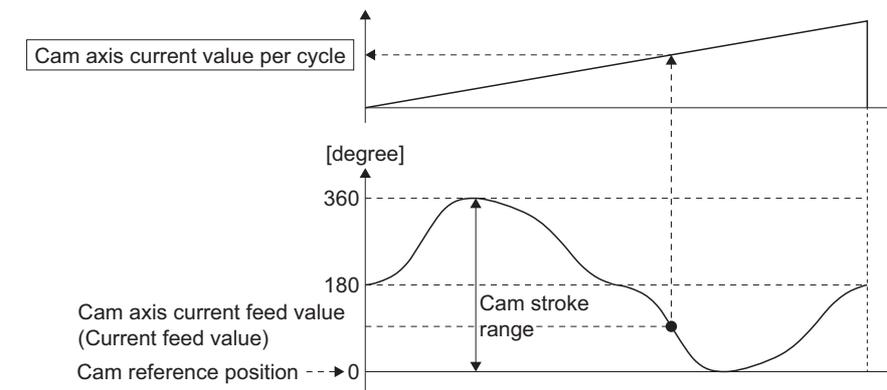
■**With a feed operation cam pattern**

• Search from "Cam axis current value per cycle = 0". (Cam data starting point = 0)

Cam axis current value per cycle

Cam axis current feed value
(Current feed value)

Cam reference position

Search from "Cam axis current value
per cycle=0".

Restore to the first current feed value
that matches.
(Other values are not restored.)

- Search from a value in the middle of the cam axis current value per cycle. (Cam data starting point = 0)

[Pr.468] Cam axis current value per cycle (Initial setting)
(R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n)

Cam axis current value per cycle

Cam axis current feed value
(Current feed value)

New cam reference position

Cam reference position
at starting the restoration

Update the cam reference
position in the next cycle
automatically.

Restore to the first current
feed value that matches.

- Search from a value in the middle of the cam axis current value per cycle. (Cam data starting point ≠ 0)

[Pr.468] Cam axis current value per cycle (Initial setting)
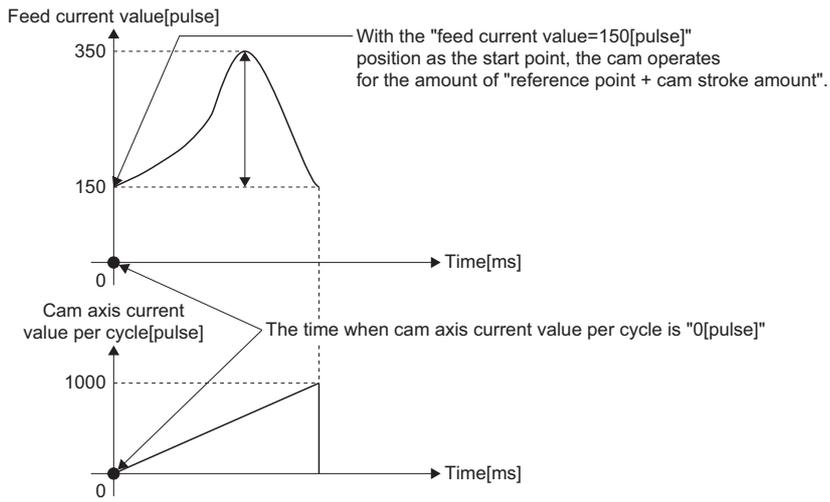(R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n)

Cam axis current value per cycle

Cam axis current feed value
(Current feed value)

New cam reference position

Cam reference position
at starting the restoration

Search from the value in the middle.

Cam data
starting point

Update the cam reference
position in the next cycle
automatically. (Update the
cam data on 0th point.)

Restore to the first current
feed value that matches.

- The first search fails and a search begins for the second time.

Cam axis current value per cycle

Feed stroke

Cam axis current feed value
(Current feed value)

New cam reference position

Cam reference position
at starting the restoration

Restore to the first current
feed value that is found in
the second search.

Once the restoration fails in the first search, the new cam reference position
is automatically updated to the one within the feed stroke amount, which is
equal to "Current feed value - New cam reference position", and the search
process starts again.

Point

If the first search fails, a second search may not be processed on the next cycle for a cam pattern with a feed
stroke that is smaller than 100% of the stroke as above.
The intended cam axis current value per cycle can be found in the first search, by setting or positioning the
cam reference position in advance.

7

## Example

The following shows an example of restarting the cam (a cam similar to a cam with a linear feed where two identical positioning points do not exist on the cam) from the feed current value after a forced stop, when the forced stop has stopped operation.

If the following settings are used in a two-way cam or a cam where identical positioning points exist on the same cam, similar to the cam axis current value per cycle restoration operation ( Page 153 Cam axis current value per cycle restoration operation), the first matching feed current value (outward route) is restored, therefore restoration may start from an unintended cam pattern position. To avoid restoring the first matching feed current value, use cam axis current feed value restoration ( Page 159 Cam axis current feed value restoration).

| Setting item | Setting value |
| --- | --- |
| [Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n) | 1000[pulse] |
| [Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n) | 200[pulse] |
| [Pr.462] Cam axis restoration object (R: D42742+160n/Q: D15102+150n) | 0: Cam axis current value per cycle restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | 1: Initial setting value of cam reference position |
| [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n) | 0: Previous value |
| [Pr.467] Cam reference position (Initial setting) (R: D42750+160n, D42751+160n/Q: D15110+150n, D15111+150n) | 0[pulse] |
| [Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n) | 0[pulse] |

• Advanced synchronous control operation



Feed current value[pulse]

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Feed current value after free run

0 → Time[ms]

Forced stop occurred during operation, and the cam decelerates to a stop.
(Advanced mode synchronous control is cancelled)
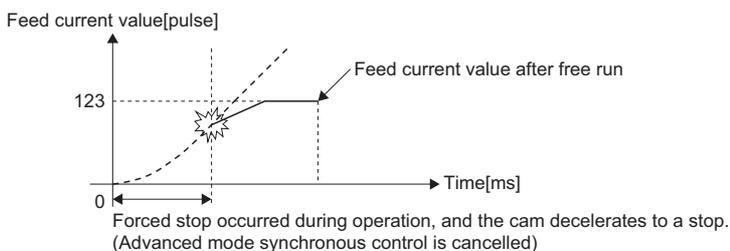
• Restore operation at restart of advanced synchronous control



Feed current value[pulse]

200
123

Reference position=0[pulse]

0 → Time[ms]

Cam axis current value per cycle[pulse]

1000

Cam is determined to restart at the position where cam axis current value per cycle is "Feed current value=123[pulse]".

0 → Time[ms]

• Cam operation

Feed current value[pulse]

200(peak) ┄┄┄┄┄┄┄┄┄

Cam operation restarts from "Feed current value=123[pulse]" when the previous forced stop occurred.

123 ┄┄┄┄┄┄

0 ──────────────► Time[ms]

Cam axis current
value per cycle[pulse]

1000 ┄┄┄┄┄┄┄┄

0 ──────────────► Time[ms]

# Cam reference position restoration

If "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" is set to "1: cam reference position restoration" when starting synchronous control, the cam reference position is restored based on the cam axis current value per cycle and the cam axis current feed value.

Select the method for the cam axis current value per cycle to be restored. The current feed value when starting synchronous control is used as the cam axis current feed value.

[Pr.464] Setting method of cam axis
current value per cycle
(R: D42744+160n/Q: D15104+150n)

0: Previous value
1: Initial setting value of cam axis current value per cycle
2: Current value per cycle after main shaft gear
3: Current value per cycle after auxiliary shaft gear

[Md.407] Cam axis current
value per cycle
(R: D39132+32n, D39133+32n/
Q: D13612+30n, D13613+30n)

The cam reference position is restored based on the cam axis current value per cycle and the cam axis current feed value.

[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/
Q: D13614+30n, D13615+30n)

[Md.20] Feed current value
(R: D32000+48n, D32001+48n/
Q: D0+20n, D1+20n)
(At synchronous control start)

[Md.409] Cam axis current
feed value
(R: D39136+32n, D39137+32n/
Q: D13616+30n, D13617+30n)

Cam axis current value per cycle

Cam axis current feed value

Cam reference position
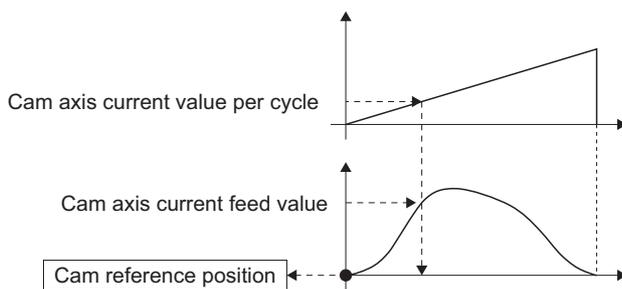
Restored by the equation of "Current feed value - Cam axis current value per cycle"

## Example

The following shows an example of starting operation from a position of "cam axis current value per cycle=0" by restoring the cam reference position when starting from "feed current value=0[pulse]", in the cam when the cam data starting point is not 0.

| Setting item | Setting value |
|---|---|
| [Pr.439] Cam axis length per cycle<br>(R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n) | 1000[pulse] |
| [Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n) | 200[pulse] |
| [Pr.462] Cam axis restoration object (R: D42742+160n/Q: D15102+150n) | 1: Cam reference position restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | None |
| [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n) | 1: Initial setting value of cam axis current value per cycle |
| [Pr.467] Cam reference position (Initial setting)<br>(R: D42750+160n, D42751+160n/Q: D15110+150n, D15111+150n) | None |
| [Pr.468] Cam axis current value per cycle (Initial setting)<br>(R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n) | 0[pulse] |

• Operation before starting advanced synchronous control
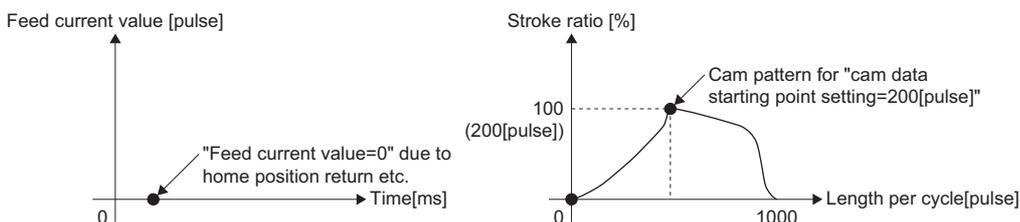


• Restore operation at start of advanced synchronous control
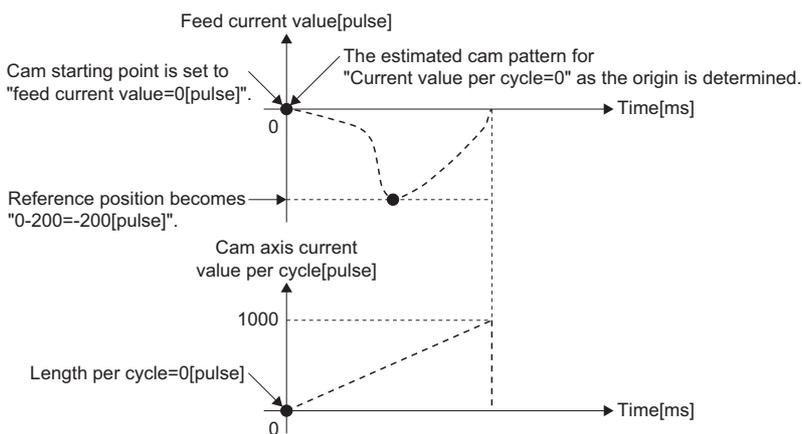


• Cam operation
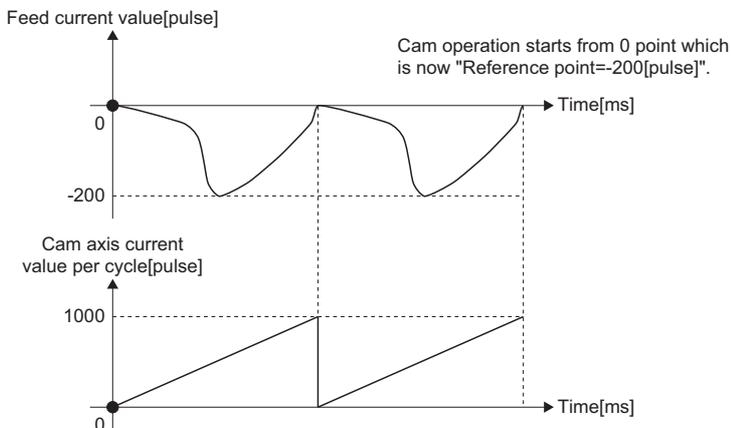
# Cam axis current feed value restoration

If "[Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n)" is set to "2: cam current feed value restoration" when starting synchronous control, the cam axis current feed value is restored based on the cam axis current value per cycle and the cam reference position.

Select the method for the cam axis current value per cycle and the method for the cam reference position to be restored.

[Pr.464] Setting method of cam axis current value per cycle
(R: D42744+160n/Q: D15104+150n)

0: Previous value
1: Initial setting value of cam axis current value per cycle
2: Current value per cycle after main shaft gear
3: Current value per cycle after auxiliary shaft gear

[Md.407] Cam axis current value per cycle
(R: D39132+32n, D39133+32n/ Q: D13612+30n, D13613+30n)

[Pr.463] Setting method of cam reference position
(R: D42743+160n/Q: D15103+150n)

0: Previous value
1: Initial setting value of cam reference position
2: Current feed value

[Md.408] Cam reference position
(R: D39134+32n, D39135+32n/ Q:D13614+30n, D13615+30n)

The cam axis current feed value is restored based on the cam axis current value per cycle and the cam reference position.

[Md.409] Cam axis current feed value
(R: D39136+32n, D39137+32n/ Q: D13616+30n, D13617+30n)

Cam axis current value per cycle

Cam axis current feed value

Cam reference position
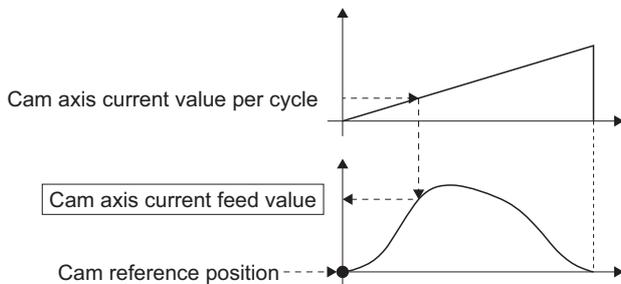
## Restrictions

The cam axis current feed value moves to its restored value just after starting synchronous control when the cam axis current feed value to be restored is different from the current feed value at synchronous control start.

If the difference is larger than "In-position width (PA10)" of servo parameter in pulse command units, minor error (error code: 1C29H) will occur and synchronous control cannot be started.

Note that, if the setting value of "In-position width" is large, a rapid operation may occur.

*Point*

With cam axis current feed value restoration, calculate the cam axis current feed value with the cam position calculation function ( ) or with synchronous control analysis mode ( ) before starting synchronous control. Then start synchronous control after positioning to the correct cam axis current feed value.

## Example

The following shows an example of starting a cam pattern from the zero point of the cam axis current value per cycle with the current feed current value position as the origin when returning to a specified point, or home position return is completed after a forced stop.

| Setting item | Setting value |
|---|---|
| [Pr.439] Cam axis length per cycle (R: D42700+160n, D42701+160n/Q: D15060+150n, D15061+150n) | 1000[pulse] |
| [Pr.441] Cam stroke amount (R: D42704+160n, D42705+160n/Q: D15064+150n, D15065+150n) | 200[pulse] |
| [Pr.462] Cam axis restoration object (R: D42742+160n/Q: D15102+150n) | 2: Cam reference position restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | 2: Current feed value |
| [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n) | 1: Initial setting value of cam axis current value per cycle |
| [Pr.467] Cam reference position (Initial setting) (R: D42750+160n, D42751+160n/Q: D15110+150n, D15111+150n) | None |
| [Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n) | 0[pulse] |

• Move to advanced synchronous control starting point
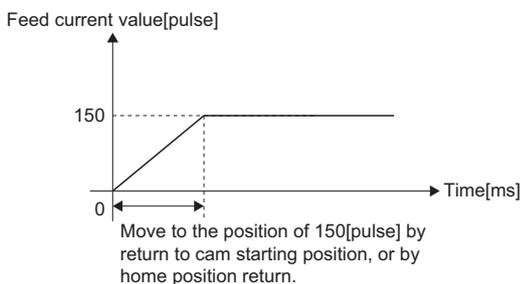


• Restore operation

• Cam operation

Feed current value[pulse]

350 ┄┄┄┄┄┄┄┄

With the "feed current value=150[pulse]"
position as the start point, the cam operates
for the amount of "reference point + cam stroke amount".

150 ┄┄┄

0 ──────────────────→ Time[ms]

Cam axis current
value per cycle[pulse]

The time when cam axis current value per cycle is "0[pulse]"

1000 ┄┄┄┄┄┄┄

0 ──────────────────→ Time[ms]
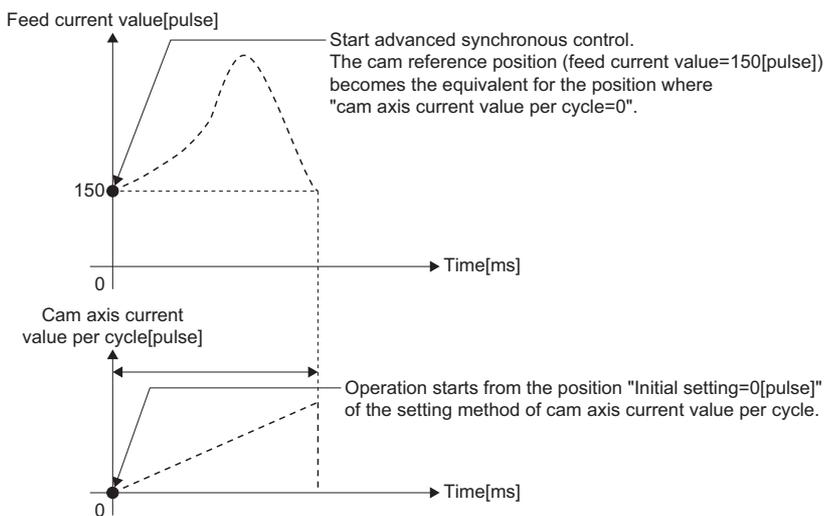
# 7.4 Synchronous Control Analysis Mode

With synchronous control analysis mode, parameters are only analyzed for synchronous control when there is a command to start synchronous control. This mode is used to confirm the synchronous positions of the output axes in order to align axes with position control before starting synchronous control.

