MITSUBISHI

MOTION CONTROLLER (SV22) (VIRTUAL MODE)

Programming Manual

type A172SHCPU,A171SHCPU

MITSUBISHI ELECTRIC

INTORODUCTION

Thank you for purchasing the Mitsubishi Motion Controller/Personal Machine Controller.
This instruction manual describes the handing and precautions of this unit. Incorrect handling will lead to unforeseen events, so we ask that you please read this manual thoroughly and use the unit correctly.
Please make sure that this manual is delivered to the final user of the unit and that it is stored for future reference.

Precautions for Safety

Please read this instruction manual and enclosed documents before starting installation, operation, maintenance or inspections to ensure correct usage. Thoroughly understand the machine, safety information and precautions before starting operation.
The safety precautions are ranked as "Warning" and "Caution" in this instruction manual.

⚠ **WARNING**	When a dangerous situation may occur if handling is mistaken leading to fatal or major injuries.
⚠ **CAUTION**	When a dangerous situation may occur if handling is mistaken leading to medium or minor injuries, or physical damage.

Note that some items described as cautions may lead to major results depending on the situation. In any case, important information that must be observed is described.

For Sate Operations

1. Prevention of electric shocks

⚠ WARNING

- Never open the front case or terminal covers while the power is ON or the unit is running, as this may lead to electric shocks.
- Never run the unit with the front case or terminal cover removed. The high voltage terminal and charged sections will be exposed and may lead to electric shocks.
- Never open the front case or terminal cover at times other than wiring work or periodic inspections even if the power is OFF.
  The insides of the control unit and servo amplifier are charged and may lead to electric shocks.
- When performing wiring work or inspections, turn the power OFF, wait at least ten minutes, and then check the voltage with a tester, etc. Failing to do so may lead to electric shocks.
- Always ground the control unit, servo amplifier and servomotor with Class 3 grounding.
  Do not ground commonly with other devices.
- The wiring work and inspections must be done by a qualified technician.
- Wire the units after installing the control unit, servo amplifier and servomotor. Failing to do so may lead to electric shocks or damage.
- Never operate the switches with wet hands, as this may lead to electric shocks.
- Do not damage, apply excessive stress, place heavy things on or sandwich the cables, as this may lead to electric shocks.
- Do not touch the control unit, servo amplifier or servomotor terminal blocks while the power is ON, as this may lead to electric shocks.
- Do not touch the internal power supply, internal grounding or signal wires of the control unit and servo amplifier, as this may lead to electric shocks.

2. For fire prevention

⚠ CAUTION

- Install the control unit, servo amplifier, servomotor and regenerative resistor on inflammable material. Direct installation on flammable material or near flammable material may lead to fires.
- If a fault occurs in the control unit or servo amplifier, shut the power OFF at the servo amplifier's power source. If a large current continues to flow, fires may occur.
- When using a regenerative resistor, shut the power OFF with an error signal. The regenerative resistor may abnormally overheat due to a fault in the regenerative transistor, etc., and may lead to fires.
- Always take heat measures such as flame proofing for the inside of the control panel where the servo amplifier or regenerative resistor is installed and for the wires used. Failing to do so may lead to fires.

3. For injury prevention

⚠ CAUTION

- ⚠ Do not apply a voltage other than that specified in A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using on any terminal. Doing so may lead to destruction or damage.
- ⚠ Do not mistake the polarity (+/–), as this may lead to destruction or damage.
- ⚠ The servo amplifier's heat radiating fins, regenerative resistor and servo amplifier, etc., will be hot while the power is ON and for a short time after the power is turned OFF. Do not touch these parts as doing so may lead to burns.
- ⚠ Always turn the power OFF before touching the servomotor shaft or coupled machines, as these parts may lead to injuries.
- ⚠ Do not go near the machine during test operations or during operations such as teaching. Doing so may lead to injuries.

4. Various precautions

Strictly observe the following precautions.
Mistaken handling of the unit may lead to faults, injuries or electric shocks.

(1) System structure

⚠ CAUTION

- ⚠ Always install a leakage breaker on the control unit and servo amplifier power source.
- ⚠ If installation of a magnetic contactor for power shut off during an error, etc., is specified in the instruction manual for the servo amplifier, etc., always install the magnetic contactor.
- ⚠ Install an external emergency stop circuit so that the operation can be stopped immediately and the power shut off.
- ⚠ Use the control unit, servo amplifier, servomotor and regenerative resistor with the combinations listed in A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using. Other combinations may lead to fires or faults.
- ⚠ If safety standards (ex., robot safety rules, etc.,) apply to the system using the control unit, servo amplifier and servomotor, make sure that the safety standards are satisfied.
- ⚠ If the operation during a control unit or servo amplifier error and the safety direction operation of the control unit differ, construct a countermeasure circuit externally of the control unit and servo amplifier.
- ⚠ In systems where coasting of the servomotor will be a problem during emergency stop, servo OFF or when the power is shut OFF, use dynamic brakes.
- ⚠ Make sure that the system considers the coasting amount even when using dynamic brakes.
- ⚠ In systems where perpendicular shaft dropping may be a problem during emergency stop, servo OFF or when the power is shut OFF, use both dynamic brakes and magnetic brakes.
- ⚠ The dynamic brakes must be used only during emergency stop and errors where servo OFF occurs. These brakes must not be used for normal braking.
- ⚠ The brakes (magnetic brakes) assembled into the servomotor are for holding applications, and must not be used for normal braking.
- ⚠ Construct the system so that there is a mechanical allowance allowing stopping even if the stroke end limit switch is passed through at the max. speed.
- ⚠ Use wires and cables that have a wire diameter, heat resistance and bending resistance compatible with the system.

⚠ CAUTION
⚠ Use wires and cables within the length of the range described in A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using . ⚠ The ratings and characteristics of the system parts (other than control unit, servo amplifier, servomotor) must be compatible with the control unit, servo amplifier and servomotor. ⚠ Install a cover on the shaft so that the rotary parts of the servomotor are not touched during operation. ⚠ There may be some cases where holding by the magnetic brakes is not possible due to the life or mechanical structure (when the ball screw and servomotor are connected with a timing belt, etc.). Install a stopping device to ensure safety on the machine side.