If the target axis bit is ON in "[Rq.381] Synchronous analysis request (R: M43250+n/Q: M12032+n)" when starting synchronous control (turning from OFF to ON for "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)"), operation enters synchronous control analysis mode.

When the synchronization position analysis is completed, the synchronous control monitor data ([Md.400] to [Md.402], [Md.406] to [Md.411], [Md.422], [Md.425], [St.420], [St.421], [St.423], [St.424] (☞ Page 137 Synchronous Control Monitor Data)) is updated, and the target axis bit in "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" turns from OFF to ON.

The "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" and "[St.1040] Start accept flag (R: M30080+n/Q: M2001+n)" is not turned ON during synchronous control analysis mode.
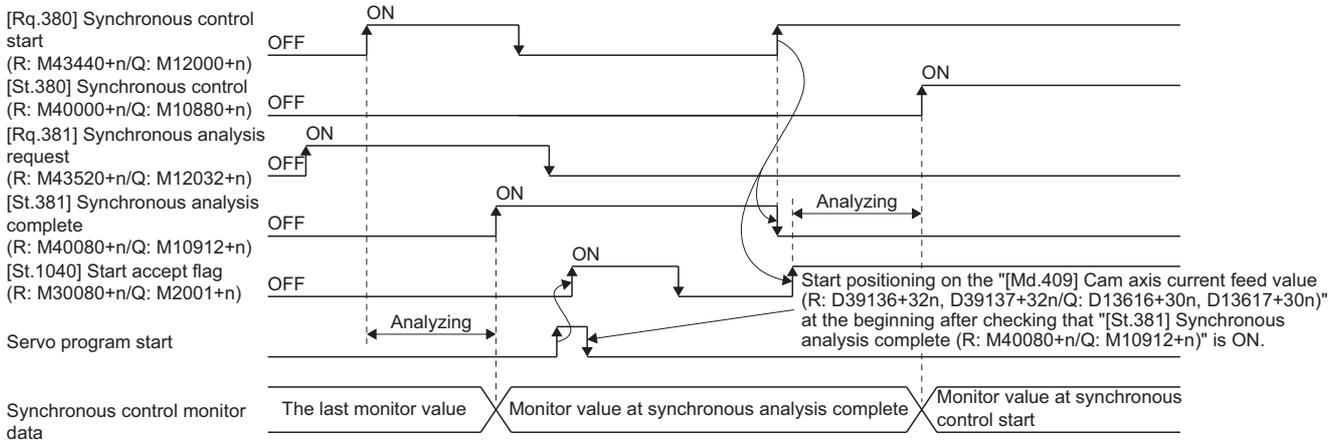


**Point**

- Since the synchronous control analysis mode is used for the synchronous control initial position, a minor error (error code: 1C29H) is not detected. Therefore, refer to "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)" that is updated by "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" turning from OFF to ON, and perform the synchronous alignment.
- When "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" is ON at the synchronous control analysis mode start, "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" is turned OFF by turning "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" from OFF to ON.

## Example

The following shows an example of aligning the synchronous position of an output axis that references the input axis.

*1.* Set the following values in the synchronous control initial position parameters.

| Setting item | Setting value |
| --- | --- |
| [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n) | 2:  Calculate from input axis |
| [Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n) | 2:  Cam axis current feed value restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | 0:  Previous value |
| [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n) | 2:  Current value per cycle after main shaft gear |

*2.* Turn ON the target axis bit of "[Rq.381] Synchronous analysis request (R: M43520+n/Q: M12032+n)", and then turn from OFF to ON in "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" to start the synchronous control analysis mode.

*3.* Verify that "[St.381] Synchronous analysis complete (R: M40080+n/Q: M10912+n)" is ON, and execute positioning for the output axis to be updated to "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)".

*4.* Turn OFF "[Rq.381] Synchronous analysis request (R: M43520+n/Q: M12032+n)", and then turn from OFF to ON "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" to start synchronous control.

**7**

# 7.5 Cam Position Calculation Function

The cam position is calculated by the CAMPSCL instruction (Cam position calculation) of Motion SFC program with this function. This function can be used to calculate the cam position for the synchronous control initial position before starting synchronous control.

Refer to the following for details of CAMPSCL instruction.

📖MELSEC iQ-R Motion controller Programming Manual (Program Design)

## Example

The following shows the procedure for synchronous position alignment, in a synchronous system where cam axes 2 and 3 are synchronized with the cam axis current value per cycle of axis 1.

*1.* Calculate the cam axis current value per cycle using this function based on the current feed value and the cam reference position of axis 1.

*2.* Calculate the cam axis current feed value of axis 2 with this function based on the cam axis current value per cycle that was calculated in Step 1.

*3.* Calculate the cam axis current feed value of axis 3 with this function based on the cam axis current value per cycle that was calculated in Step 1.

*4.* Execute positioning on axis 2 to bring the cam to the cam axis current feed value which was calculated in Step 2, and also on axis 3 to the cam axis current feed value which was calculated in Step 3.

*5.* Start synchronous control on axis 1, 2 and 3 with the current feed value restoration mode. Use the cam axis current value per cycle that was calculated in Step 1 for the cam axis current value per cycle (Initial setting).

# 7.6 Method to Restart Synchronous Control

The relationship of the synchronous position for synchronous control is always saved in the Motion CPU module. Synchronous control can be restarted without returning all axes to their starting points by restoring the synchronized relationship through the synchronous control initial position parameters. (☞ Page 148 Synchronous Control Initial Position Parameters)

The reference axis used to restart synchronous control is different for each system. The following procedure shows an example of how to restore synchronized values based on the servo input axis as reference position.

## Example

Restoring 2 output axes (axis 2, axis 3) based on the servo input axis (axis 1) as the reference position. (Press conveyance device)
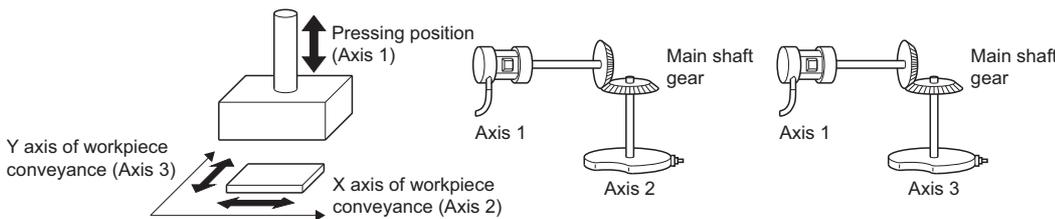


### ■Procedure for synchronous control (first time)

*1.* Execute home position return for axis 1, 2 and 3, and position to the synchronization starting point.

*2.* Set the synchronous control initial position parameters for axis 2 and 3 as follows.

| Setting item | Setting value |
|---|---|
| [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n) | 2: Calculate from input axis |
| [Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n) | 2: Cam axis current value per cycle restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | 0: Previous value |
| [Pr.468] Cam axis current value per cycle (Initial setting) (R: D42752+160n, D42753+160n/Q: D15112+150n, D15113+150n) | 0 |

*3.* Turn ON the bit device for axis 2 and 3 in "[Rq.380] Synchronous control start (R: D43440+n/Q: M12000+n)" to start synchronous control.

### ■Procedure for restarting synchronous control

*1.* Set the synchronous control initial position parameters for axis 2 and 3 as follows.

| Setting item | Setting value |
|---|---|
| [Pr.460] Setting method of current value per cycle after main shaft gear (R: D42740+160n/Q: D15100+150n) | 2: Calculate from input axis |
| [Pr.462] Cam axis position restoration object (R: D42742+160n/Q: D15102+150n) | 2: Cam axis current feed value restoration |
| [Pr.463] Setting method of cam reference position (R: D42743+160n/Q: D15103+150n) | 0: Previous value |
| [Pr.464] Setting method of cam axis current value per cycle (R: D42744+160n/Q: D15104+150n) | 2: Current value per cycle after main shaft gear |

*2.* Turn ON the bit device for axis 2 and 3 in "[Rq.381] Synchronous analysis request (R: D43520+n/Q: M12032+n)", and then turn ON the bit device for axis 2 and 3 in "[Rq.380] Synchronous control start (R: D43440+n/Q: M12000+n)" to execute the synchronous control analysis. The analyzed result is updated in Synchronous control monitor data ([Md.400] to [Md.402], [Md.406] to [Md.411], [Md.422], [Md.425], [St.420], [St.421], [St.423], [St.424]. (☞ Page 137 Synchronous Control Monitor Data))

*3.* Position axis 2 and 3 to "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)" which has been updated in Step 2.

*4.* Turn OFF the bit device for axis 2 and 3 in "[Rq.381] Synchronous analysis request (R: D43520+n/Q: M12032+n)", and then turn ON the bit device for axis 2 and 3 in "[Rq.380] Synchronous control start (R: D43440+n/Q: M12000+n)" to start synchronous control.

# 8 AUXILIARY AND APPLIED FUNCTIONS

## 8.1 Phase Compensation Function

In synchronous control, delays in progresses, etc. cause the phase to deviate at the output axis motor shaft end with respect to the input axis (servo input axis or synchronous encoder axis). The phase compensation function compensates in this case so that the phase does not deviate.

Phase compensation can be set for the input and the output axis. It is possible to compensate using the delay time peculiar to the system based on the servo input axis or the synchronous encoder axis on the input axis side. It is also possible to use a compensation delay time equivalent to the position deviation for each servo amplifier on the output axis side.

### Phase compensation on delay time of the input axis

Set delay time peculiar to the system in the phase compensation advance time of the input axis ("[Pr.302] Servo input axis phase compensation advance time (R: D41200+8n, D41201+8n/Q: D14600+2n, D14601+2n)", "[Pr.326] Synchronous encoder axis phase compensation advance time (R: D42320+16n, D42321+16n/Q: D14820+10n, D14821+10n)"). The command generation axis does not have the phase compensation function since the delay time specific to the system is 0. The delay time peculiar to the system is shown below.

#### ■Delay time peculiar to the system for a servo input axis
• When using MR-J5(W)-□B

| Operation cycle [ms] | [Pr.300] Servo input axis type | | | |
|---|---|---|---|---|
| | Current feed value | Real current value | Command to servo amplifier | Feedback value |
| 0.222 | 0[μs] | 1930[μs] | 0[μs] | 1930[μs] |
| 0.444 | 0[μs] | 2820[μs] | 0[μs] | 2820[μs] |
| 0.888 | 0[μs] | 4597[μs] | 0[μs] | 4597[μs] |
| 1.777 | 0[μs] | 6375[μs] | 0[μs] | 6375[μs] |
| 3.555 | 0[μs] | 9931[μs] | 0[μs] | 9931[μs] |
| 7.111 | 0[μs] | 20597[μs] | 0[μs] | 20597[μs] |

• When using MR-J4(W)-□B

| Operation cycle [ms] | [Pr.300] Servo input axis type | | | |
|---|---|---|---|---|
| | Current feed value | Real current value | Command to servo amplifier | Feedback value |
| 0.222 | 0[μs] | 944[μs] | 0[μs] | 944[μs] |
| 0.444 | 0[μs] | 1833[μs] | 0[μs] | 1833[μs] |
| 0.888 | 0[μs] | 3611[μs] | 0[μs] | 3611[μs] |
| 1.777 | 0[μs] | 5388[μs] | 0[μs] | 5388[μs] |
| 3.555 | 0[μs] | 8945[μs] | 0[μs] | 8945[μs] |
| 7.111 | 0[μs] | 19612[μs] | 0[μs] | 19612[μs] |

## ■Delay time peculiar to the system for a synchronous encoder axis

| Operation cycle [ms] | [Pr.320] Synchronous encoder axis type | | | | | |
|---|---|---|---|---|---|---|
| | Incremental synchronous encoder | Absolute synchronous encoder | Synchronous encoder via device | Synchronous encoder via sensing module | Synchronous encoder via servo amplifier | |
| | | | | | MR-J5(W)-□B | MR-J4(W)-□B |
| 0.222 | 614[µs] | 968[µs] | 614+Input value refresh timing[µs] | 968[µs] | 2024[µs] | 1034[µs] |
| 0.444 | 1276[µs] | 1871[µs] | 1276+Input value refresh timing[µs] | 1871[µs] | 2091[µs] | 1937[µs] |
| 0.888 | 2600[µs] | 3638[µs] | 2600+Input value refresh timing[µs] | 3638[µs] | 4685[µs] | 3676[µs] |
| 1.777 | 4396[µs] | 5422[µs] | 4396+Input value refresh timing[µs] | 5422[µs] | 6473[µs] | 5451[µs] |
| 3.555 | 7933[µs] | 8980[µs] | 7933+Input value refresh timing[µs] | 8980[µs] | 10034[µs] | 9035[µs] |
| 7.111 | 18616[µs] | 19648[µs] | 18616+Input value refresh timing[µs] | 19648[µs] | 20673[µs] | 19699[µs] |

*1   The delay time for a SSI serial communication compatible encoder is a value that satisfies "Motion operation cycle ≥ data update cycle". (☞ Page 66 Via sensing module)

## Phase compensation of delay time of the output axis

Set delay time equivalent to the position deviation on the servo amplifier in "[Pr.444] Cam axis phase compensation advance time (R: D42706+160n, D42707+160n/Q: D15066+150n, D15067+150n)" for the output axis. The delay time equivalent to position deviation of the servo amplifier is calculated using the following formula.

$$\text{Delay time [µs]} = \frac{1000000}{\text{Servo parameter "Model loop gain (PB07)"}}$$

**Point**

When the feed forward gain is set, the delay time is set to a smaller value than the value listed above.

The model loop gain will change when the gain adjustment method is auto tuning mode 1 or 2. The model loop gain must not be changed on the axis executing phase compensation through preventing change with the manual mode or interpolation mode setting.

## Setting example

When axis 1 is synchronized with an incremental synchronous encoder axis, the phase compensation advance time is set as follows.

(If the operation cycle is as 1.777[ms] and model loop gain of axis 1 is as 80.)

| Setting item | Setting value |
|---|---|
| [Pr.326] Synchronous encoder axis phase compensation advance time (R: D42320+16n, D42321+16n/Q: D14820+10n, D14821+10n) | 4396[µs] (Reference: Delay time peculiar to system for a synchronous encoder axis) |
| [Pr.444] Cam axis phase compensation advance time (R: D42706+160n, D42707+160n/Q: D15066+150n, D15067+150n) | $\frac{1000000}{80} = 12500$[µs] |

When overshoot or undershoot occurs during acceleration/deceleration, set a longer time for the phase compensation time constant.

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# 8.2 Relationship between the Output Axis and Each Function

The relationship between the output axis of synchronous control and each function is shown below.

○: Valid, —: Invalid

| Function | | Output axis | Details |
|---|---|---|---|
| Fixed parameter | Unit setting | ○ | The same control as other methods. |
| | Number of pulses per rotation (AP) | ○ | |
| | Travel value per rotation (AL) | ○ | |
| | Backlash compensation amount | ○ | |
| | Upper stroke limit | ○ | The axis stops immediately when exceeding the software stroke limit range. To disable the software stroke limit, set the setting value so that "Upper limit value = Lower limit value". |
| | Lower stroke limit | ○ | |
| | Command in-position range | — | Setting is ignored. |
| | Speed control 10 × multiplier setting for degree axis | ○ | Reflected on monitor data. |
| Torque limit function | | ○ | The torque limit value can be changed by torque limit value change request instruction (M(P).CHGT/D(P).CHGT, CHGT). |
| Hardware stroke limit | | ○ | Controlled the same as positioning control. |
| Forced stop | | ○ | The same control as other methods. |
| Control change | Current value change | — | Ignored. |
| | Speed change | — | |
| | Target position change | — | |
| Absolute position system | | ○ | The same control as other methods. |
| M-code output function | | — | M-code is not able to output. |
| Operation setting for incompletion of home position return | | ○ | Controlled the same as positioning control. For a system that needs alignment, start synchronous control after establishing a home position. |
| Servo ON/OFF request | | — | Servo OFF request is ignored during synchronous control similar to positioning control. |

> **Point**
>
> Functions for an input axis in synchronous control conform to the specification of each control (Home position return control, Positioning control, Manual control, Speed-torque control).

# 8.3 Speed-Torque Control

Control mode can be switched for output axis during synchronous control.

The control is performed with "speed-torque control data".

Data that is needed to be set with speed-torque control during synchronous control is shown in the table below.

| Setting item | Setting necessity | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | During control other than synchronous control | | | During synchronous control | | |
| | Speed control | Torque control | Continuous operation to torque control | Speed control | Torque control | Continuous operation to torque control |
| Control mode switching request device | ○ | ○ | ○ | ○ | ○ | ○ |
| Control mode setting device | ○ | ○ | ○ | ○ | ○ | ○ |
| Speed limit value at speed-torque control | ○ | ○ | ○ | — | — | — |
| Torque limit value at speed-torque control | ○ | ○ | ○ | ○ | ○ | ○ |
| Speed command device | ○ | ○ | ○ | — | — | — |
| Command speed acceleration time | ○ | — | ○ | — | — | — |
| Command speed deceleration time | ○ | — | ○ | — | — | — |
| Torque command device | — | ○ | ○ | — | ○ | ○ |
| Command torque time constant (positive direction) | — | ○ | ○ | — | ○ | ○ |
| Command torque time constant (negative direction) | — | ○ | ○ | — | ○ | ○ |
| Speed initial value selection at control mode switching | ○ | — | ○ | — | — | — |
| Torque initial value selection at control mode switching | — | ○ | ○ | — | ○ | ○ |
| Invalid selection during zero speed at control mode switching | ○ | ○ | ○ | ○ | ○ | ○ |

*1 Refer to the following for details of speed-torque control data.
&#x1F4D5;MELSEC iQ-R Motion controller Programming Manual (Positioning Control)

## Speed-torque control in output axis

- The speed-torque control can be executed for the output axis of the cam No.0 (linear cam) during synchronous control. When the control mode switching is executed for the output axis of cam other than cam No.0 or the output axis where synchronous control change function is being performed, a warning (error code: 0C16H) will occur, and the control mode is not switched. When the output axis where the speed-torque control is performed is set to other than cam No.0, a warning (error code: 0C17H) will occur, and it is not switched to the set cam No. When the mode is switched to position control, it is switched to the cam No. set at passing through the 0th point of cam data. When the motor is operating at control mode switching request, a warning (error code: 09E7H) will occur, and the control mode is not switched. The mode can be switched to continuous operation to torque control mode even when the motor is operating.

- Turn from OFF to ON the control mode switching request device after setting the control mode (10: Speed control mode, 20: Torque control mode, 30: Continuous operation to torque control mode) in the control mode setting device to switch the control mode. The following shows the switching condition of each control mode.
  - Speed control/Torque control
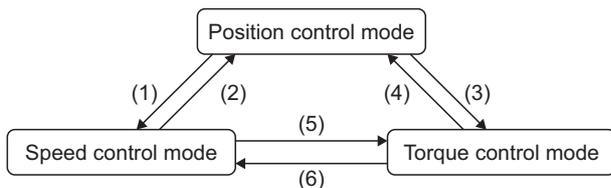


| Switching operation | | Switching condition |
|---|---|---|
| (1) | Position control mode → Speed control mode | During synchronous control[*1], and during motor stop[*2] |
| (2) | Speed control mode → Position control mode | |
| (3) | Position control mode → Torque control mode | |
| (4) | Torque control mode → Position control mode | |
| (5) | Speed control mode → Torque control mode | During synchronous control[*1] |
| (6) | Torque control mode → Speed control mode | |

*1 The "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" is ON. During the synchronous control mode switching analysis or during the synchronous control stop due to "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" turning from ON to OFF or stop factor occurrence, the control mode switching request is ignored.

*2 ZERO speed (b3) of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" is ON. The control mode can be changed without checking the switching condition of "during motor stop" in Motion CPU by setting "1: Condition during zero speed at control mode switching: invalid" in "Invalid selection during zero speed at control mode switching". Set "1: Condition during zero speed at control mode switching: invalid" to switch the control mode without waiting for stop of servo motor.

- Continuous operation to torque control
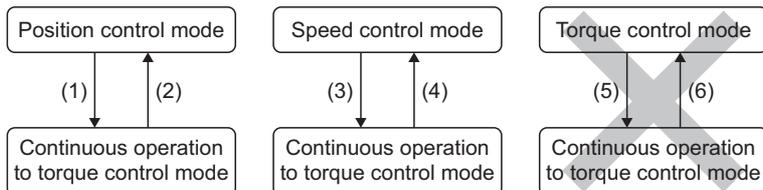


| Switching operation | | Switching condition |
|---|---|---|
| (1) | Position control mode → Continuous operation to torque control mode | During synchronous control[*1] |
| (2) | Continuous operation to torque control mode → Position control mode | During synchronous control[*1], and during motor stop[*2] |
| (3) | Speed control mode → Continuous operation to torque control mode | During synchronous control[*1] |
| (4) | Continuous operation to torque control mode → Speed control mode | |
| (5) | Torque control mode → Continuous operation to torque control mode | Switching not possible |
| (6) | Continuous operation to torque control mode → Torque control mode | |

*1 The "[St.380] Synchronous control (R: M40000+n/Q: M10880+n)" is ON. During the synchronous control mode switching analysis or during the synchronous control stop due to "[Rq.380] Synchronous control start (R: M43440+n/Q: M12000+n)" turning from ON to OFF or stop factor occurrence, the control mode switching request is ignored.

*2 ZERO speed (b3) of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" is ON. The control mode can be changed without checking the switching condition of "during motor stop" in Motion CPU by setting "1: Condition during zero speed at control mode switching: invalid" in "Invalid selection during zero speed at control mode switching". Set "1: Condition during zero speed at control mode switching: invalid" to switch the control mode without waiting for stop of servo motor.

- The command speed at speed control is the speed command to the output axis. The command speed at torque/continuous operation to torque control is the speed limit value.
- Command torque at torque control and continuous operation to torque control are set in the "torque command device" of "speed-torque control data". The command torque is limited with "Torque limit value at speed-torque control". If the torque exceeds torque limit value is set, a warning (error code: 09E4H) will occur, the operation is controlled with torque limit value at speed-torque control. Torque limit value to servo amplifier can be changed within the range of "Torque limit value at speed-torque control" by torque limit value change request (CHGT, M(P).CHGT/D(P).CHGT). If the change outside the range of "Torque limit value at speed-torque control" is requested by torque limit value change request torque limit value individual change request, a warning (error code: 0A5EH) will occur, and the torque limit value is not changed.
- Values of "[Md.407] Cam axis current value per cycle (R: D39132+32n, D39133+32n/Q: D13612+30n, D13613+30n)", "[Md.408] Cam reference position (R: D39134+32n, D39135+32n/Q: D13614+30n, D13615+30n)", and "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)" during speed-torque control are based on the command from the input axis. It is not based on the actual output axis position. "[Md.407] Cam axis current value per cycle (R: D39132+32n, D39133+32n/Q: D13612+30n, D13613+30n)", "[Md.408] Cam reference position (R: D39134+32n, D39135+32n/Q: D13614+30n, D13615+30n)", and "[Md.409] Cam axis current feed value (R: D39136+32n, D39137+32n/Q: D13616+30n, D13617+30n)" are restored based on the actual output axis position at the position control mode switching.
- Phase compensation is valid during speed-torque control.
- Switching to speed control mode, torque control mode, or continuous operation to torque control mode during synchronous control is not reflected on the scroll monitor.
- During synchronous control start analysis or during the synchronous control stop due to "[Rq.380] Synchronous control start (R: M40000+n/Q: M12000+n)" turning from ON to OFF or stop factor occurrence, the control mode switching request is ignored. Take "[Rq.380] Synchronous control start (R: M40000+n/Q: M12000+n)" in an interlock.
- The synchronous control change function cannot be used during speed-torque control.

## Precautions at control mode switching

When using continuous operation to torque control mode, use the servo amplifiers that are compatible with continuous operation to torque control. If servo amplifiers that are not compatible with continuous operation to torque control are used, a minor error (error code: 19E7H) will occur at request of switching to continuous operation to torque control mode.

## Stop cause

### ■Stop cause during speed control mode

The operation for stop cause during speed control mode is shown below.

The synchronous control ends by the stop cause occurrence.

| Item | Operation during speed control mode |
|---|---|
| The "[Rq.380] Synchronous control start (R: M43440+n/ Q: M12000+n)" turned OFF.[*1] | The motor decelerates to speed "0" by setting value of parameter block set in "[Pr.448] Synchronous control parameter block No. (R: D42709+160n/Q: D15069+150n)"[*4]. The mode is switched to position control mode when "Zero speed (b3)" of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" turns ON, and the operation stops. |
| The "[Rq.1140] Stop command (R: M34480+32n/Q: M3200+20n)" turned ON.[*1] | |
| The "[Rq.1141] Rapid stop command (R: M34481+32n/ Q: M3201+20n)" turned ON.[*2] | |
| The external stop input turned ON.[*3] | |
| The "[Rq.1123] All axes servo ON command (R: M30042/ Q: M2042)" turned OFF. | The servo OFF is not executed during synchronous control. (The synchronous control does not end.) When the synchronous control is ended and the mode is switched to position control mode, the command status at the time becomes valid. |
| The "[Rq.1155] Servo OFF command (R: M34495+32n/ Q: M3215+20n)" turned ON. | |
| The current value reached to software stroke limit. | A minor error (error code: 1900H, 1905H, 1907H, 1993H, 1995H) will occur, and the motor decelerates to speed "0" by setting value of parameter block set in "[Pr.448] Synchronous control parameter block No. (R: D42709+160n/Q: D15069+150n)"[*4]. The mode is switched to position control when "Zero speed (b3)" of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" turns ON, and the operation stops. |
| The position of motor reached to hardware stroke limit.[*3] | |
| The "[Rq.1120] PLC ready flag (R: M30000/Q: M2000)" turned OFF. | |
| The main shaft gear/auxiliary shaft gear/speed change gear 1/speed change gear 2 operation overflow error occurred.[*3] | The motor decelerates to speed "0" by setting value of parameter block set in "[Pr.448] Synchronous control parameter block No. (R: D42709+160n/Q: D15069+150n)"[*4]. The mode is switched to position control when "Zero speed (b3)" of "[Md.1022] Servo status 2 (R: D32033+48n/ Q: #8011+20n)" turns ON, and the operation stops. |
| The forced stop input to Motion CPU. | The mode is switched to position control mode when the servo OFF (The "[St.1075] Servo ready (R: M32415+32n/Q: M2415+20n)" turns OFF) is executed. (While the servo amplifier is servo OFF, even if the mode is switched to position control mode, the servo motor occurs to the free run. (The operation stops with dynamic brake.)) |
| The forced stop input to servo amplifier. | |
| The servo error occurred. | |
| The servo amplifier's power supply turned OFF. | The motor occurs to the free run. (The operation stops with dynamic brake.) (The mode is to position control mode at the servo amplifier's power supply ON again.) |

*1 The motor stops based on the deceleration time.
*2 The motor stops based on the rapid stop deceleration time.
*3 The motor stops based on the setting of "Deceleration processing on stop input" of parameter block.
*4 The setting of "S-curve ratio".

## ■Stop cause during torque control mode

The operation for stop cause during torque control mode is shown below.

The synchronous control ends by the stop cause occurrence.

| Item | Operation during torque control mode |
|---|---|
| The "[Rq.380] Synchronous control start (R: M43440+n/ Q: M12000+n)" turned OFF. | The mode is switched to position control mode when the speed limit command value is set to "0" and "Zero speed (b3)" of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" turns ON, and the operation stops immediately. (Deceleration processing is not executed.) The value of command torque is not changed. It might take time to reach at the speed "0" depending on the current torque command value. |
| The "[Rq.1140] Stop command (R: M34480+32n/Q: M3200+20n)" turned ON. | |
| The "[Rq.1141] Rapid stop command (R: M34481+32n/ Q: M3201+20n)" turned ON. | |
| The external stop input turned ON. | |
| The "[Rq.1123] All axes servo ON command (R: M30042/ Q: M2042)" turned OFF. | The servo OFF is not executed during synchronous control. (The synchronous control does not end.) When the synchronous control is ended valid when and the mode is switched to position control mode, the command status at the time becomes valid. |
| The "[Rq.1155] Servo OFF command (R: M34495+32n/ Q: M3215+20n)" turned ON. | |
| The current value reached to software stroke limit. | The minor error (error code: 1900H, 1905H, 1907H ,1993H, 1995H) will occur. The mode is switched to position control mode at current position, and the operation immediately stops. (Deceleration processing is not executed.) When the operation immediately stops, the motor will start hunting depending on the motor speed. Therefore, be sure not to reach to limit in high speed or do not turn OFF the PLC READY. |
| The position of motor reached to hardware stroke limit. | |
| The "[Rq.1120] PLC ready flag (R: M30000/Q: M2000)" turned OFF. | |
| The main shaft gear/auxiliary shaft gear/speed change gear 1/speed change gear 2 operation overflow error occurred. | The mode is switched to position control mode at current position, and the operation immediately stops. (Deceleration processing is not executed.) When the operation immediately stops, the motor will start hunting depending on the motor speed. |
| The forced stop input to Motion CPU. | The mode is switched to position control mode when the servo OFF (The "[St.1075] Servo ready (R: M32415+32n/Q: M2415+20n)" turns OFF) is executed. (While the servo amplifier is servo OFF, even if the mode is switched to position control mode, the servo motor occurs to the free run. (The operation stops with dynamic brake.)) |
| The forced stop input to servo amplifier. | |
| The servo error occurred. | |
| The servo amplifier's power supply turned OFF. | The motor occurs to the free run. (The operation stops with dynamic brake.) (The mode is to position control mode at the servo amplifier's power supply ON again.) |

## ■Stop cause during continuous operation to torque control mode

The operation for stop cause during continuous operation to torque control mode is shown below.

The synchronous control ends by the stop cause occurrence.

| Item | Operation during continuous operation to torque control mode |
|---|---|
| The "[Rq.380] Synchronous control start (R: M43440+n/ Q: M12000+n)" turned OFF. | The mode is switched to position control mode when the speed limit command value is set to "0" and "Zero speed (b3)" of "[Md.1022] Servo status 2 (R: D32033+48n/Q: #8011+20n)" turns ON, and the operation stops immediately. (Deceleration processing is not executed.) The value of command torque is not changed. It might take time to reach at the speed "0" depending on the current torque command value. |
| The "[Rq.1140] Stop command (R: M34480+32n/Q: M3200+20n)" turned ON. | |
| The "[Rq.1141] Rapid stop command (R: M34481+32n/ Q: M3201+20n)" turned ON. | |
| The external stop input turned ON. | |
| The "[Rq.1123] All axes servo ON command (R: M30042/ Q: M2042)" turned OFF. | The servo OFF is not executed during synchronous control. (The synchronous control does not end.) When the synchronous control is ended and the mode is switched to position control mode, the command status at the time becomes valid. |
| The "[Rq.1155] Servo OFF command (R: M34495+32n/ Q: M3215+20n)" turned ON. | |
| The current value reached to software stroke limit. | The minor error (error code: 1900H, 1905H, 1907H, 1993H, 1995H) will occur. The mode is switched to position control mode at current position, and the operation immediately stops. (Deceleration processing is not executed.)When the operation immediately stops, the motor will start hunting depending on the motor speed. Therefore, be sure not to reach to limit in high speed or do not turn OFF the PLC READY. |
| The position of motor reached to hardware stroke limit. | |
| The "[Rq.1120] PLC ready flag (R: M30000/Q: M2000)" turned OFF. | |
| The main shaft gear/auxiliary shaft gear/speed change gear 1/speed change gear 2 operation overflow error occurred. | The mode is switched to position control mode at current position, and the operation immediately stops. (Deceleration processing is not executed.) When the operation immediately stops, the motor will start hunting depending on the motor speed. |
| The forced stop input to Motion CPU. | The mode is switched to position control mode when the servo OFF (The "[St.1075] Servo ready signal (R: M32415+32n/Q: M2415+20n)" turns OFF) is executed. (While the servo amplifier is servo OFF, even if the mode is switched to position control mode, the servo motor occurs to the free run. (The operation stops with dynamic brake.)) |
| The forced stop input to servo amplifier. | |
| The servo error occurred. | |
| The servo amplifier's power supply turned OFF. | The motor occurs to the free run. (The operation stops with dynamic brake.) (The mode is to position control mode at the servo amplifier's power supply ON again.) |

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# 8.4 Multiple CPU Advanced Synchronous Control

## Multiple CPU advanced synchronous control overview

By synchronizing with the input axis of the master CPU and executing synchronous control on the slave CPU, synchronous operation between Multiple CPUs can be executed.

The settings of the master CPU and slave CPU are set with the Multiple CPU advanced synchronous control setting. Also, by setting the status device to be used in Multiple CPU advanced synchronous control, you can monitor the status of other CPUs that constitute the Multiple CPU advanced synchronous control.

By setting the input axis type (master CPU servo input axis, master CPU command generation axis, master CPU synchronous encoder axis) of the master CPU that is to be connected as a synchronous encoder on the slave CPU side, it can be synchronized with the input axis of the master CPU by starting synchronous control.



MR-J5(W)-□B/MR-J4(W)-□B/MR-J3(W)-□B/MR-JE-□B model servo amplifier
Up to 192 axes (64 axes × 3 CPUs)/system
R64MTCPU: 2 lines (Up to 64 axes)
R32MTCPU: 2 lines (Up to 32 axes)
R16MTCPU: 1 line (Up to 16 axes)
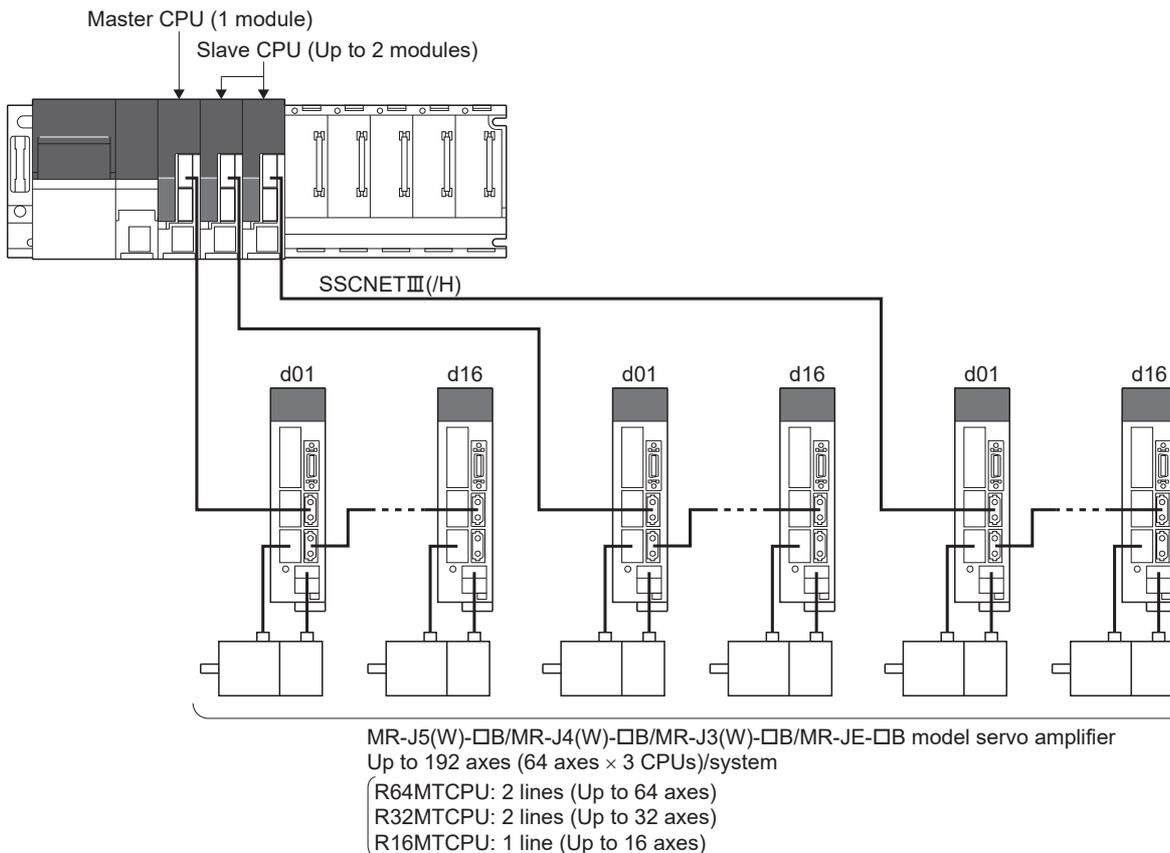
## Features of Multiple CPU advanced synchronous control

The features of Multiple CPU advanced synchronous control are shown below.