(2) Parameter settings and programming

⚠ CAUTION
⚠ Set the parameter values to those that are compatible with the control unit, servo amplifier, servomotor and regenerative resistor model and the system application. The protective functions may not function if the settings are incorrect. ⚠ The regenerative resistor model and capacity parameters must be set to values that conform to the operation mode, servo amplifier and servo power unit. The protective functions may not function if the settings are incorrect. ⚠ Set the mechanical brake output and dynamic brake output validity parameters to values that are compatible with the system application. The protective functions may not function if the settings are incorrect. ⚠ Set the stroke limit input validity parameter to a value that is compatible with the system application. The protective functions may not function if the setting is incorrect. ⚠ Set the servomotor encoder type (increment, absolute position type, etc.) parameter to a value that is compatible with the system application. The protective functions may not function if the setting is incorrect. ⚠ Set the servomotor capacity and type (standard, low-inertia, flat, etc.) parameter to values that are compatible with the system application. The protective functions may not function if the settings are incorrect. ⚠ Set the servo amplifier capacity and type parameters to values that are compatible with the system application. The protective functions may not function if the settings are incorrect. ⚠ Use the program commands for the program with the conditions specified in the instruction manual. ⚠ Set the sequence function program capacity setting, device capacity, latch validity range, I/O assigment setting, and validity of continuous operation during error detection to values that are compatible with the system application. The protective functions may not function if the settings are incorrect. ⚠ Some devices used in the program have fixed applications, so use these with the conditions specified in the instruction manual. ⚠ The input devices and data registers assigned to the link will hold the data previous to when communication is terminated by an error, etc. Thus, an error correspondence interlock program specified in the instruction manual must be used. ⚠ Use the interlock program specified in the special function unit's instruction manual for the program corresponding to the special function unit.

(3) Transportation and installation

⚠ CAUTION

- ⚠ Transport the product with the correct method according to the weight.
- ⚠ Use the servomotor suspension bolts only for the transportation of the servomotor. Do not transport the servomotor with machine installed on it.
- ⚠ Do not stack products past the limit.
- ⚠ When transporting the control unit or servo amplifier, never hold the connected wires or cables.
- ⚠ When transporting the servomotor, never hold the cabled, shaft or detector.
- ⚠ When transporting the control unit or servo amplifier, never hold the front case as it may fall off.
- ⚠ When transporting, installing or removing the control unit or servo amplifier, never hold the edges.
- ⚠ Install the unit according to A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using in a place where the weight can be withstood.
- ⚠ Do not get on or place heavy objects on the product.
- ⚠ Always observe the installation direction.
- ⚠ Keep the designated clearance between the control unit or servo amplifier and control panel inner surface or the control unit and servo amplifier, control unit or servo amplifier and other devices.
- ⚠ Do not installer operate control units, servo amplifiers or servomotors that are damaged or that have missing parts.
- ⚠ Do not block the intake/outtake ports of the servomotor with cooling fan.
- ⚠ Do not allow conductive matter such as screw or cutting chips or combustible matter such as oil enter the control unit, servo amplifier or servomotor.
- ⚠ The control unit, servo amplifier and servomotor are precision machines, so do not drop or apply strong impacts on them.
- ⚠ Securely fix the control unit and servo amplifier to the machine according to A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using. If the fixing is insufficient, these may come off during operation.
- ⚠ Always install the servomotor with reduction gears in the designated direction. Failing to do so may lead to oil leaks.
- ⚠ Store and use the unit in the following environmental conditions.

Environment	Conditions	
	Control unit/Servo Amplifier	**Servo Motor**
Ambient temperature	0°C to +55°C (With no freezing)	0°C to +40°C (With no freezing)
Ambient humidity	According to each instruction manual	80%RH or less (With no dew condensation)
Storage temperature	According to each instruction manual	–20°C to +65°C
Atmosphere	Indoors (where not subject to direct sunlight). No corrosive gases, flammable gases, oil mist or dust must exist	
Altitude	1000 m (305 Feet) or less above sea level	
Vibration	According to each instruction manual	

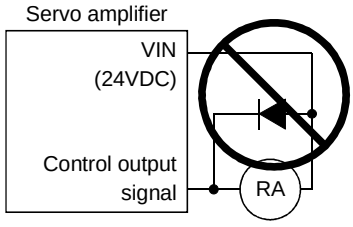
⚠ CAUTION

- ⚠ When coupling with the synchronization encoder or servomotor shaft end, do not apply impact such as by hitting with a hammer. Doing so may lead to detector damage.
- ⚠ Do not apply a load larger than the tolerable load onto the servomotor shaft. Doing so may lead to shaft breakage.
- ⚠ When not using the unit for a long time, disconnect the power line from the control unit or servo amplifier.
- ⚠ Place the control unit and servo amplifier in static electricity preventing vinyl bags and store.
- ⚠ When storing for a long time, contact the Service Center or Service Station.

(4) Wiring

⚠ CAUTION

- ⚠ Correctly and securely wire the wires. Reconfirm the connections for mistakes and the terminal screws for tightness after wiring. Failing to do so may lead to run away of the servomotor.
- ⚠ After wiring, install the protective covers such as the terminal covers to the original positions.
- ⚠ Do not install a phase advancing capacitor, surge absorber or radio noise filter (option FR-BIF) on the output side of the servo amplifier.
- ⚠ Correctly connect the output side (terminals U, V, W). Incorrect connections will lead the servomotor to operate abnormally.
- ⚠ Do not connect a commercial power supply to the servomotor, as this may lead to trouble.
- ⚠ Do not mistake the direction of the surge absorbing diode installed on the DC relay for the control signal output of brake signals, etc. Incorrect installation may lead to signals not being output when trouble occurs or the protective functions not functioning.



- ⚠ Do not connect or disconnect the connection cables between each unit, the encoder cable or sequence expansion cable while the power is ON.
- ⚠ Securely tighten the cable connector fixing screws and fixing mechanisms. Insufficient fixing may lead to the cables combing off during operation.
- ⚠ Do not bundle the power line or cables.

(5) Trial operation and adjustment

⚠ CAUTION

- ⚠ Confirm and adjust the program and each parameter before operation. Unpredictable movements may occur depending on the machine.
- ⚠ Extreme adjustments and changes may lead to unstable operation, so never make them.
- ⚠ If the absolute positioning system is used, home position return is required after initial start up or after replacement of a controller or absolute positioning compatible motor.