### ■Synchronous operation of up to 192 axes

By having up to three Motion CPU modules (One master CPU, up to two slave CPUs) constituting the Multiple CPU system on one base unit, the servo motors of up to 192 axes (64 axes × 3 CPUs) can be synchronized.

### ■All status devices can be transmitted

The transmission of all status devices related to Multiple CPU advanced synchronous control can be transmitted between the master CPU and the slave CPU.

## Setting example

The following shows an example for synchronizing the output axis of the slave CPU (CPU No.3, CPU No.4) with the command generation axis (Axis 1) of the master CPU (CPU No.2).

| Setting item | CPU No. | | |
| --- | --- | --- | --- |
| | CPU No.2 (Master CPU) | CPU No.3 (Slave CPU) | CPU No.4 (Slave CPU) |
| Multiple CPU synchronous control CPU setting | Master CPU | Slave CPU | Slave CPU |
| [Pr.340] Command generation axis valid setting (Axis 1) | 1: Valid | — | — |
| [Pr.320] Synchronous encoder axis type (Axis 1) | — | 401: Master CPU command generation axis (Axis 1) | 401: Master CPU command generation axis (Axis 1) |
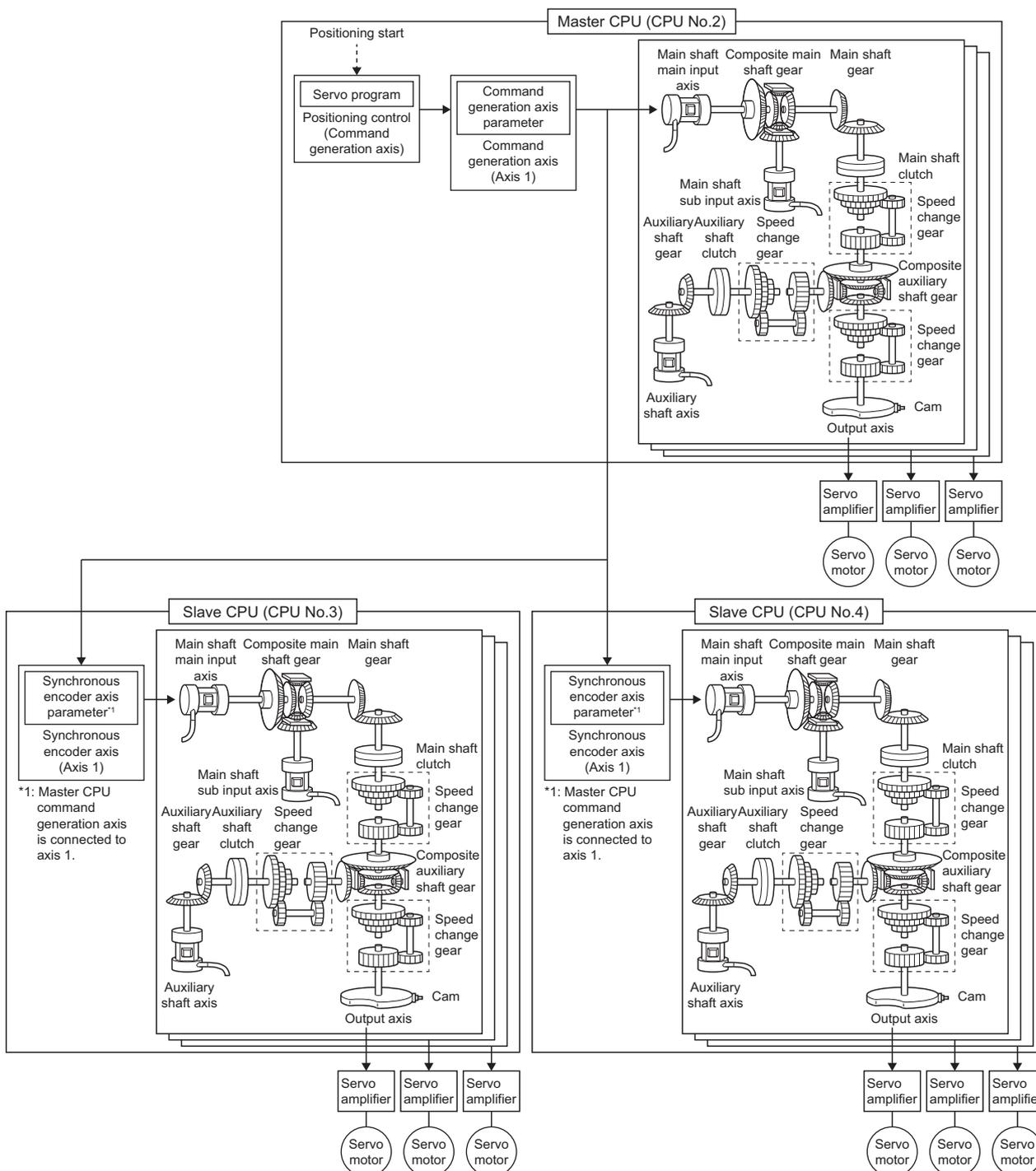
- It takes two operation cycles until the slave CPU processes the command value sent from the master CPU. For this reason, the processing software in the Motion CPU, compensates for this by delaying the output axis of the master CPU side by two operation cycles. By doing this, the timing of commands to the output axes of the master CPU and slave CPU do not deviate largely.
- Because of the compensation in (1), the update of the synchronous control monitor data in the output axis for the input axis on the master CPU side, is delayed two operation cycles. Also, when an operation such as a current value change etc. is executed at the main input axis, the timing of the change of "[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)" is also delayed two operation cycles.

(Example) For setting the command generation axis in the master CPU
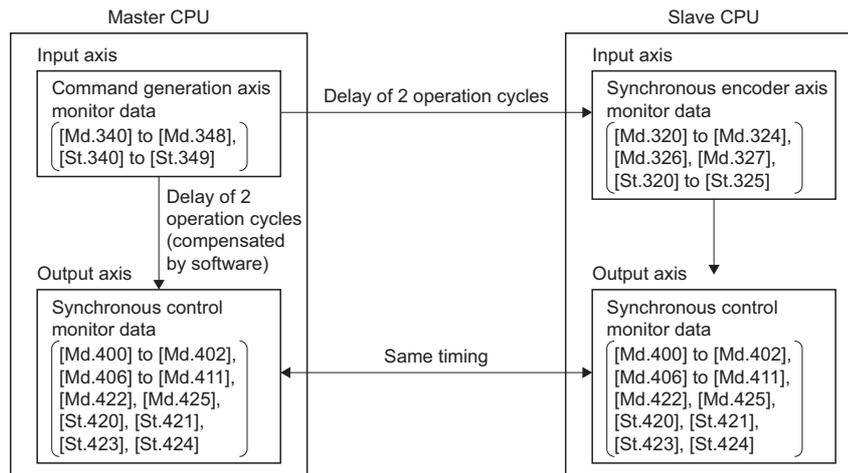


- To remove the delay time described above, using the phase compensation function of the output axis for the slave CPU and the master CPU, set a value that adds a delay compensation time of two operation cycles to the delay time inherent to the system. Refer to phase compensation on delay time of the input axis for delay time inherent to the system. (☞ Page 166 Phase compensation on delay time of the input axis)

## Precautions

- In the master CPU, when changing "[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)" continuously, execute after two operation cycles have passed. If executed within two operation cycles, "[Md.400] Current value after composite main shaft gear (R: D39120+32n, D39121+32n/Q: D13600+30n, D13601+30n)" might not be changed.
- When using Multiple CPU advanced synchronous control with a master CPU that has the mixed operation cycle function enabled, the data between CPUs is refreshed every operation cycle. Therefore, axes that are operating at the operation cycle should be set for sending command values from master CPUs to slave CPUs.

# Setting for Multiple CPU advanced synchronous control

The setting of the master CPU and slave CPU are necessary for Multiple CPU advanced synchronous control.

Also, in order to monitor the information of other CPUs that constitute the Multiple CPU advanced synchronous control, setting of the status device of each CPU is executed.

The settings for Multiple CPU advanced synchronous control are set in the Multiple CPU advanced synchronous control setting.

🖱 [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Multiple CPU advanced synchronous control setting]

| Item | | | Setting range | Default value |
|---|---|---|---|---|
| Multiple CPU advanced synchronous control CPU setting | | | 0: Independent CPU/1: Master CPU/2: Slave CPU | Independent CPU |
| Status device setting[*1][*2] | Synchronous controlling | | Word device/Bit device/—[*4] | — |
| | Master CPU input axis[*3] | Transfer information | | — |
| | | Error information | | — |
| | Status for each CPU | | | — |
| | Error status for each CPU and axis | | | — |

*1 By setting devices for CPU No.2 to 4, the status of each Motion CPU can be monitored.
*2 If Motion CPU is set to independent operation, nothing will be stored in the device.
*3 Can be set when Multiple CPU synchronous control setting is "Slave CPU".
*4 This setting can be omitted.

> **Point**
>
> A delay of two operation cycles occurs for the device value assigned to each Motion CPU.

## Multiple CPU advanced synchronous control CPU setting

Execute the setting of the master CPU and slave CPU that constitute the Multiple CPU advanced synchronous control.

| Setting value | Description |
|---|---|
| 0: Independent CPU | Operates as an independent CPU. (Operation in normal state that does not use Multiple CPU advanced synchronous control.) |
| 1: Master CPU | Operates as master CPU. (Can be set in a Motion CPU other than CPU No.2.) |
| 2: Slave CPU | Operates as slave CPU. |

In a Multiple CPU system configuration, it is possible to have a mixture of Motion CPU that operate independently (independent CPU), and Motion CPU that operate in Multiple CPU synchronous control (master CPU, slave CPU).

If configuring a Multiple CPU system, it is necessary to have one master CPU, and at least one slave CPU.

> **Point**
>
> • Set the same operation cycle for all Motion CPU that are executing Multiple CPU advanced synchronous control.
> • For the master CPU and slave CPU, the operation time is approximately an additional 130[µs] more compared to an independent CPU. When an operation cycle over is detected, change the operation cycle to a larger value.

## Status device setting

Refer to the following for the setting range of usable word devices and bit devices.

📖 MELSEC iQ-R Motion Controller Programming Manual (Common)

### ■Synchronous controlling (4 words)

Set the start number of the device to monitor the status of CPU No.2 to 4 synchronous control for each Motion CPU.
This setting can be omitted.

- Word device setting

  Set an even number at the start of the device.

  The status of synchronous control is stored in the set devices as follows.

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +0 | +0 | Synchronous control signal |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.380] Synchronous control Axis 1 | M40000 | M10880 |
| 1 | [St.380] Synchronous control Axis 2 | M40001 | M10881 |
| to | to | to | to |
| 15 | [St.380] Synchronous control Axis 16 | M40015 | M10895 |

| Offset | | Item |
|---|---|---|
| +1 | +1 | Synchronous control signal |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.380] Synchronous control Axis 17 | M40016 | M10896 |
| 1 | [St.380] Synchronous control Axis 18 | M40017 | M10897 |
| to | to | to | to |
| 15 | [St.380] Synchronous control Axis 32 | M40031 | M10911 |

| Offset | | Item |
|---|---|---|
| +2 | — | Synchronous control signal |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.380] Synchronous control Axis 33 | M40032 | |
| 1 | [St.380] Synchronous control Axis 34 | M40033 | |
| to | to | to | |
| 15 | [St.380] Synchronous control Axis 48 | M40047 | |

| Offset | | Item |
|---|---|---|
| +3 | | Synchronous control signal |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.380] Synchronous control Axis 49 | M40048 | |
| 1 | [St.380] Synchronous control Axis 50 | M40049 | |
| to | to | to | |
| 15 | [St.380] Synchronous control Axis 64 | M40063 | |

• Bit device setting

Set a number in a unit of 32 points at the start of the device.

The status of synchronous control is stored in the set devices as follows.

| Offset | | Item | Device | |
|---|---|---|---|---|
| "07" or later[1] | "05" or earlier[1] | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| +0 | +0 | [St.380] Synchronous control Axis 1 | M40000 | M10880 |
| +1 | +1 | [St.380] Synchronous control Axis 2 | M40001 | M10881 |
| to | to | to | to | |
| +31 | +31 | [St.380] Synchronous control Axis 32 | M40031 | M10911 |
| +32 | — | [St.380] Synchronous control Axis 33 | M40032 | |
| +33 | | [St.380] Synchronous control Axis 34 | M40033 | |
| to | | to | to | |
| +63 | | [St.380] Synchronous control Axis 64 | M40063 | |

*1   Operating system software version

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## ■Master CPU input axis transfer information (10 words)

Set the start number of the device to monitor the connection status for each input axis type of the master CPU. Only set this when set as "Slave CPU".

This setting can be omitted.

| Master CPU input axis | Description |
|---|---|
| Servo input axis | When the type is set in "[Pr. 300] Servo input axis type", and connection to servo amplifier is complete, status turns ON. |
| Command generation axis | When the "[Pr.340] Command generation axis valid setting" is set to "1: Valid", status turns ON. |
| Synchronous encoder axis | When the "[St.321] Synchronous encoder axis connecting valid flag (R: M38641+26n/Q: M10441+10n)" is ON, status turns ON. |

- Word device setting

  Set an even number at the start of the device.

  The connection status for each input axis type is stored in the set devices as follows.

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +0 | +0 | Servo input axis connecting information |
| | | <table><tr><th>Bit</th><th>Details</th></tr><tr><td>0</td><td>Servo input axis connecting information Axis 1</td></tr><tr><td>1</td><td>Servo input axis connecting information Axis 2</td></tr><tr><td>to</td><td>to</td></tr><tr><td>15</td><td>Servo input axis connecting information Axis 16</td></tr></table> |
| +1 | +1 | Servo input axis connecting information |
| | | <table><tr><th>Bit</th><th>Details</th></tr><tr><td>0</td><td>Servo input axis connecting information Axis 17</td></tr><tr><td>1</td><td>Servo input axis connecting information Axis 18</td></tr><tr><td>to</td><td>to</td></tr><tr><td>15</td><td>Servo input axis connecting information Axis 32</td></tr></table> |
| +2 | — | Servo input axis connecting information |
| | | <table><tr><th>Bit</th><th>Details</th></tr><tr><td>0</td><td>Servo input axis connecting information Axis 33</td></tr><tr><td>1</td><td>Servo input axis connecting information Axis 34</td></tr><tr><td>to</td><td>to</td></tr><tr><td>15</td><td>Servo input axis connecting information Axis 48</td></tr></table> |
| +3 | | Servo input axis connecting information |
| | | <table><tr><th>Bit</th><th>Details</th></tr><tr><td>0</td><td>Servo input axis connecting information Axis 49</td></tr><tr><td>1</td><td>Servo input axis connecting information Axis 50</td></tr><tr><td>to</td><td>to</td></tr><tr><td>15</td><td>Servo input axis connecting information Axis 64</td></tr></table> |
| +4 | +2 | Command generation axis connecting information |
| | | <table><tr><th>Bit</th><th>Details</th></tr><tr><td>0</td><td>Command generation axis connecting information Axis 1</td></tr><tr><td>1</td><td>Command generation axis connecting information Axis 2</td></tr><tr><td>to</td><td>to</td></tr><tr><td>15</td><td>Command generation axis connecting information Axis 16</td></tr></table> |

| Offset | | Item | |
|---|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | | |
| +5 | +3 | Command generation axis connecting information | |

| Bit | Details |
|---|---|
| 0 | Command generation axis connecting information Axis 17 |
| 1 | Command generation axis connecting information Axis 18 |
| to | to |
| 15 | Command generation axis connecting information Axis 32 |

| Offset | | Item | |
|---|---|---|---|
| +6 | — | Command generation axis connecting information | |

| Bit | Details |
|---|---|
| 0 | Command generation axis connecting information Axis 33 |
| 1 | Command generation axis connecting information Axis 34 |
| to | to |
| 15 | Command generation axis connecting information Axis 48 |

| Offset | | Item | |
|---|---|---|---|
| +7 | | Command generation axis connecting information | |

| Bit | Details |
|---|---|
| 0 | Command generation axis connecting information Axis 49 |
| 1 | Command generation axis connecting information Axis 50 |
| to | to |
| 15 | Command generation axis connecting information Axis 64 |

| Offset | | Item | |
|---|---|---|---|
| +8 | +4 | Synchronous encoder axis connecting information | |

| Bit | Details |
|---|---|
| 0 | Synchronous encoder axis connecting information Axis 1 |
| 1 | Synchronous encoder axis connecting information Axis 2 |
| to | to |
| 11 | Synchronous encoder axis connecting information Axis 12 |
| 12 | Empty |
| to | |
| 15 | |

| Offset | | Item | |
|---|---|---|---|
| +9 | +5 | Empty | |

*1   Operating system software version

**8**

- Bit device setting

Set a number in a unit of 32 points at the start of the device.

The connection status for each input axis type is stored in the set devices as follows.

| Offset | | Item |
|---|---|---|
| "07" or later[1] | "05" or earlier[1] | |
| +0 | +0 | Servo input axis connecting information Axis 1 |
| +1 | +1 | Servo input axis connecting information Axis 2 |
| to | to | to |
| +31 | +31 | Servo input axis connecting information Axis 32 |
| +32 | — | Servo input axis connecting information Axis 33 |
| to | | to |
| +63 | | Servo input axis connecting information Axis 64 |
| +64 | +32 | Command generation axis connecting information Axis 1 |
| +65 | +33 | Command generation axis connecting information Axis 2 |
| to | to | to |
| +95 | +63 | Command generation axis connecting information Axis 32 |
| +96 | — | Command generation axis connecting information Axis 33 |
| to | | to |
| +127 | | Command generation axis connecting information Axis 64 |
| +128 | +64 | Synchronous encoder axis connecting information Axis 1 |
| +129 | +65 | Synchronous encoder axis connecting information Axis 2 |
| to | to | to |
| +139 | +75 | Synchronous encoder axis connecting information Axis 12 |
| +140 | +76 | Empty |
| to | to | |
| +159 | +95 | |

*1   Operating system software version

## ■Master CPU input axis error information (10 words)

Set the start number of the device to monitor the error detection information of each input axis type of the master CPU. Only set this when set as "Slave CPU".

This setting can be omitted.

| Master CPU input axis | Description |
|---|---|
| Servo input axis error detection | When the master CPU "[St.1067] Error detection (R: M32407+32n/Q: M2407+20n)" or "[St.1068] Servo error detection (R: M32408+32n/Q: M2408+20n)" is ON, the status is ON. |
| Command generation axis error detection | The status of "[St.344] Command generation axis error detection (R: M36567+32n/Q: M9807+20n)" of the master CPU is stored. |
| Synchronous encoder axis error detection | The status of "[St.324] Synchronous encoder axis error detection (R: M38644+16n/Q: M10444+10n)" of the master CPU is stored. |

- Word device setting

  Set an even number at the start of the device.

  The error detection information for each input axis type is stored in the set devices as follows.

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +0 | +0 | Servo input axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | Servo input axis error detection Axis 1 | M32407, M32408 | M2407, M2408 |
| 1 | Servo input axis error detection Axis 2 | M32439, M32440 | M2427, M2428 |
| to | to | to | to |
| 15 | Servo input axis error detection Axis 16 | M32887, M32788 | M2707, M2708 |

| Offset | | Item |
|---|---|---|
| +1 | +1 | Servo input axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | Servo input axis error detection Axis 17 | M32919, M32920 | M2727, M2728 |
| 1 | Servo input axis error detection Axis 18 | M32951, M32952 | M2747, M2748 |
| to | to | to | to |
| 15 | Servo input axis error detection Axis 32 | M32399, M32400 | M3027, M3028 |

| Offset | | Item |
|---|---|---|
| +2 | — | Servo input axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | Servo input axis error detection Axis 33 | M33431, M33432 | |
| 1 | Servo input axis error detection Axis 34 | M33463, M33464 | |
| to | to | to | |
| 15 | Servo input axis error detection Axis 48 | M33911, M33912 | |

| Offset | | Item |
|---|---|---|
| +3 | | Servo input axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | Servo input axis error detection Axis 49 | M33943, M33944 | |
| 1 | Servo input axis error detection Axis 50 | M33975, M33976 | |
| to | to | to | |
| 15 | Servo input axis error detection Axis 64 | M34423, M33424 | |

| Offset | | Item |
|---|---|---|
| **"07" or later**[*1] | **"05" or earlier**[*1] | |

| +4 | +2 | Command generation axis error information |
|---|---|---|

| Bit | Details | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| 0 | Command generation axis error detection Axis 1 | M36567 | M9807 |
| 1 | Command generation axis error detection Axis 2 | M36599 | M9827 |
| to | to | to | to |
| 15 | Command generation axis error detection Axis 16 | M37047 | M10107 |

| +5 | +3 | Command generation axis error information |
|---|---|---|

| Bit | Details | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| 0 | Command generation axis error detection Axis 17 | M37079 | M10127 |
| 1 | Command generation axis error detection Axis 18 | M37111 | M10147 |
| to | to | to | to |
| 15 | Command generation axis error detection Axis 32 | M37559 | M10427 |

| +6 | — | Command generation axis error information |
|---|---|---|

| Bit | Details | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| 0 | Command generation axis error detection Axis 33 | M37591 | |
| 1 | Command generation axis error detection Axis 34 | M37623 | |
| to | to | to | |
| 15 | Command generation axis error detection Axis 48 | M38071 | |

| +7 | | Command generation axis error information |
|---|---|---|

| Bit | Details | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| 0 | Command generation axis error detection Axis 49 | M38103 | |
| 1 | Command generation axis error detection Axis 50 | M38135 | |
| to | to | to | |
| 15 | Command generation axis error detection Axis 64 | M38583 | |

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +8 | +4 | Synchronous encoder axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | Synchronous encoder axis error detection Axis 1 | M38644 | M10444 |
| 1 | Synchronous encoder axis error detection Axis 2 | M38676 | M10454 |
| to | to | to | to |
| 11 | Synchronous encoder axis error detection Axis 12 | M38820 | M10554 |
| 12 | Empty | — | |
| to | | | |
| 15 | | | |

| Offset | | Item |
|---|---|---|
| +9 | +5 | Empty |

*1   Operating system software version

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- Bit device setting

  Set a number in a unit of 32 points at the start of the device.

  The error detection information for each input axis type is stored in the set devices as follows.

| Offset | | Item | Device | |
|---|---|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| +0 | +0 | Servo input axis error detection Axis 1 | M32407, M32408 | M2407, M2408 |
| +1 | +1 | Servo input axis error detection Axis 2 | M32439, M32440 | M2427, M2428 |
| to | to | to | to | to |
| +31 | +31 | Servo input axis error detection Axis 32 | M33399, M33400 | M3027, M3028 |
| +32 | — | Servo input axis error detection Axis 33 | M33431, M33432 | |
| +33 | | Servo input axis error detection Axis 34 | M33463, M33646 | |
| to | | to | to | |
| +63 | | Servo input axis error detection Axis 64 | M34423, M34424 | |
| +64 | +32 | Command generation axis error detection Axis 1 | M36567 | M9807 |
| +65 | +33 | Command generation axis error detection Axis 2 | M36599 | M9827 |
| to | to | to | to | to |
| +95 | +63 | Command generation axis error detection Axis 32 | M37559 | M10427 |
| +96 | — | Command generation axis error detection Axis 33 | M37591 | |
| +97 | | Command generation axis error detection Axis 34 | M37623 | |
| to | | to | to | |
| +127 | | Command generation axis error detection Axis 64 | M38583 | |
| +128 | +64 | Synchronous encoder axis error detection Axis 1 | M38644 | M10444 |
| +129 | +65 | Synchronous encoder axis error detection Axis 2 | M38660 | M10454 |
| to | to | to | to | to |
| +139 | +75 | Synchronous encoder axis error detection Axis 12 | M38820 | M10554 |
| +140 | +76 | Empty | | |
| to | to | | | |
| +159 | +95 | | | |

*1 Operating system software version

## ■Status for each CPU (1 word)

Set the start number of the device to monitor the information of the "PLC ready flag", "PCPU READY complete flag" and other devices in CPU No.2 to 4 below for each Motion CPU.

This setting can be omitted.

- Word device setting

  The device information is stored in the set devices as follows.

| Bit | Item | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| 0 | PLC ready flag | M30000 | M2000 |
| 1 | Unusable | — | — |
| 2 | PCPU READY complete flag | SM500 | |
| 3 | TEST mode ON flag | SM501 | |
| 4 | External forced stop input flag | SM502 | |
| 5 | Unusable | — | — |
| 6 | Operation cycle over flag | M30054 | M2054 |
| 7 | Latest self-diagnostic error | SM0 | |
| 8 | Warning detection | SM4 | |
| 9 to 15 | Unusable | — | — |

- Bit device setting

  Set a number in a unit of 16 points at the start of the device.

  The device information is stored in the set devices as follows.

| Offset | Item | Device | |
|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** |
| +0 | PLC ready flag | M30000 | M2000 |
| +1 | Unusable | — | — |
| +2 | PCPU READY complete flag | SM500 | |
| +3 | TEST mode ON flag | SM501 | |
| +4 | External forced stop input flag | SM502 | |
| +5 | Unusable | — | — |
| +6 | Operation cycle over flag | M30054 | M2054 |
| +7 | Latest self-diagnostic error | SM0 | |
| +8 | Warning detection | SM4 | |
| +9 to +15 | Unusable | | — |

**8**

## ■Error status for each CPU and axis (8 words)

Set the start number of the device to monitor the error information of each axis in CPU No. 2 to 4 for each Motion CPU.

This setting can be omitted.

- Word device setting

  Set an even number at the start of the device.

  The error information of each axis is stored in the set devices as follows.

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +0 | +0 | Axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1067] Error detection Axis 1 | M32407 | M2407 |
| 1 | [St.1067] Error detection Axis 2 | M32439 | M2427 |
| to | to | to | to |
| 15 | [St.1067] Error detection Axis 16 | M32887 | M2707 |

| Offset | | Item |
|---|---|---|
| +1 | +1 | Axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1067] Error detection Axis 17 | M32919 | M2727 |
| 1 | [St.1067] Error detection Axis 18 | M32951 | M2747 |
| to | to | to | to |
| 15 | [St.1067] Error detection Axis 32 | M33399 | M3027 |

| Offset | | Item |
|---|---|---|
| +2 | — | Axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1067] Error detection Axis 33 | M33431 | |
| 1 | [St.1067] Error detection Axis 34 | M33463 | |
| to | to | to | |
| 15 | [St.1067] Error detection Axis 48 | M33911 | |

| Offset | | Item |
|---|---|---|
| +3 | | Axis error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1067] Error detection Axis 49 | M33943 | |
| 1 | [St.1067] Error detection Axis 50 | M33975 | |
| to | to | to | |
| 15 | [St.1067] Error detection Axis 64 | M34423 | |

| Offset | | Item |
|---|---|---|
| +4 | +2 | Servo error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1068] Servo error detection Axis 1 | M32408 | M2408 |
| 1 | [St.1068] Servo error detection Axis 2 | M32440 | M2428 |
| to | to | to | to |
| 15 | [St.1068] Servo error detection Axis 16 | M32888 | M2708 |

| Offset | | Item |
|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | |
| +5 | +3 | Servo error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1068] Servo error detection Axis 17 | M32920 | M2728 |
| 1 | [St.1068] Servo error detection Axis 18 | M32952 | M2748 |
| to | to | to | to |
| 15 | [St.1068] Servo error detection Axis 32 | M33400 | M3028 |

| Offset | | Item |
|---|---|---|
| +6 | — | Servo error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1068] Servo error detection Axis 33 | M33432 | |
| 1 | [St.1068] Servo error detection Axis 34 | M33464 | |
| to | to | to | |
| 15 | [St.1068] Servo error detection Axis 48 | M33912 | |

| Offset | Item |
|---|---|
| +7 | Servo error information |

| Bit | Details | Device | |
|---|---|---|---|
| | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| 0 | [St.1068] Servo error detection Axis 49 | M33944 | |
| 1 | [St.1068] Servo error detection Axis 50 | M33976 | |
| to | to | to | |
| 15 | [St.1068] Servo error detection Axis 64 | M34424 | |

*1 Operating system software version

- Bit device setting

  Set a number in a unit of 32 points at the start of the device.

  The error information of each axis is stored in the set devices as follows.

| Offset | | Item | Device | |
|---|---|---|---|---|
| "07" or later[*1] | "05" or earlier[*1] | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment |
| +0 | +0 | [St.1067] Error detection Axis 1 | M32407 | M2407 |
| +1 | +1 | [St.1067] Error detection Axis 2 | M32439 | M2427 |
| to | to | to | to | to |
| +31 | +31 | [St.1067] Error detection Axis 32 | M33399 | M3027 |
| +32 | — | [St.1067] Error detection Axis 33 | M33431 | |
| +33 | | [St.1067] Error detection Axis 34 | M33463 | |
| to | | to | to | |
| +63 | | [St.1067] Error detection Axis 64 | M34423 | |
| +64 | +32 | [St.1068] Servo error detection Axis 1 | M32408 | M2408 |
| +65 | +33 | [St.1068] Servo error detection Axis 2 | M32440 | M2428 |
| to | to | to | to | to |
| +95 | +63 | [St.1068] Servo error detection Axis 32 | M33400 | M3028 |
| +96 | — | [St.1068] Servo error detection Axis 33 | M33432 | |
| +97 | | [St.1068] Servo error detection Axis 34 | M33464 | |
| to | | to | to | |
| +127 | | [St.1068] Servo error detection Axis 64 | M34424 | |

*1 Operating system software version

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# Fixed scan communication setting/inter-module synchronization setting

For Motion CPUs that constitute Multiple CPU advanced synchronous control, fixed scan communication function, or inter-module synchronization function between CPUs must be enabled. If neither fixed scan communication function nor inter-module synchronization function are set, a moderate error (error code: 30F5H) occurs after the Multiple CPU system power supply is turned ON.

Refer to the following for details on fixed scan communication function and inter-module synchronization function.

📖MELSEC iQ-R Motion Controller Programming Manual (Common)

> **Point**🔎
>
> - For Motion CPUs that constitute Multiple CPU advanced synchronous control, be sure to set "Synchronize" for all CPUs in [System Parameter] ⇨ [Multiple CPU Setting] ⇨ "Operation Mode Setting" ⇨ "Synchronous Startup Setting" in GX Works3. If "Do not Synchronize" is set, the startup timing of the CPUs differs, and a moderate error (error code: 30F6H) may occur.
> - For Motion CPUs that constitute Multiple CPU advanced synchronous control, when fixed scan communication function is set to "Not Used", and inter-module synchronization function is set to "Use", be sure to set "Synchronize" for all modules in [System Parameter] ⇨ [Synchronization Setting within the Modules] ⇨ "Synchronization Setting within the Modules" ⇨ "Select Synchronous Target Unit between Unit" in GX Works3. If "Do not Synchronize" is set, a moderate error (error code: 30F5H) occurs.

# Selection of slave CPU input axis type

In the slave CPU side, by setting the input axis type of the master CPU from the input axis parameter "[Pr.320] Synchronous encoder axis type", the change amount from the master CPU becomes the input value, and is controlled as a synchronous encoder axis.

When the master CPU input axis type is servo input axis or synchronous encoder axis, the input value transmitted to the slave CPU from the master CPU and the relation with each monitor data of the input axis is shown below. (For the command generation axis, the change amount of the generated command, is transmitted).

- If "301: Master CPU servo input axis" in "[Pr.320] Synchronous encoder axis type" is selected

  The change amount generated from the current value of the master CPU servo input axis is transmitted to the slave CPU.

Master CPU side

[Pr.300]Servo input axis type
Servo motor potion
  Current feed value
  Real current value
  Servo command value
  Feedback value

Input smoothing processing

Phase compensation on processing

[Md.302] Servo input axis phase compensation amount (R: D35444+16n, D35445+16n/ Q: D12284+10n, D12285+10n)

Rotation direction restriction

[Md.303] Servo input axis rotation direction restriction amount (R: D35446+16n, D35447+16n/ Q: D12286+10n, D12287+10n)

[Md.300] Servo input axis current value (R: D35440+16n, D35441+16n/ Q: D12280+10n, D12281+10n)
[Md.301] Servo input axis speed (R: D35442+16n, D35443+16n/ Q: D12282+10n, D12283+10n)

Current value of servo input axis

Slave CPU side

[Pr.320] Synchronous encoder axis type
  301: Master CPU servo input axis
  Synchronous encoder input

Counter disable/ Counter enable

Unit conversion

Input smoothing processing

Phase compensation on processing

[Md.323] Synchronous encoder axis phase compensation amount (R: D38566+32n, D38567+32n/ Q: D13246+20n, D13247+20n)

Rotation direction restriction

[Md.324] Synchronous encoder axis rotation direction restriction amount (R: D38568+32n, D38569+32n/ Q: D13248+20n, D13249+20n)

Current value change

Current value of synchronous encoder axis

[Md.320] Synchronous encoder axis current value (R: D38560+32n, D38561+32n/ Q: D13240+20n, D13241+20n)
[Md.321] Synchronous encoder axis current value per cycle (R: D38562+32n, D38563+32n/ Q: D13242+20n, D13243+20n)
[Md.322] Synchronous encoder axis speed (R: D38564+32n, D38565+32n/ Q: D13244+20n, D13245+20n)

- If "501: Master CPU synchronous encoder axis" in "[Pr.320] Synchronous encoder axis type" is selected

   The change amount of the input pulse to the synchronous encoder on the master CPU is transmitted to the slave CPU.