(6) Usage methods

⚠ CAUTION

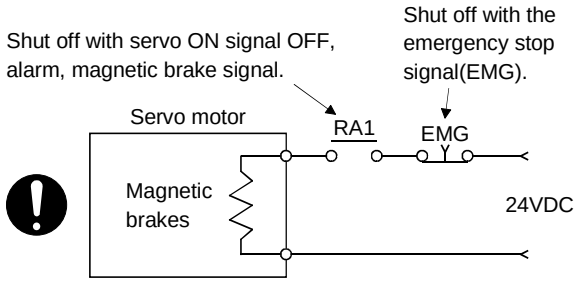
- ⚠ Immediately turn OFF the power if smoke, abnormal sounds or odors are emitted from the control unit, servo amplifier or servomotor.
- ⚠ Always execute a test operation before starting actual operations after the program or parameters have been changed or after maintenance and inspection.
- ⚠ The units must be disassembled and repaired by a qualified technician.
- ⚠ Do not make any modifications to the unit.
- ⚠ Keep the effect or magnetic obstacles to a minimum by installing a noise filter or by using wire shields, etc. Magnetic obstacles may affect the electronic devices used near the control unit or servo amplifier.
- ⚠ Use the units with the following conditions.

Item	Conditions
Input power	According to A172SHCPU/A171SHCPU specifications
Input frequency	According to A172SHCPU/A171SHCPU specifications
Tolerable momentary power failure	According to A172SHCPU/A171SHCPU specifications

(7) Remedies for errors

⚠ CAUTION

- ⚠ If an error occurs in the self diagnosis of the control unit or servo amplifier, confirm the check details according to this manual or the instruction manual, and restore the operation.
- ⚠ If a dangerous state is predicted in case of a power failure or product failure, use a servomotor with magnetic brakes or install a brake mechanism externally.
- ⚠ Use a double circuit construction so that the magnetic brake operation circuit can be operated by emergency stop signals set externally.
- ⚠ If an error occurs, remove the cause, secure the safety and then resume operation.
- ⚠ The unit may suddenly resume operation after a power failure is restored, so do not go near the machine. (Design the machine so that personal safety can be ensured even if the machine restarts suddenly.)



(8) Maintenance, inspection and part replacement

⚠ CAUTION

- ⚠ Perform the daily and periodic inspections according to A172SHCPU user's manual/ A171SHCPU user's manual, or the instruction manual for the product you are using.
- ⚠ Perform maintenance and inspection after backing up the program and parameters for the control unit and servo amplifier.
- ⚠ Do not place fingers or hands in the clearance when opening or closing any opening.
- ⚠ Periodically replace consumable parts such as batteries according to A172SHCPU user's manual/A171SHCPU user's manual, or the instruction manual for the product you are using.

⚠ CAUTION

- ⚠ Do not touch the lead sections such as ICs or the connector contacts.
- ⚠ Do not place the control unit or servo amplifier on metal that may cause a power leakage or wood, plastic or vinyl that may cause static electricity buildup.
- ⚠ Do not perform a mugger test (insulation resistance measurement) during inspection.
- ⚠ When replacing the control unit or servo amplifier, always set the new unit settings correctly.
- ⚠ To prevent positional displacements after a controller or absolute positioning compatible motor is replaced, use one of the following methods to conduct home position return.
  1) PC write the servo data with the peripheral device, turn the power OFF and back ON, then conduct home position return.
  2) Use the peripheral device back-up functions to load the data backed up before replacement.
- ⚠ After maintenance and inspections are completed, confirm that the position detection of the absolute position detector function is correct.
- ⚠ Do not short circuit, charge, overheat, incinerate or disassemble the batteries.
- ⚠ The electrolytic capacitor will generate gas during a fault, so do not place your face near the control unit or servo amplifier.
- ⚠ The electrolytic capacitor and fan will deteriorate. Periodically change these to prevent secondary damage from faults. Replacements can be made by the Service Center or Service Station.

(9) Disposal

⚠ CAUTION

- ⚠ Dispose of this unit as general industrial waste.
- ⚠ Do not disassemble the control unit, servo amplifier or servomotor parts.
- ⚠ Dispose of the battery according to local laws and regulations.

(10) General cautions

⚠ CAUTION

All drawings provided in the instruction manual show the state with the covers and safety partitions removed to explain detailed sections. When operating the product, always return the covers and partitions to the designated positions, and operate according to this manual.

Revisions

*The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Apr.,1998	IB(NA)-67397-B	First edition

CONTENTS

1. GENERAL DESCRIPTION

1. GENERAL DESCRIPTION

The A172SHCPU/A171SHCPU (hereafter referred to as "servo system CPU") features two operating modes (REAL and VIRTUAL) at motion controllers where the operating systems (OS) shown below have been installed:

A172SHCPU	• SW0SRX-SV22C • SW0NX-SV22C	···· collectively abbreviated to "SV22"
A171SHCPU	• SW0SRX-SV22F • SW0NX-SV22F	

This manual explains the mechanical device program required to operate the motion controller in the VIRTUAL mode.
In order to execute positioning control in the VIRTUAL mode, positioning parameter settings, servo programs, and a positioning sequence program must be created in addition to the mechanical system program. Details for these procedures are given in the following manual:

Motion Controller (SV13/22)
Programming Manual (REAL Mode) IB-67265

Differences between the REAL and VIRTUAL modes are discussed in section 2.3 of this manual.
Be sure to familiarize yourself with these differences before attempting positioning control in the VIRTUAL mode.

REMARK

(1) Abbreviations used in this manual are shown in the following table.

Names	Abbreviation
IBM PC/AT in which PC-DOS V5.0 or later version is installed	IBM PC
MR-H-B/MR-J2-B type servo amplifier	MR-[ ]-B

IBM PC/AT is a register trade mark of the International Business Machines Corporation

⚠ CAUTION

⚠ When designing the system, provide external protective and safety circuits for safety in the event of trouble with the motion controller.
⚠ Printed circuit boards have components susceptible to the effects of static electricity mounted on them: ground your body or the work bench before handling them.
Do not directly touch conductive or electric parts of the product.
⚠ Set parameter within the ranges indicated in this manual.
⚠ Use the program instructions in accordance with the conditions stipulated in this manual.
⚠ Some of the devices used in programs have fixed applications: use them in accordance with the conditions stipulated in this manual.

[Conventions Used in This Manual]

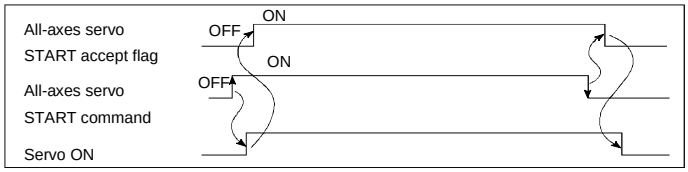
Where positioning signals appear in this manual, they are shown in the "A172SHCPU→A171SHCPU"order. If only one positioning signal is shown, it applies to all the CPUs.
Moreover, all detailed explanations given in this manual are based on the A172SHCPU operation. If another CPU is being used, the positioning signals which appear in these explanations should be replaced with the ones which apply to the CPU being used. (Positioning signals for each CPU are shown in Appendix 4.)

4. SERVO SYSTEM CPU DEVICES

4.2.3 All-Axes servo START accept flag (M2009) ·····Signal sent from PCPU to SCPU

The all-axes servo START flag indicates that servo operation is possible.

・ON····· Servo is operative.
・OFF····· Servo is inoperative.



4.2.4 Manual pulse generator enabled flag (M2012) ·····Signal sent from SCPU to PCPU

The manual pulse generator flag designates the enabled/disabled status for positioning executed by pulse inputs from manual pulse generators connected to the A172SENC /A171SENC PULSER.

・ON····· Positioning control by manual pulse generator inputs is enabled.
・OFF···· Positioning control by manual pulse generator inputs is disabled (inputs are ignored)

4.2.5 JOG simultaneous START command (M2015) ·····Signal sent from SCPU to PCPU

(1) When M2015 switches ON. a JOG simultaneous START will occur at the JOG execution axis (axes 1 to 8/axes 1 to 4/axes) designated at the JOG Simultaneous START Axis Area (D1015).

(2) When M2015 switches OFF, the JOG axis motion will decelerate and stop.

REMARK

*1: For details regarding the A172SENC/A171SENC PULSER(connector), refer to the Motion Controller(A172SHCPU/A171SHCPU) User's Manual.

1. GENERAL DESCRIPTION

1.1 General Comparison Between A172SH·A171SH·A171S(S3)

	Item		A172SHCPU	A171SHCPU	A171SCPU(S3)	
Motion	Number of control axes		8-axes	4-axes	4-axes	
	Computing frequency		3.5ms/1 to 8axes	3.5ms/1 to 4axes	SV13	3.5ms/1 to 3axes
						7.1ms/4axes
					SV22	3.5ms/1 to 2axes
						7.1ms/3 to 4axes
PC	Sequencer CPU		Equivalent to reinforced I/O memory of A2SHCPU	Equivalent to A2SHCPU	Equivalent to A1SCPU	
	Processing speed (μs) (Sequence instruction)	Direct method	0.25 to 1.9μs/step		1.0 to 2.3μs/step	
		Refresh method	0.25μs/step		1.0μs/step	
	Number of I/O		2048 I/O		——	
	Number of actual I/O		1024 I/O	512 I/O	256 I/O	
	Memory capacity (built-in RAM)		192k bytes (Equivalent to A3NMCA24)	64k bytes (Equivalent to A3NMCA8)	32k bytes	
	Program capacity (main sequence)		Max. 30k step	Max. 14k step	Max. 8k step	
	Number of file register (R)		Max. 8192 registers		Max. 4096 registers	
	Number of expansion file register block (*1)		Max. 11 blocks	Max. 3 blocks	None	
	MELSECNET/J		○(Supported by special commands)		○(By means of FROM/TO commands)	
	Number of PC extension base units		Max. 1		Max. 1	
System configuration	Pulse synchronous encoder interface unit		A172SENC (Corresponding to external signal input 8-axes)		A171SENC (Corresponding to external signal input 4-axes)	
	Number of SSCNET I/F		2CH. SSCNET1.....For connection of servo amplifier SSCNET2.....For personal computer link dedicated		A171S :1CH.	
					A171S-S3 :2CH.(as given to the left)	
	Number of available A271DVP		Unavailable		Max. 2	
	Teaching unit (OS with teaching function)	A30TU	○		○	
		A31TU	○(With deadman switch)		×	
Compatibility	Sequence program, parameter		After starting A172SH/A171SH and reading a file, those created by A171SCPU can be used as it is.			
	Servo program					
	Mechanical program (SV22)					
	Parameter					
	System setting		By making sure of system setting screen after being started up by A172SH/A171SH and reading a file, changeover below is carried out: now the system is ready for operation.			
Added functions	• Compatible with a high resolution encoder (32768PLS/131072PLS)		○		×	
	• Possible to change the torque limit value from the sequence program (CHGT instruction newly added)	REAL mode	○		×	
		VIRTUAL mode	× (However, it is possible in the mechanical system program.)		× (However, it is possible in the mechanical system program.)	
	• Reverse return is possible during positioning		○		×	
	• Possible to invalidate the virtual servo motor stroke limit (SV22)		○		×	