   Also, control by a current value change by "[Rq.320] Synchronous encoder axis control request (R: M42241+8n/Q: D14823+20n)", counter enable, and counter disable, are not reflected in the change amount that is transmitted.
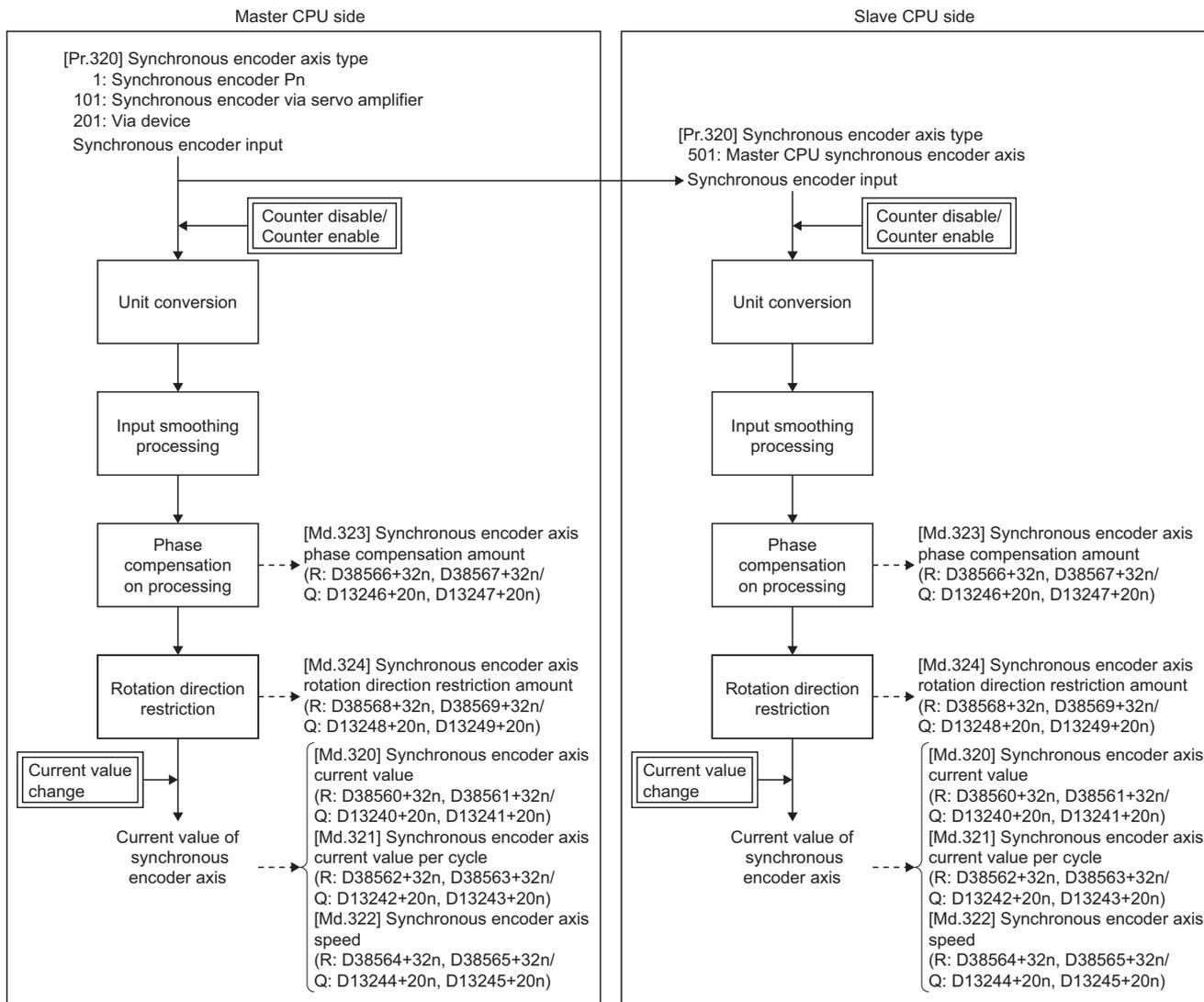


## Setting method

Set the input axis of the master CPU in "[Pr.320] Synchronous encoder axis type".

Connection is invalid just after the system's power supply is ON. If "[Rq.324] Connection command of synchronous encoder via device/master CPU (R: M42242+8n/Q: M11602+4n)" is turned ON, connection becomes valid, "0" is stored in "[Md.320] Synchronous encoder axis current value (R: D38560+32n, D38561+32n/Q: D13240+20n, D13241+20n)", "[Md.321] Synchronous encoder axis current value per cycle (R: D38562+32n, D38563+32n/Q: D13242+20n, D13243+20n)", and will be on the counter enabling status.

At this time, if setting the input axis of the master CPU to current value, execute a current value change.

When the input axis set in "[Pr. 320] Synchronous encoder axis type" is invalid on the master CPU side, or not connected, a minor error (error code: 1BDEH) occurs, and connection becomes invalid.

> **Point**
>
> Match the control unit of "[Pr.321] Synchronous encoder axis unit setting" with the unit settings of the input axis of the master CPU.

## Setting example

The following shows an example for setting the input from axis 8 of the master CPU servo input axis to the synchronous encoder axis 2 of the slave CPU.

### ■Master CPU side

Set the following in the Multiple CPU advanced synchronous control setting.

| Setting item | Setting value |
|---|---|
| Multiple CPU advanced synchronous control CPU setting | 1: Master CPU |

✎ [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Multiple CPU Advanced Synchronous Control Setting]
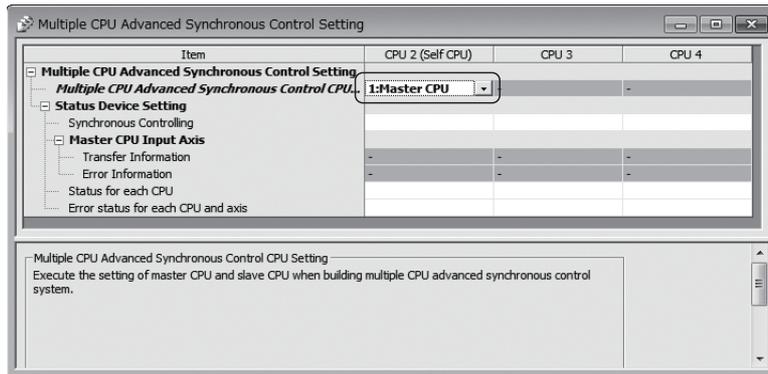


Set the master CPU servo input axis settings in the servo input axis parameters. (☞ Page 32 Servo input axis parameters)

### ■Slave CPU side

Set the following in the Multiple CPU advanced synchronous control setting.

| Setting item | Setting value |
|---|---|
| Multiple CPU advanced synchronous control CPU setting | 2: Slave CPU |

✎ [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Multiple CPU Advanced Synchronous Control Setting]
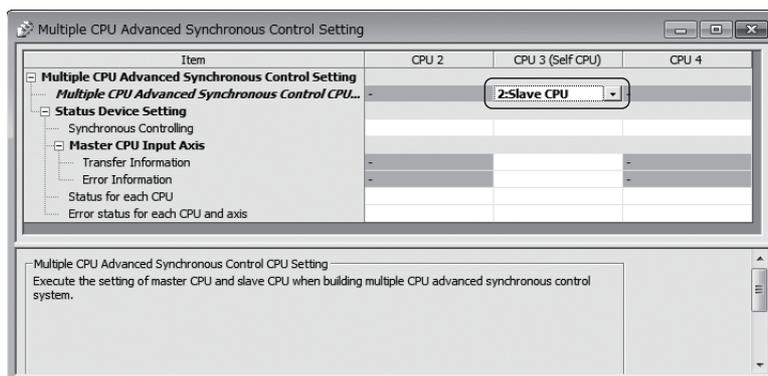
Set the following in synchronous encoder axis setting of synchronous encoder axis 2 on the synchronous encoder axis parameter screen.

| Item | Setting value |
|---|---|
| Type | 301: Master CPU servo input axis |
| Synchronous encoder No. (Pn) | 8 |

👉 [Motion Control Parameter] ⇨ [Synchronous Control Parameter] ⇨ [Input Axis Parameter] ⇨ [Synchronous Encoder Axis Parameter]



**Point** 🖋
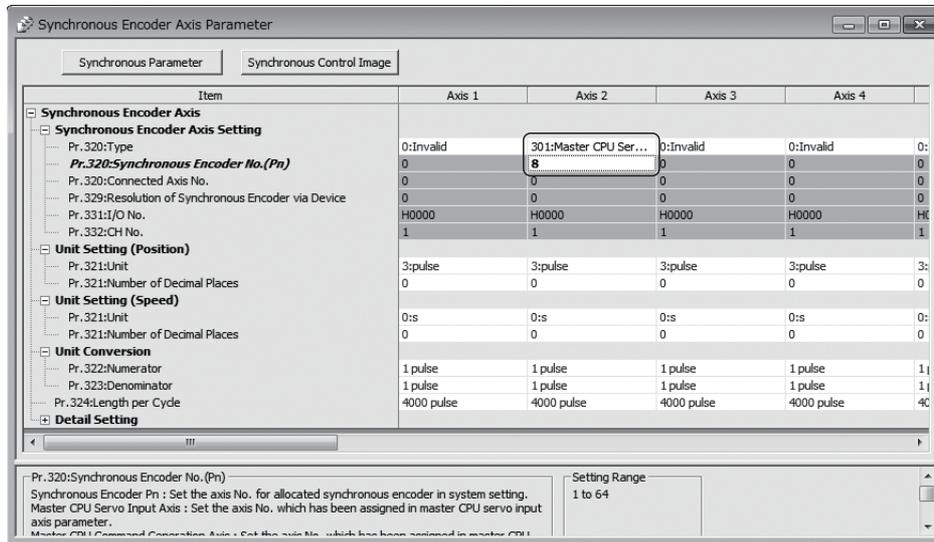
When confirming the status of other CPUs, in the status device setting, set the device for each item.

# Multiple CPU advanced synchronous control monitor device

The status of initial processing and CPU setting in Multiple CPU advanced synchronous control can be confirmed with the following monitor devices.

| Device No. | Monitor item | Storage details | Monitor value | Refresh cycle |
|---|---|---|---|---|
| SD561 | Multiple CPU advanced synchronous control setting status | The CPU setting status of Multiple CPU advanced synchronous control is stored. | 0: Independent CPU<br>1: Master CPU<br>2: Slave CPU | At power supply ON |
| SM561 | Multiple CPU advanced synchronous control initial complete flag | Turns ON when the initial processing of Multiple CPU advanced synchronous control is completed. | ON : Initial processing complete<br>OFF: Initial processing not complete | |

## Multiple CPU advanced synchronous control setting status (SD561)

At Multiple CPU system power supply ON, the CPU setting status of Multiple CPU advanced synchronous control is stored.

## Multiple CPU advanced synchronous control initial complete flag (SM561)

After Multiple CPU system power supply ON, this flag turns ON when the initial processing of Multiple CPU advanced synchronous control is completed normally.

This flag does not turn ON when a moderate error of Multiple CPU advanced synchronous control occurs or the CPU is operating as an independent CPU.

# Example programs

In order to maintain synchronizing between master CPU and slave CPU, start synchronizing by the following procedure. This program example is explained in the "Q series Motion compatible device assignment" for operating system software version "07" or later.

**1.** Match the relationship of the controlling position of the master CPU and slave CPU.

**2.** Set the "[Rq.324] Connection command of synchronous encoder via device/master CPU (M11602+4n)" in the slave CPU ON, and confirm the connection is valid in "[St.321] Synchronous encoder axis connecting valid flag (M10441+10n)".

**3.** Start synchronous control of the output axis in the slave CPU, and operate the input axis of the master CPU.

If synchronous control in the output axis of the slave CPU is started after operating the input axis of the master CPU first, the synchronous relationship between the master CPU and slave CPU will deviate for the movement up until the synchronous control in the output axis of the slave CPU was started.
When ending synchronous control, end synchronous control after stopping operation of the input axis.

## Setting of program example

### ■Master CPU: CPU No.2
- Input axis : Servo input axis Axis 3
- Output axis : Axis 1
- Multiple CPU advanced synchronous control setting

| Item | | | CPU No.2 | CPU No.3 |
|---|---|---|---|---|
| Multiple CPU advanced synchronous control CPU setting | | | 1: Master CPU | — |
| Status device setting | Synchronous controlling | | M128 | M192 |
| | Master CPU input axis | Transfer information | — | — |
| | | Error information | — | — |
| | Status for each CPU | | D1800 | D1801 |
| | Error status for each CPU and axis | | D2000 | D2010 |

### ■Slave CPU: CPU No.3
- Input axis : Synchronous encoder axis Axis 8 (Select master CPU servo input axis Axis 3)
- Output axis : Axis 16
- Multiple CPU advanced synchronous control setting

| Item | | | CPU No.2 | CPU No.3 |
|---|---|---|---|---|
| Multiple CPU advanced synchronous control CPU setting | | | — | 2: Slave CPU |
| Status device setting | Synchronous controlling | | M128 | M192 |
| | Master CPU input axis | Transfer information | — | M256 |
| | | Error information | — | D8000 |
| | Status for each CPU | | D1800 | D1801 |
| | Error status for each CPU and axis | | D2000 | D2010 |

# ■Synchronous control start program

<Master CPU>
After completing alignment, confirm that the output axis of the slave CPU is in synchronous control and turn ON synchronous control start.

```
┌─────────────────────────────────────┐
(         Sync_ax1                      )
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ Axis alignment                        │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G   1]                               │
│ //Waiting for subroutine process complete │
│ NOP                                   │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [F   1]                               │
│ //Master CPU alignment complete signal │
│ SET B1000                             │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G   2]                               │
│ //Master CPU axis 1 start accept OFF by [St.380] │
│   Synchronous control ON of slave CPU (CPU No.3) │
│   axis 16                             │
│ M207*!M2001                           │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [F   2]                               │
│ //Axis 1 [Rq.380] Synchronous control start ON │
│ SET M12000                            │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
(              END                       )
└─────────────────────────────────────┘
```
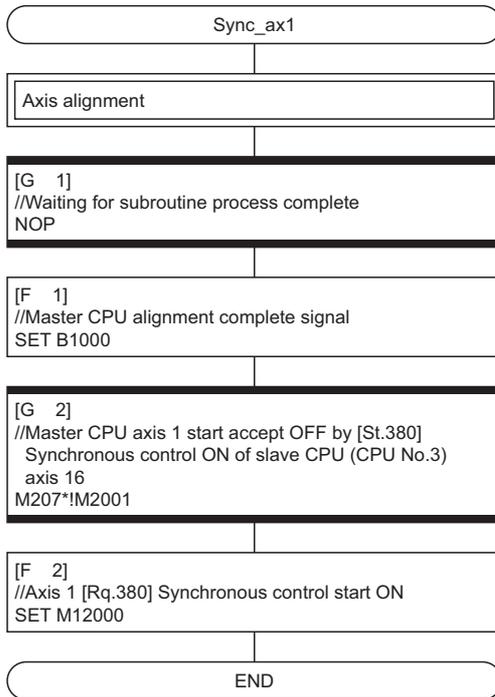
<Slave CPU>
After completing alignment, connect the synchronous encoder and then after executing a current value change, turn ON synchronous control start.

```
┌─────────────────────────────────────┐
(         Sync_ax16                     )
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ Axis alignment                        │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G   1]                               │
│ //Waiting for subroutine process complete │
│ NOP                                   │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G  10]                               │
│ //Master CPU servo input axis (axis 3) confirms │
│   connection status and aligning completion │
│ M98*B1000                             │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [F  10]                               │
│ //[Rq.324] Connection command of synchronous encoder │
│   via device/master CPU               │
│ SET M11630                            │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G  11]                               │
│ //[Sr.321] Synchronous encoder axis connection valid flag │
│   (Axis 8)                            │
│ M10511                                │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [F  12]                               │
│ //Current value change for synchronous encoder axis │
│   (axis 8) of slave CPU               │
│ D14893=0                              │
│   //[Cd.321] Synchronous encoder axis control method: │
│       Current value change            │
│ D14894L=200000                        │
│   //[Cd.322] Synchronous encoder axis current value │
│       setting address                 │
│ SET M11629                            │
│   //[Rq.320] Synchronous encoder axis control request ON │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [G  13]                               │
│ //[St.325] Synchronous encoder axis control complete flag │
│   ON and slave CPU axis 16 start accept OFF │
│ M10516*!M2016                         │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
│ [F  14]                               │
│ //[Rq.380] Synchronous control start ON of axis 16 │
│ SET M12015                            │
└─────────────────────────────────────┘
                 │
┌─────────────────────────────────────┐
(              END                       )
└─────────────────────────────────────┘
```