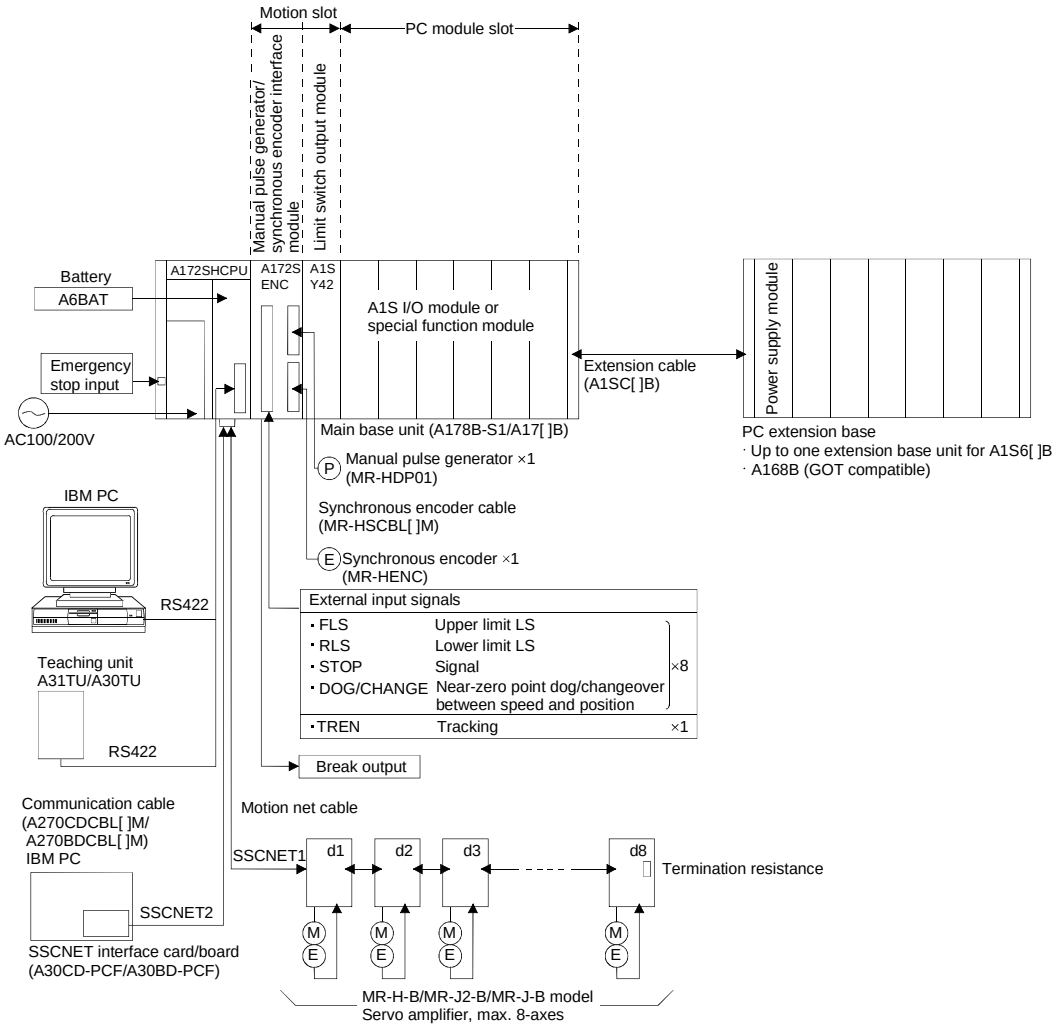
(*1) The number of expansion file register blocks will vary depending on such things as program capacity, number of file registers, and number of comments.

1. GENERAL DESCRIPTION

1.2 System Configuration

1.2.1 A172SHCPU System overall configuration

The following diagram indicates the system configuration when A172SHCPU is used.

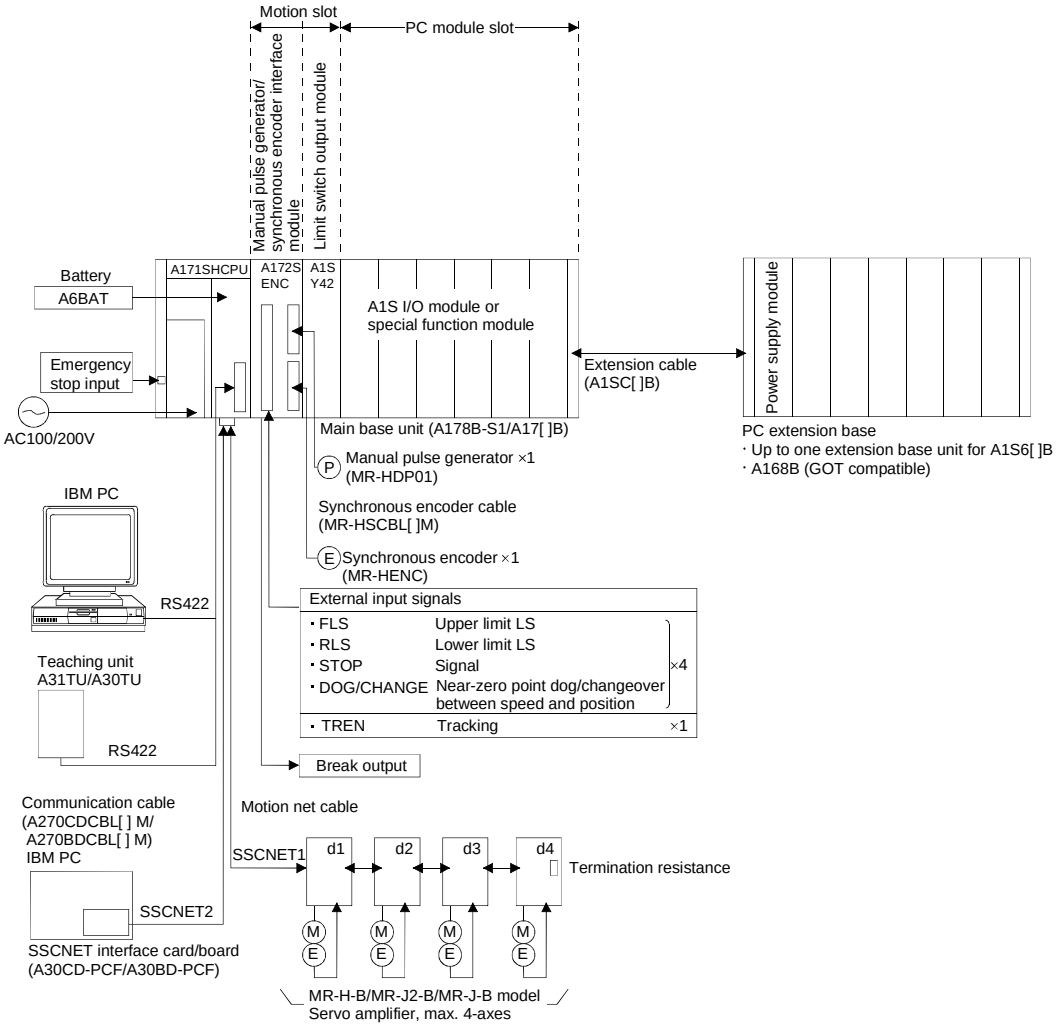


NOTES

(1) Use A168B when the GOT bus connecting type is used.
(2) When using a teaching unit (A31TU) with a deadman switch, use a dedicated cable (A31TUCBL03M) to connect the CPU and A31TU connector. When the dedicated cable is not used, i.e., the teaching unit is directly connected to the CPU RS422 connector, it does not work at all. Attach a short-circuit connector (A31SHORTCON) for A31TUCBL after detaching the A31TU.
(3) Use motion slots to mount PC A1S I/O modules if necessary.
(4) When the power supply to the servo system CPU is switched ON and OFF, erroneous process outputs may temporarily be made due to the delay between the servo system CPU power supply and the external power supply for processing (especially DC), and the difference in startup times.
For example, if the power supply to the servo system CPU comes on after the external power supply for processing comes on at a DC output module, the DC output module may temporarily give erroneous outputs when the power to the servo system CPU comes on. Accordingly a circuit that ensures that the power supply to the servo system CPU comes on first should be constructed.

1.2.2 A171SHCPU System overall configuration

The following diagram indicates the system configuration when A171SHCPU is used.



NOTES

(1) Use A168B when the GOT bus connecting type is used.
(2) When using a teaching unit (A31TU) with a deadman switch, use a dedicated cable (A31TUCBL03M) to connect the CPU and A31TU connector. When the dedicated cable is not used, i.e., the teaching unit is directly connected to the CPU RS422 connector, it does not work at all. Attach a short-circuit connector (A31SHORTCON) for A31TUCBL after detaching the A31TU.
(3) Use motion slots to mount PC A1S I/O modules if necessary.
(4) Though A172SENC has external input signals for 8 axes, make settings for the first 4 axes (PX0 to PX0F).
(5) When the power supply to the servo system CPU is switched ON and OFF, erroneous process outputs may temporarily be made due to the delay between the servo system CPU power supply and the external power supply for processing (especially DC), and the difference in startup times.
For example, if the power supply to the servo system CPU comes on after the external power supply for processing comes on at a DC output module, the DC output module may temporarily give erroneous outputs when the power to the servo system CPU comes on. Accordingly a circuit that ensures that the power supply to the servo system CPU comes on first should be constructed.

1.2.3 System configuration precautions

The following table summarizes the notes on system configuration, system setup items, and relative checks that differ from those of the A171SCPU.

<table>
<tr><th>Product Name</th><th>Module Name</th><th>Number of Available Modules</th><th>System Setup Item</th><th>Relative Check</th><th>Notes and Remarks</th></tr>
<tr><td>Separated amplifier</td><td>MR-J2-B
MR-H-B
MR-J-B</td><td>• Max. 8 axes for A172SHCPU
• Max. 4 axes for A171SHCPU</td><td>1. MR-J2-B allows the use of the following motors with high-resolution encoders.
• HC-MF***W1 (32768PLS)
• HA-FF***W1 (32768PLS)
• HC-SF**2W2 (131072PLS)
2. [Allowable travel value during power-off]
When ABS motor is used, set the allowable travel value during servo amplifier power-off by rpm (rotations per minute).
This setting value is used for checking when the servo amplifier is switched ON.
<table><tr><th>Setting range</th><th>Default value</th></tr><tr><td>0 to 16383 (rpm)</td><td>10 (rpm)</td></tr></table></td><td></td><td>• Connect the servo amplifier to the "SSCNET1" interface.
• The setting range changes for high-resolution encoder support.</td></tr>
<tr><td rowspan="2">Manual pulse generator/ synchro-nous encoder interface module</td><td>A172SENC</td><td>1</td><td>1. External signals
(1) Set the axis numbers of external signals FLS, RLS, STOP, and DOG/CHANGE for A172SENC CTRL connector signals PX0 to PX1F.
Axes need not be set unless they are used by external signals.
<table><tr><th>CPU unit</th><th>Setting range</th><th>Default value</th></tr><tr><td>A172SHCPU</td><td>Set axes 1 to 8 for PX0 to PX1F.</td><td>Axes 1 to 8 are set.</td></tr><tr><td>A172SHCPU</td><td>Set axes 1 to 4 for the first half (PX0 to PX0F).</td><td>Axes 1 to 4 are set.</td></tr></table></td><td>• The same axis number must not be set.</td><td rowspan="2">• The external signal setup window has been improved for a better understanding.
• The conventional A171SENC can also be used for A171SHCPU and A172SHCPU. However, it must be set as A172SENC during system setting.</td></tr>
<tr><td>A171SENC</td><td>0</td><td>Settings cannot be made.</td><td></td></tr>
<tr><td>Man/machi-ne control module</td><td>A271DVP</td><td>0</td><td>Not available. Settings cannot be made.</td><td></td><td></td></tr>
<tr><td>PC CPU I/O module (motion slot)</td><td>A1SX**
A1SY**
A1SH42</td><td>Up to 256 I/O points (total)</td><td>1. Set the number of points and the starting I/O number for PC CPU I/O modules to be mounted on the motion extension base unit. The number to be set must not precede the I/O numbers for use by the PC extension base unit.
<table><tr><th>CPU unit</th><th>Effective setting range</th><th>Default value</th></tr><tr><td>A172SHCPU</td><td>X/Y0 to X/Y3FF</td><td>———</td></tr><tr><td>A171SHCPU</td><td>X/Y0 to X/Y1FF</td><td>———</td></tr></table></td><td>• The total number of points must be less than or equal to 256.
• The starting I/O number plus number of occupied points must be less than or equal to X/Y800.</td><td>• Though settings can be made within a range of X/Y0 to X/Y7FF, they must be made in the range defined in the left-hand column.</td></tr>
<tr><td rowspan="2">PC extension base unit</td><td>A1S68B
A1S65B</td><td>1 stage</td><td colspan="2" rowspan="2"></td><td>• Use this unit for systems capable of one-stage extension.</td></tr>
<tr><td>A168B</td><td>1 stage</td><td>• Use this unit for bus connection GOT.</td></tr>
</table>

1. GENERAL DESCRIPTION

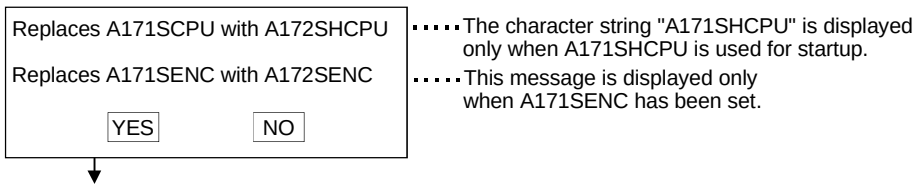
POINTS

1. When using the existing A171SCPU user program and parameters, perform the following procedure:

(1) Start the peripheral S/W package by A172SHCPU or A171SHCPU, then read the sequence file and servo file created for A171SCPU via the File Read function.

↓

(2) Display the System Setup screen.
The existing system status is displayed with the following alert:
(Start by A172SHCPU)



↓

(3) Select "YES" and the existing settings will be replaced with those for the startup CPU module.
Select "NO" and the existing A171SCPU settings will remain in effect.

* Other than system setup data can be used without change.

1.3 Summary of REAL and VIRTUAL Modes

(1) REAL mode

(a) The REAL mode is used to execute direct control by the servo program at systems using servomotors.