## ■Error detection program

| <Master CPU> | <Slave CPU> |
|---|---|
| If each error detection signal of the master CPU and slave CPU, or servo error detection signals turn ON, synchronous control start turns OFF. | If the input axis error information of the master CPU, error detection signals of the slave CPU, or servo error detection signals turn ON, synchronous control start turns OFF. |
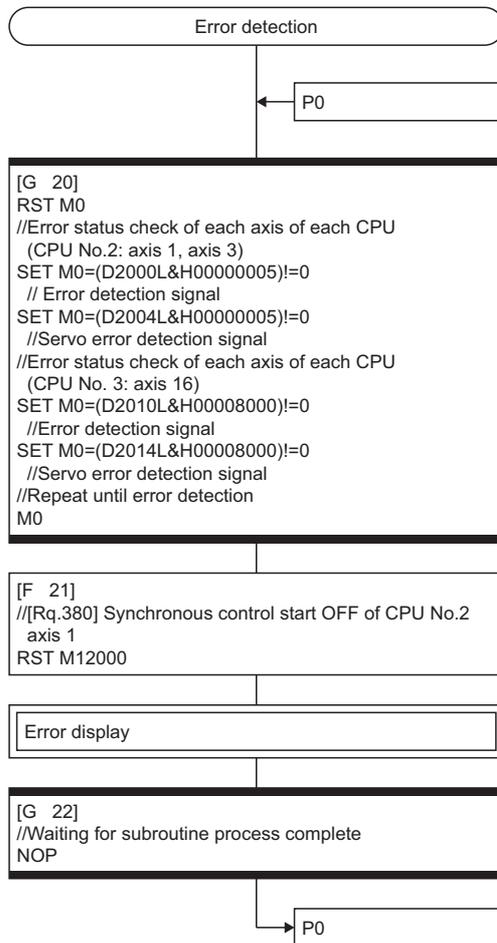
**<Master CPU>**

```
( Error detection )
        |
        |←[ P0 ]
        |
┌──────────────────────────────────┐
│ [G  20]                          │
│ RST M0                           │
│ //Error status check of each axis│
│   of each CPU                    │
│   (CPU No.2: axis 1, axis 3)     │
│ SET M0=(D2000L&H00000005)!=0     │
│  // Error detection signal       │
│ SET M0=(D2004L&H00000005)!=0     │
│   //Servo error detection signal │
│ //Error status check of each axis│
│   of each CPU                    │
│   (CPU No. 3: axis 16)           │
│ SET M0=(D2010L&H00008000)!=0     │
│   //Error detection signal       │
│ SET M0=(D2014L&H00008000)!=0     │
│   //Servo error detection signal │
│ //Repeat until error detection   │
│ M0                               │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ [F  21]                          │
│ //[Rq.380] Synchronous control   │
│   start OFF of CPU No.2 axis 1    │
│ RST M12000                       │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ Error display                    │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ [G  22]                          │
│ //Waiting for subroutine process │
│   complete                       │
│ NOP                              │
└──────────────────────────────────┘
        |
        |→[ P0 ]
```

**<Slave CPU>**

```
( Error detection )
        |
        |←[ P0 ]
        |
┌──────────────────────────────────┐
│ [G  30]                          │
│ RST M0                           │
│ //Check master CPU input axis    │
│   error information              │
│ SET M0=(D8000L&H00000004)!=0     │
│ //Error status check of each axis│
│   of each CPU                    │
│   (CPU No.2: axis 1, axis 3)     │
│ SET M0=(D2000L&H00000005)!=0     │
│  //Error detection signal        │
│ SET M0=(D2004L&H00000005)!=0     │
│   //Servo error detection signal │
│ //Error status check of each axis│
│   of each CPU                    │
│   (CPU No.3: axis 16)            │
│ SET M0=(D2010L&H00008000)!=0     │
│   //Error detection signal       │
│ SET M0=(D2014L&H00008000)!=0     │
│   //Servo error detection signal │
│ //Repeat until error detection   │
│ M0                               │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ [F  31]                          │
│ //[Rq.380] Synchronous control   │
│   start OFF of CPU No.3 axis 16   │
│ RST M12015                       │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ Error display                    │
└──────────────────────────────────┘
        |
┌──────────────────────────────────┐
│ [G  32]                          │
│ //Waiting for subroutine process │
│   complete                       │
│ NOP                              │
└──────────────────────────────────┘
        |
        |→[ P0 ]
```

# APPENDICES

## Appendix 1 Sample Program of Synchronous Control

The following shows a sample program of executing synchronous control on the axis 1 with the command generation axis 4 of R16MTCPU as an input axis.

This program example is explained in the "Q series Motion compatible device assignment" device assignment method.

***1.*** Set MR-J4(W)-B on the axis 1 in the servo network setting.
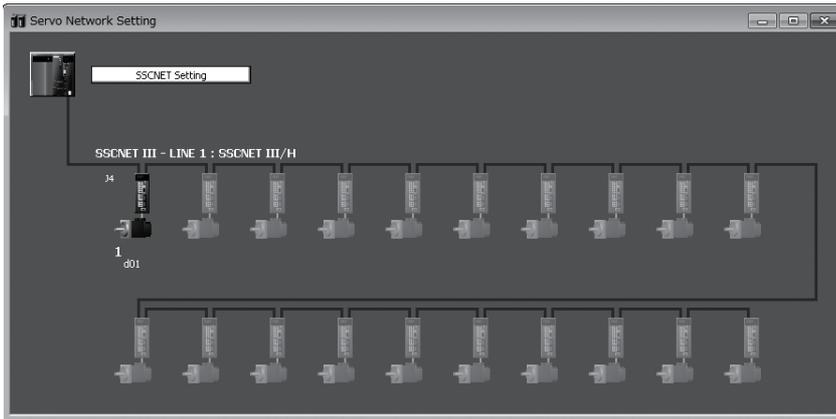


| Item | | Setting value |
|---|---|---|
| Amplifier information | Amplifier model | MR-J4(W)-B(-RJ) |
| | Amplifier operation mode | Standard |
| Axis information | Axis No. | 1 |
| | Station No.d | 1 |

***2.*** Set the axis 4 in the command generation axis parameter of synchronous control parameter.
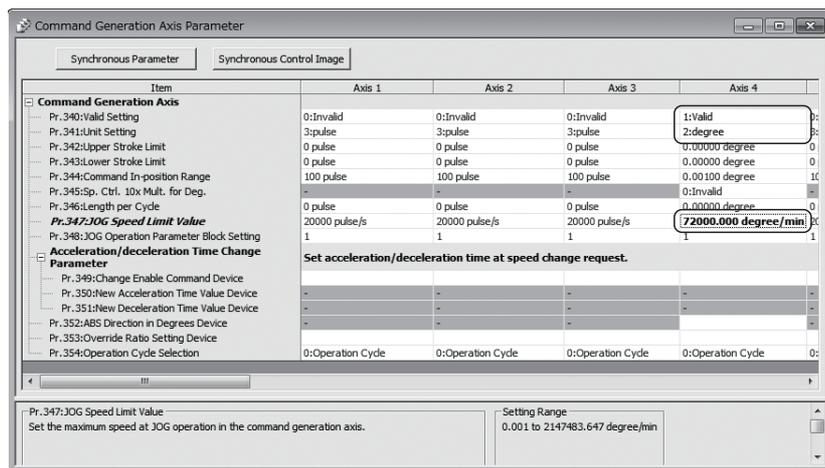


| Item | | Axis 4 |
|---|---|---|
| Command generation axis | Valid setting | 1: Valid |
| | Unit setting | 2: degree |
| | JOG speed limit value | 72000.000degree/min |

**3.** Create the cam data (cam No.1).



| Section No. | Start angle [degree] | End angle [degree] | Stroke [%] | Cam curve |
|---|---|---|---|---|
| 1 | 0.00000 | 90.00000 | 100.0000000 | Constant speed |
| 2 | 90.00000 | 270.00000 | -60.0000000 | Constant speed |
| 3 | 270.00000 | 0.00000 | 50.0000000 | Constant speed |

**4.** Set the synchronous parameter of the axis 1.
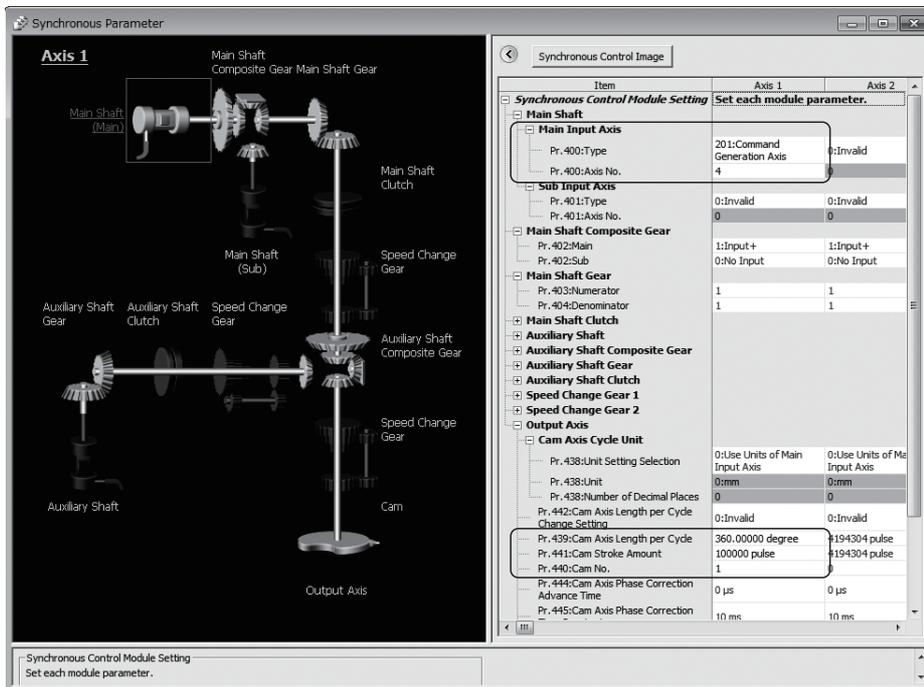


| Item | | | | Setting value |
|---|---|---|---|---|
| Synchronous control module setting | Main shaft | Main input axis | Type | 201: Command generation axis |
| | | | Axis No. | 4 |
| | Output axis | Cam axis cycle unit | Cam axis length per cycle | 360.00000degree |
| | | | Cam stroke amount | 100000pulse |
| | | | Cam No. | 1 |

**5.** Create the Motion SFC program to start synchronous control. (Executed after home position return completion)

```
                    ( sync_ax1 )
                         │
         ┌───────────────────────────────┐
         │ [F0]                          │
         │ SET M2042 //All axes servo ON │
         └───────────────────────────────┘
                         │
         ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
         ┃ [G0]                          ┃
         ┃ M2415*!M2001                  ┃
         ┃ //Axis 1 servo ready ON, start accept flag OFF? ┃
         ┗━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┛
                         │
         ┌───────────────────────────────┐
         │ [F1]                          │
         │ SET M12000 //Axis 1 Synchronous control start │
         └───────────────────────────────┘
                         │
         ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
         ┃ [G1]                          ┃
         ┃ M100*M10880                   ┃
         ┃ //M100 ON and axis 1 during synchronous control? ┃
         ┗━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┛
                         │
         ┌───────────────────────────────┐
         │ [F2]                          │
         │ D14692L=72000000              │
         │ //Command generation axis JOG speed= │
         │   72000.000degree/min         │
         │ SET M11022                    │
         │ //Command generation axis 4 forward rotation JOG ON │
         └───────────────────────────────┘
                         │
         ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
         ┃ [G2]                          ┃
         ┃ !M100 //M100 OFF? (Synchronous control stop) ┃
         ┗━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┛
                         │
         ┌───────────────────────────────┐
         │ [F3]                          │
         │ RST M11022                    │
         │ //Command generation axis 4 forward rotation JOG OFF │
         └───────────────────────────────┘
                         │
         ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
         ┃ [G3]                          ┃
         ┃ !M9870                        ┃
         ┃ //Command generation axis 4 start accept flag OFF? ┃
         ┗━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┛
                         │
         ┌───────────────────────────────┐
         │ [F4]                          │
         │ RST M12000 //Axis 1 synchronous control stop │
         └───────────────────────────────┘
                         │
         ┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┓
         ┃ [G0]                          ┃
         ┃ M2415*!M2001                  ┃
         ┃ //Axis 1 servo ready ON, start accept flag OFF? ┃
         ┗━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┛
                         │
                    ( END )
```

# Appendix 2 Advanced Synchronous Control Device List

## Synchronous control system control data

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Rq.380 | Synchronous control start | M43440+n | M12000+n | ☞ Page 22 Synchronous control system control data |
| Rq.381 | Synchronous analysis request | M43520+n | M12032+n | |

## Synchronous control system monitor data

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| St.380 | Synchronous control | M40000+n | M10880+n | ☞ Page 23 Synchronous control system monitor data |
| St.381 | Synchronous analysis complete | M40080+n | M10912+n | |

## Servo input axis parameters

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Pr.300 | Servo input axis type | — | | ☞ Page 32 Servo input axis parameters |
| Pr.301 | Servo input axis smoothing time constant | — | | |
| Pr.302 | Servo input axis phase compensation advance time | D41200+8n D41201+8n | D14600+2n D14601+2n | |
| Pr.303 | Servo input axis phase compensation time constant | — | | |
| Pr.304 | Servo input axis rotation direction restriction | — | | |

## Servo input axis monitor data

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Md.300 | Servo input axis current value | D35440+16n D35441+16n | D12280+10n D12281+10n | ☞ Page 35 Servo input axis monitor data |
| Md.301 | Servo input axis speed | D35442+16n D35443+16n | D12282+10n D12283+10n | |
| Md.302 | Servo input axis phase compensation amount | D35444+16n D35445+16n | D12284+10n D12285+10n | |
| Md.303 | Servo input axis rotation direction restriction amount | D35446+16n D35447+16n | D12286+10n D12287+10n | |

**A**

## Command generation axis parameters

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Pr.340 | Command generation axis valid setting | — | | ☞ Page 41 Command generation axis parameters |
| Pr.341 | Command generation axis unit setting | — | | |
| Pr.342 | Command generation axis upper stroke limit | — | | |
| Pr.343 | Command generation axis lower stroke limit | — | | |
| Pr.344 | Command generation axis command in-position range | — | | |
| Pr.345 | Command generation axis speed control 10 × multiplier setting for degree axis | — | | |
| Pr.346 | Command generation axis length per cycle | — | | |
| Pr.347 | Command generation axis JOG speed limit value | — | | |
| Pr.348 | Command generation axis JOG operation parameter block setting | D41762+8n | D14682+4n | |
| Pr.349 | Command generation axis acceleration/ deceleration time change enable device | Optional device | | |
| Pr.350 | Command generation axis new acceleration time value device | Optional device | | |
| Pr.351 | Command generation axis new deceleration time value device | Optional device | | |
| Pr.352 | Command generation axis ABS direction in degrees device | Optional device | | |
| Pr.353 | Command generation axis override ratio setting device | Optional device | | |
| Pr.354 | Command generation axis operation cycle selection | — | | |

## Command generation axis control data

### ■Word device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Cd.340 | Command generation axis JOG speed setting | D41760+8n D41761+8n | D14680+4n D14681+4n | ☞ Page 45 Command generation axis control data (Word device) |

### ■Bit device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Rq.341 | Command generation axis stop command | M40160+32n | M10960+20n | ☞ Page 45 Command generation axis control data (Bit device) |
| Rq.342 | Command generation axis rapid stop command | M40161+32n | M10961+20n | |
| Rq.343 | Command generation axis forward rotation JOG start command | M40162+32n | M10962+20n | |
| Rq.344 | Command generation axis reverse rotation JOG start command | M40163+32n | M10963+20n | |
| Rq.345 | Command generation axis complete signal OFF command | M40164+32n | M10964+20n | |
| Rq.346 | Command generation axis error reset command | M40167+32n | M10967+20n | |
| Rq.347 | Feed current value update request command | M40172+32n | M10972+20n | |
| Rq.348 | Command generation axis FIN signal | M40179+32n | M10979+20n | |

# Command generation axis monitor data

## ■Word device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Md.340 | Command generation axis feed current value | D36480+32n D36481+32n | D12600+20n D12601+20n | ☞ Page 48 Command generation axis monitor data (Word device) |
| Md.341 | Command generation axis warning code | D36482+32n | D12602+20n | |
| Md.342 | Command generation axis error code | D36483+32n | D12603+20n | |
| Md.343 | Command generation axis execute program No. | D36484+32n | D12604+20n | |
| Md.344 | Command generation axis M-code | D36485+32n | D12605+20n | |
| Md.345 | Command generation axis accumulative current value | D36486+32n D36487+32n | D12606+20n D12607+20n | |
| Md.346 | Command generation axis data set pointer for continuous trajectory control | D36489+32n | D12609+20n | |
| Md.347 | Command generation axis current value per cycle | D36490+32n D36491+32n | D12610+20n D12611+20n | |
| Md.348 | Command generation axis command speed | D36492+32n D36493+32n | D12612+20n D12613+20n | |

## ■Bit device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| St.340 | Command generation axis positioning start complete | M36560+32n | M9800+20n | ☞ Page 50 Command generation axis monitor data (Bit device) |
| St.341 | Command generation axis positioning complete | M36561+32n | M9801+20n | |
| St.342 | Command generation axis command in-position | M36563+32n | M9803+20n | |
| St.343 | Command generation axis speed controlling | M36564+32n | M9804+20n | |
| St.344 | Command generation axis error detection | M36567+32n | M9807+20n | |
| St.345 | Command generation axis start accept flag | M36570+32n | M9810+20n | |
| St.346 | Command generation axis speed change accepting flag | M36571+32n | M9811+20n | |
| St.347 | Command generation axis speed change "0" accepting flag | M36572+32n | M9812+20n | |
| St.348 | Command generation axis automatic decelerating flag | M36573+32n | M9813+20n | |
| St.349 | Command generation axis M-code outputting | M36579+32n | M9819+20n | |

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## Synchronous encoder axis parameters

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Pr.320 | Synchronous encoder axis type | — | | ☞ Page 69 Synchronous encoder axis parameters |
| Pr.321 | Synchronous encoder axis unit setting | — | | |
| Pr.322 | Synchronous encoder axis unit conversion: Numerator | — | | |
| Pr.323 | Synchronous encoder axis unit conversion: Denominator | — | | |
| Pr.324 | Synchronous encoder axis length per cycle | — | | |
| Pr.325 | Synchronous encoder axis smoothing time constant | — | | |
| Pr.326 | Synchronous encoder axis phase compensation advance time | D42320+16n D42321+16n | D14820+10n D14821+10n | |
| Pr.327 | Synchronous encoder axis phase compensation time constant | — | | |
| Pr.328 | Synchronous encoder axis rotation direction restriction | — | | |
| Pr.329 | Resolution of synchronous encoder via device | — | | |
| Pr.331 | I/O number | — | | |
| Pr.332 | Channel number | — | | |

## Synchronous encoder axis control data

### ■Word device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Cd.320 | Synchronous encoder axis control start condition | D42322+16n | D14822+10n | ☞ Page 75 Synchronous encoder axis control data (Word device) |
| Cd.321 | Synchronous encoder axis control method | D42323+16n | D14823+10n | |
| Cd.322 | Synchronous encoder axis current value setting address | D42324+16n D42325+16n | D14824+10n D14825+10n | |
| Cd.325 | Input value for synchronous encoder via device | D42326+16n D42327+16n | D14826+10n D14827+10n | |