(b) To utilize the REAL mode, positioning parameter settings must be designated ,and a positioning sequence program must be created.

(c) The procedure for REAL mode positioning control is as follows:

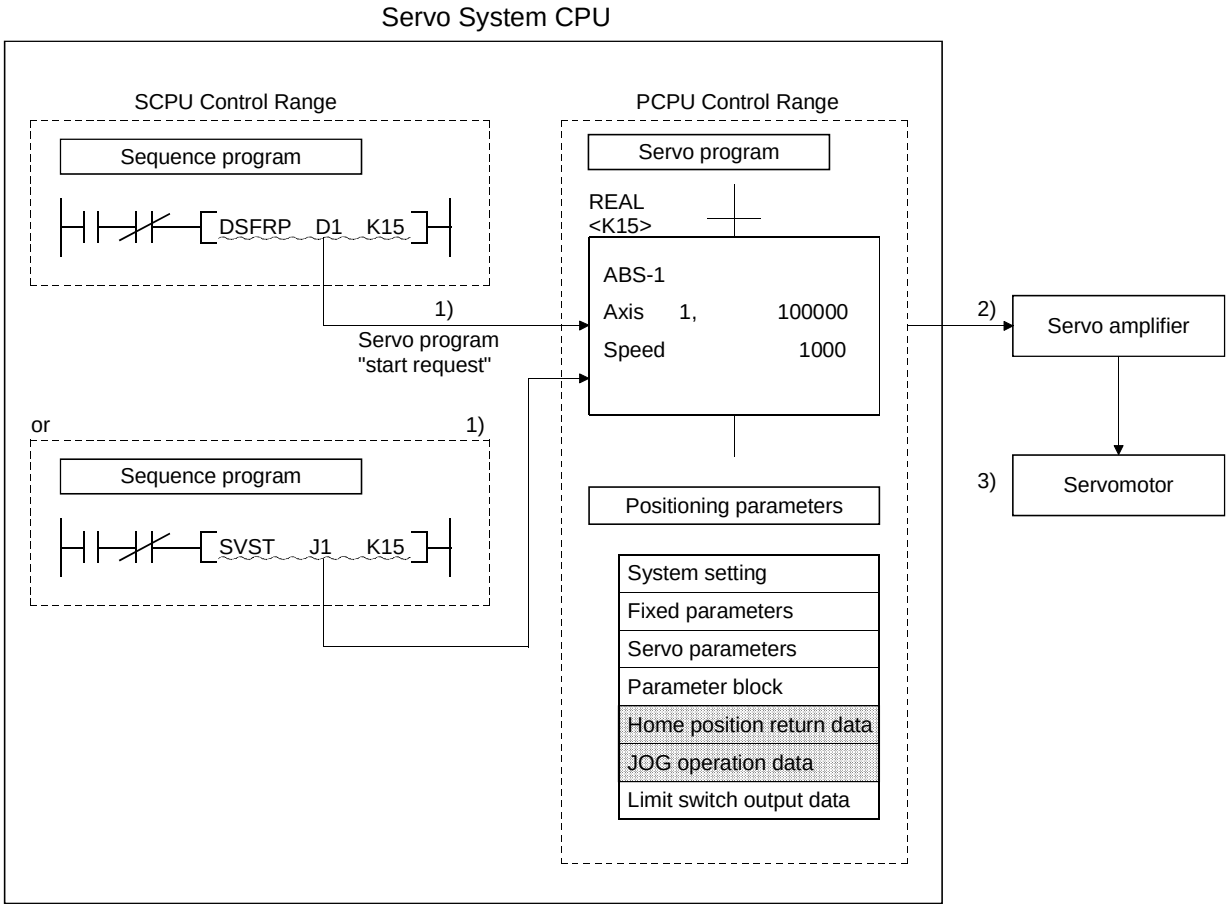
1) A REAL mode servo program "start request" is issued with a DSFRP/SVST instruction in the positioning sequence program.

↓

2) Positioning control occurs in accordance with the specified servo program. (Output to amplifier and servo amplifier modules.)

↓

3) Servomotor control is executed.



(2) VIRTUAL mode

(a) The VIRTUAL mode is used to execute synchronous processing (with software) using a mechanical system program comprised of a virtual main shaft and mechanical module.
This mode permits the synchronous control for conventional positioning by main shaft, gear, and cam, etc., to be replaced by a servomotor positioning control format.

(b) In addition to the positioning parameter settings, servo program, and positioning sequence program used in the REAL mode, the VIRTUAL mode also requires a "mechanical system program".