### ■Bit device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Rq.323 | Synchronous encoder axis error reset | M42240+8n | M11600+4n | ☞ Page 77 Synchronous encoder axis control data (Bit device) |
| Rq.320 | Synchronous encoder axis control request | M42241+8n | M11601+4n | |
| Rq.324 | Connection command of synchronous encoder via device/master CPU | M42242+8n | M11602+4n | |

## Synchronous encoder axis monitor data

### ■Word device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Md.320 | Synchronous encoder axis current value | D38560+32n<br>D38561+32n | D13240+20n<br>D13241+20n | ☞ Page 79 Synchronous encoder axis monitor data (Word device) |
| Md.321 | Synchronous encoder axis current value per cycle | D38562+32n<br>D38563+32n | D13242+20n<br>D13243+20n | |
| Md.322 | Synchronous encoder axis speed | D38564+32n<br>D38565+32n | D13244+20n<br>D13245+20n | |
| Md.323 | Synchronous encoder axis phase compensation amount | D38566+32n<br>D38567+32n | D13246+20n<br>D13247+20n | |
| Md.324 | Synchronous encoder axis rotation direction restriction amount | D38568+32n<br>D38569+32n | D13248+20n<br>D13249+20n | |
| Md.327 | Synchronous encoder axis warning code | D38570+32n | D13250+20n | |
| Md.326 | Synchronous encoder axis error code | D38571+32n | D13251+20n | |

### ■Bit device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| St.320 | Synchronous encoder axis setting valid flag | M38640+16n | M10440+10n | ☞ Page 81 Synchronous encoder axis monitor data (Bit device) |
| St.321 | Synchronous encoder axis connecting valid flag | M38641+16n | M10441+10n | |
| St.322 | Synchronous encoder axis counter enable flag | M38642+16n | M10442+10n | |
| St.323 | Synchronous encoder axis current value setting request flag | M38643+16n | M10443+10n | |
| St.324 | Synchronous encoder axis error detection flag | M38644+16n | M10444+10n | |
| St.325 | Synchronous encoder axis control complete flag | M38646+16n | M10446+10n | |

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## Synchronous parameter

| Symbol | Setting item | | Device No. | | Reference |
|---|---|---|---|---|---|
| | | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Pr.400 | Main shaft | Main input axis No. | D42640+160n | D15000+150n | ☞ Page 93 Main shaft parameters |
| Pr.401 | | Sub input axis No. | D42641+160n | D15001+150n | |
| Pr.402 | | Composite main shaft gear | D42642+160n | D15002+150n | |
| Pr.403 | | Main shaft gear: Numerator | D42644+160n D42645+160n | D15004+150n D15005+150n | |
| Pr.404 | | Main shaft gear: Denominator | D42646+160n D42647+160n | D15006+150n D15007+150n | |
| Pr.405 | | Main shaft clutch control setting | D42648+160n | D15008+150n | ☞ Page 95 Main shaft clutch parameters |
| Pr.406 | | Main shaft clutch reference address setting | D42649+160n | D15009+150n | |
| Pr.407 | | Main shaft clutch ON address | D42650+160n D42651+160n | D15010+150n D15011+150n | |
| Pr.408 | | Travel value before main shaft clutch ON | D42652+160n D42653+160n | D15012+150n D15013+150n | |
| Pr.409 | | Main shaft clutch OFF address | D42654+160n D42655+160n | D15014+150n D15015+150n | |
| Pr.410 | | Travel value before main shaft clutch OFF | D42656+160n D42657+160n | D15016+150n D15017+150n | |
| Pr.411 | | Main shaft clutch smoothing method | D42658+160n | D15018+150n | |
| Pr.412 | | Main shaft clutch smoothing time constant | D42659+160n | D15019+150n | |
| Pr.413 | | Slippage amount at main shaft clutch ON | D42660+160n D42661+160n | D15020+150n D15021+150n | |
| Pr.414 | | Slippage amount at main shaft clutch OFF | D42662+160n D42663+160n | D15022+150n D15023+150n | |
| Pr.418 | Auxiliary shaft | Auxiliary shaft axis No. | D42664+160n | D15024+150n | ☞ Page 102 Auxiliary shaft parameters |
| Pr.419 | | Composite auxiliary shaft gear | D42665+160n | D15025+150n | |
| Pr.420 | | Auxiliary shaft gear: Numerator | D42666+160n D42667+160n | D15026+150n D15027+150n | |
| Pr.421 | | Auxiliary shaft gear: Denominator | D42668+160n D42669+160n | D15028+150n D15029+150n | |
| Pr.422 | | Auxiliary shaft clutch control setting | D42670+160n | D15030+150n | ☞ Page 104 Auxiliary shaft clutch parameters |
| Pr.423 | | Auxiliary shaft clutch reference address setting | D42671+160n | D15031+150n | |
| Pr.424 | | Auxiliary shaft clutch ON address | D42672+160n D42673+160n | D15032+150n D15033+150n | |
| Pr.425 | | Travel value before auxiliary shaft clutch ON | D42674+160n D42675+160n | D15034+150n D15035+150n | |
| Pr.426 | | Auxiliary shaft clutch OFF address | D42676+160n D42677+160n | D15036+150n D15037+150n | |
| Pr.427 | | Travel value before auxiliary shaft clutch OFF | D42678+160n D42679+160n | D15038+150n D15039+150n | |
| Pr.428 | | Auxiliary shaft clutch smoothing method | D42680+160n | D15040+150n | |
| Pr.429 | | Auxiliary shaft clutch smoothing time constant | D42681+160n | D15041+150n | |
| Pr.430 | | Slippage amount at auxiliary shaft clutch ON | D42682+160n D42683+160n | D15042+150n D15043+150n | |
| Pr.431 | | Slippage amount at auxiliary shaft clutch OFF | D42684+160n D42685+160n | D15044+150n D15045+150n | |

| Symbol | Setting item | | Device No. | | Reference |
|---|---|---|---|---|---|
| | | | MELSEC iQ-R Motion device assignment | Q series Motion compatible device assignment | |
| Pr.434 | Speed change gear | Speed change gear 1 | D42686+160n | D15046+150n | ☞ Page 123 Speed change gear parameters |
| Pr.435 | | Speed change gear 1 smoothing time constant | D42687+160n | D15047+150n | |
| Pr.436 | | Speed change ratio 1: Numerator | D42688+160n D42689+160n | D15048+150n D15049+150n | |
| Pr.437 | | Speed change ratio 1: Denominator | D42690+160n D42691+160n | D15050+150n D15051+150n | |
| Pr.490 | | Speed change gear 2 | D42692+160n | D15052+150n | |
| Pr.491 | | Speed change gear 2 smoothing time constant | D42693+160n | D15053+150n | |
| Pr.492 | | Speed change ratio 2: Numerator | D42694+160n D42695+160n | D15054+150n D15055+150n | |
| Pr.493 | | Speed change ratio 2: Denominator | D42696+160n D42697+160n | D15056+150n D15057+150n | |
| Pr.438 | Output axis | Cam axis cycle unit setting | D42698+160n | D15058+150n | ☞ Page 127 Cam axis cycle units |
| Pr.439 | | Cam axis length per cycle | D42700+160n D42701+160n | D15060+150n D15061+150n | |
| Pr.440 | | Cam No. | D42702+160n | D15062+150n | |
| Pr.441 | | Cam stroke amount | D42704+160n D42705+160n | D15064+150n D15065+150n | |
| Pr.442 | | Cam axis length per cycle change setting | D42699+160n | D15059+150n | |
| Pr.444 | | Cam axis phase compensation advance time | D42706+160n D42707+160n | D15066+150n D15067+150n | |
| Pr.445 | | Cam axis phase compensation time constant | D42708+160n | D15068+150n | |
| Pr.448 | | Synchronous control parameter block No. | D42709+160n | D15069+150n | |
| Pr.447 | | Output axis smoothing time constant | D42710+160n | D15070+150n | |
| Pr.460 | Synchronous control Initial position | Setting method of current value per cycle after main shaft gear | D42740+160n | D15100+150n | ☞ Page 148 Synchronous Control Initial Position Parameters |
| Pr.461 | | Setting method of current value per cycle after auxiliary shaft gear | D42741+160n | D15101+150n | |
| Pr.462 | | Cam axis position restoration object | D42742+160n | D15102+150n | |
| Pr.463 | | Setting method of cam reference position | D42743+160n | D15103+150n | |
| Pr.464 | | Setting method of cam axis current value per cycle | D42744+160n | D15104+150n | |
| Pr.465 | | Current value per cycle after main shaft gear (Initial setting) | D42746+160n D42747+160n | D15106+150n D15107+150n | |
| Pr.466 | | Current value per cycle after auxiliary shaft gear (Initial setting) | D42748+160n D42749+160n | D15108+150n D15109+150n | |
| Pr.467 | | Cam reference position (Initial setting) | D42750+160n D42751+160n | D15110+150n D15111+150n | |
| Pr.468 | | Cam axis current value per cycle (Initial setting) | D42752+160n D42753+160n | D15112+150n D15113+150n | |

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## Control Data for Synchronous Control

### ■Bit device

| Symbol | Setting item | | Device No. | | Reference |
|---|---|---|---|---|---|
| | | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Rq.400 | Main shaft | Main shaft clutch command | M42400+16n | M11680+10n | ☞ Page 101 Main shaft clutch control data |
| Rq.401 | | Main shaft clutch control invalid command | M42401+16n | M11681+10n | |
| Rq.402 | | Main shaft clutch forced OFF command | M42402+16n | M11682+10n | |
| Rq.403 | Auxiliary shaft | Auxiliary shaft clutch command | M42404+16n | M11684+10n | ☞ Page 110 Auxiliary shaft clutch control data |
| Rq.404 | | Auxiliary shaft clutch control invalid command | M42405+16n | M11685+10n | |
| Rq.405 | | Auxiliary shaft clutch forced OFF command | M42406+16n | M11686+10n | |
| Rq.406 | Synchronous control change | Control change request command | M42408+16n | M11688+10n | ☞ Page 132 Synchronous control change control data (Bit device) |

### ■Word device

| Symbol | Setting item | | Device No. | | Reference |
|---|---|---|---|---|---|
| | | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Cd.407 | Synchronous control change | Synchronous control change command | D42770+160n | D15130+150n | ☞ Page 133 Synchronous control change control data (Word device) |
| Cd.408 | | Synchronous control change value | D42772+160n D42773+160n | D15132+150n D15133+150n | |
| Cd.409 | | Synchronous control reflection time | D42771+160n | D15131+150n | |

## Synchronous Control Monitor Data

### ■Word device

| Symbol | Setting item | Device No. | | Reference |
|---|---|---|---|---|
| | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| Md.400 | Current value after composite main shaft gear | D39120+32n<br>D39121+32n | D13600+30n<br>D13601+30n | ☞ Page 138 Synchronous Control Monitor Data (Word device) |
| Md.401 | Current value per cycle after main shaft gear | D39122+32n<br>D39123+32n | D13602+30n<br>D13603+30n | |
| Md.402 | Current value per cycle after auxiliary shaft gear | D39124+32n<br>D39125+32n | D13604+30n<br>D13605+30n | |
| Md.406 | Cam axis phase compensation amount | D39130+32n<br>D39131+32n | D13610+30n<br>D13611+30n | |
| Md.407 | Cam axis current value per cycle | D39132+32n<br>D39133+32n | D13612+30n<br>D13613+30n | |
| Md.408 | Cam reference position | D39134+32n<br>D39135+32n | D13614+30n<br>D13615+30n | |
| Md.409 | Cam axis current feed value | D39136+32n<br>D39137+32n | D13616+30n<br>D13617+30n | |
| Md.410 | Execute cam No. | D39138+32n | D13618+30n | |
| Md.411 | Execute cam stroke amount | D39140+32n<br>D39141+32n | D13620+30n<br>D13621+30n | |
| Md.412 | Execute cam axis length per cycle | D39142+32n<br>D39143+32n | D13622+30n<br>D13623+30n | |
| Md.422 | Main shaft clutch slippage (accumulative) | D39126+32n<br>D39127+32n | D13606+30n<br>D13607+30n | |
| Md.425 | Auxiliary shaft clutch slippage (accumulative) | D39128+32n<br>D39129+32n | D13608+30n<br>D13609+30n | |

### ■Bit device

| Symbol | Setting item | | Device No. | | Reference |
|---|---|---|---|---|---|
| | | | **MELSEC iQ-R Motion device assignment** | **Q series Motion compatible device assignment** | |
| St.420 | Main shaft clutch ON/OFF status | | M38960+16n | M10560+10n | ☞ Page 142 Synchronous Control Monitor Data (Bit device) |
| St.421 | Main shaft clutch smoothing status | | M38961+16n | M10561+10n | |
| St.423 | Auxiliary shaft clutch ON/OFF status | | M38962+16n | M10562+10n | |
| St.424 | Auxiliary shaft clutch smoothing status | | M38963+16n | M10563+10n | |
| St.426 | Synchronous control change | Control change complete | M38966+16n | M10566+10n | ☞ Page 132 Synchronous control change control data (Bit device) |

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# REVISIONS

| Revision date | *Manual number | Description |
|---|---|---|
| June 2014 | IB(NA)-0300243-A | First edition |
| March 2015 | IB(NA)-0300243-B | ■Added functions<br>ABS direction in degrees, Clutch smoothing slippage method (Linear: Input value follow up) , Multiple CPU advanced synchronous control<br>■Added or modified parts<br>SAFETY PRECAUTIONS, RELEVANT MANUALS, TERMS, Section 1.2, 3.1, 4.2, 4.3, 6.1, 6.2, 6.3, 6.7, 7.2, 7.3, 7.4, 7.10, Appendix 1, 2 |
| June 2015 | IB(NA)-0300243-C | ■Added or modified parts<br>TERMS, Section 2.1, 4.2, Appendix 2 |
| February 2016 | IB(NA)-0300243-D | ■Added models<br>R64MTCPU<br>■Added or modified parts<br>SAFETY PRECAUTIONS, INTRODUCTION, RELEVANT MANUALS, TERMS, MANUAL PAGE ORGANIZATION, Section 1.2, 2.1, 2.2, 2.3, 3.1, 4.1, 4.2, 4.3, 5.1, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 7.1, 7.3, 7.4, 7.5, 7.6, 7.7, 7.9, 7.10, Appendix 1, 2, WARRANTY |
| June 2016 | IB(NA)-0300243-E | ■Added or modified parts<br>SAFETY PRECAUTIONS, INTRODUCTION, Section 5.2 |
| December 2016 | IB(NA)-0300243-F | ■Added functions<br>Synchronous encoder via sensing module<br>■Added or modified parts<br>SAFETY PRECAUTIONS, TERMS, Section 1.2, 4.2, 4.3, 6.3, 7.1, 7.10, Appendix 1, 2 |
| December 2017 | IB(NA)-0300243-G | ■Added or modified parts<br>SAFETY PRECAUTIONS, RELEVANT MANUALS, MANUAL PAGE ORGANIZATION |
| December 2018 | IB(NA)-0300243-H | ■Added or modified parts<br>SAFETY PRECAUTIONS, Section 6.6, 7.7 |
| February 2020 | IB(NA)-0300243-J | ■Added or modified parts<br>Section 5.1, Chapter 7, Section 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, Chapter 8, Section 8.1, 8.2, 8.3, 8.4 |
| June 2022 | IB(NA)-0300243-K | ■Added or modified parts<br>SAFETY PRECAUTIONS, CONDITIONS OF USE FOR THE PRODUCT, TERMS, Section 2.2, 4.3, 7.1, 8.1, 8.4 |
| June 2023 | IB(NA)-0300243-L | ■Added or modified parts<br>SAFETY PRECAUTIONS, Section 4.2, 7.1 |
| November 2023 | IB(NA)-0300243-M | ■Added or modified parts<br>SAFETY PRECAUTIONS, TERMS, Section 8.1, 8.4 |

Japanese manual number: IB-0300242-M

# WARRANTY

Please confirm the following product warranty details before using this product.

## 1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the sales representative or Mitsubishi Service Company.

However, if repairs are required onsite at domestic or overseas location, expenses to send an engineer will be solely at the customer's discretion. Mitsubishi shall not be held responsible for any re-commissioning, maintenance, or testing on-site that involves replacement of the failed module.

[Gratis Warranty Term]

The gratis warranty term of the product shall be for one year after the date of purchase or delivery to a designated place. Note that after manufacture and shipment from Mitsubishi, the maximum distribution period shall be six (6) months, and the longest gratis warranty term after manufacturing shall be eighteen (18) months. The gratis warranty term of repair parts shall not exceed the gratis warranty term before repairs.

[Gratis Warranty Range]

(1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.

(2) Even within the gratis warranty term, repairs shall be charged for in the following cases.

   1. Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.

   2. Failure caused by unapproved modifications, etc., to the product by the user.

   3. When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.

   4. Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.

   5. Failure caused by external irresistible forces such as fires or abnormal voltages, and Failure caused by force majeure such as earthquakes, lightning, wind and water damage.

   6. Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.

   7. Any other failure found not to be the responsibility of Mitsubishi or that admitted not to be so by the user.

## 2. Onerous repair term after discontinuation of production

(1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued. Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.

(2) Product supply (including repair parts) is not available after production is discontinued.

## 3. Overseas service

Overseas, repairs shall be accepted by Mitsubishi's local overseas FA Center. Note that the repair conditions at each FA Center may differ.

## 4. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:

(1) Damages caused by any cause found not to be the responsibility of Mitsubishi.

(2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.

(3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products.

(4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

## 5. Changes in product specifications

The specifications given in the catalogs, manuals or technical documents are subject to change without prior notice.

# INFORMATION AND SERVICES

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MITSUBISHI ELECTRIC Factory Automation Global Website

Locations Worldwide

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