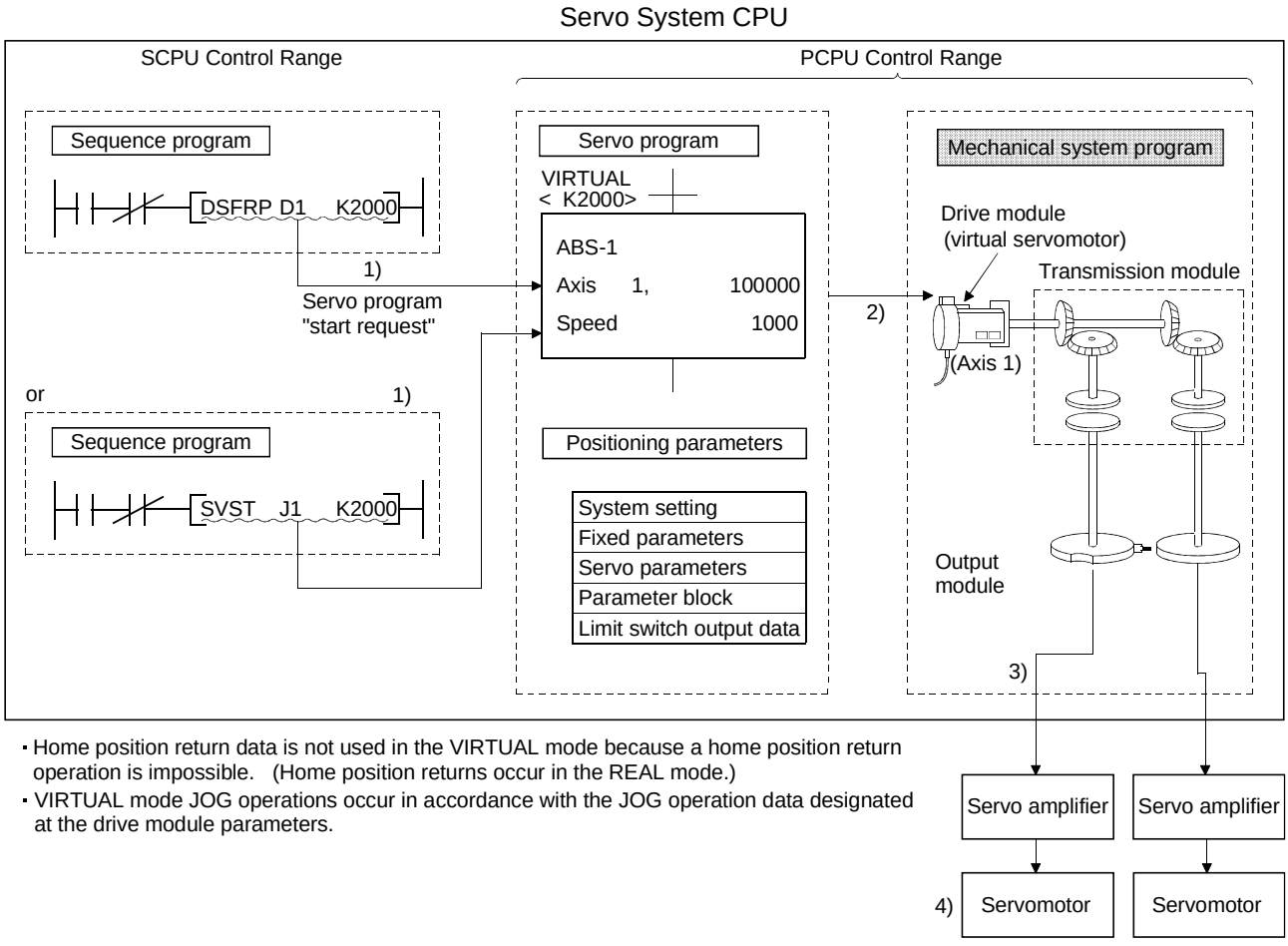
(c) The procedure for VIRTUAL mode positioning control is as follows.

1) A VIRTUAL mode servo program "start request" is issued with a DSFRP/SVST instruction in the positioning sequence program.

2) The mechanical system program's virtual servomotor is started.

3) The calculation result from the transmission module is output to the amplifier module/servo amplifier designated for the output module.

4) Servomotor control is executed.



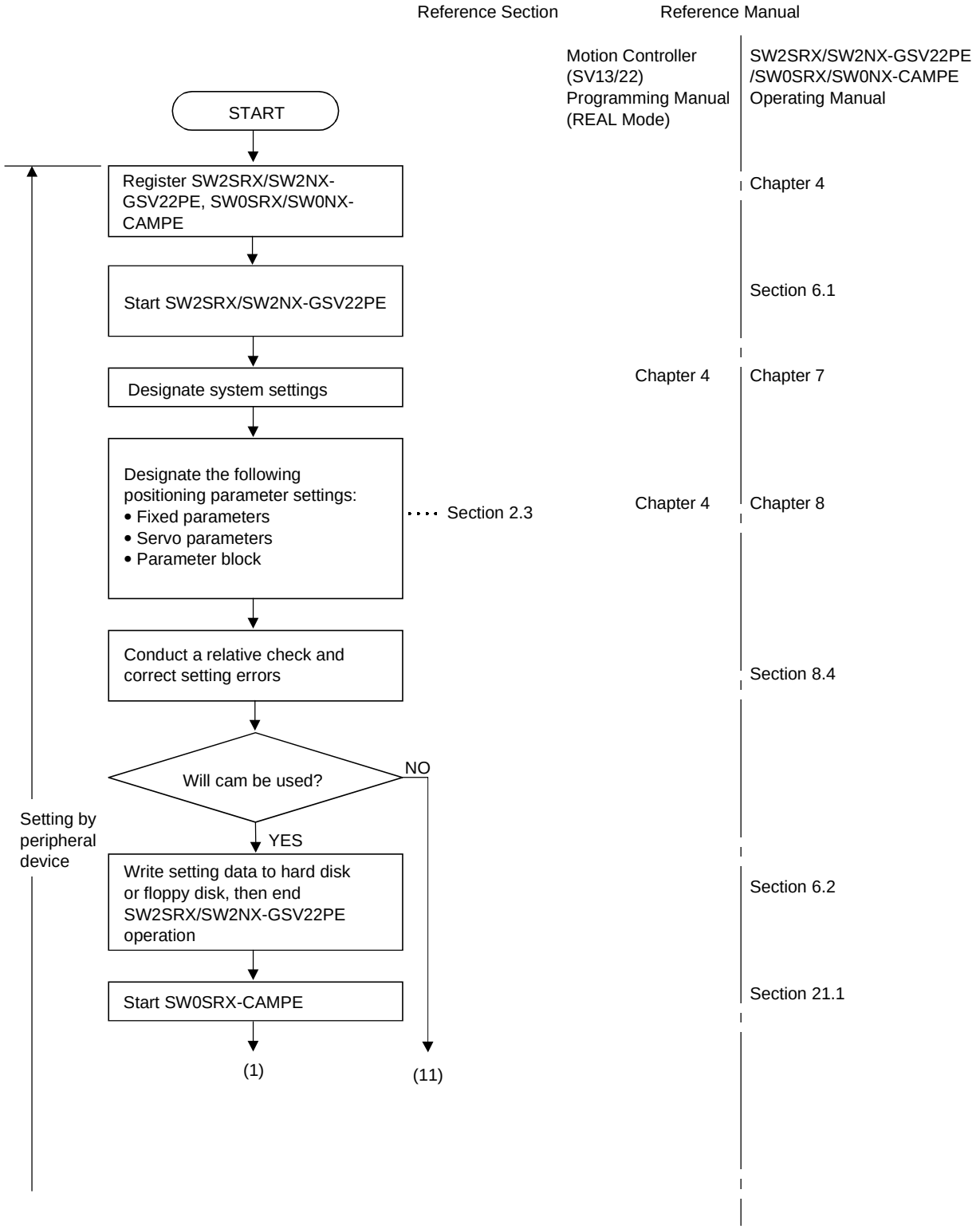
- Home position return data is not used in the VIRTUAL mode because a home position return operation is impossible. (Home position returns occur in the REAL mode.)
- VIRTUAL mode JOG operations occur in accordance with the JOG operation data designated at the drive module parameters.

2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL

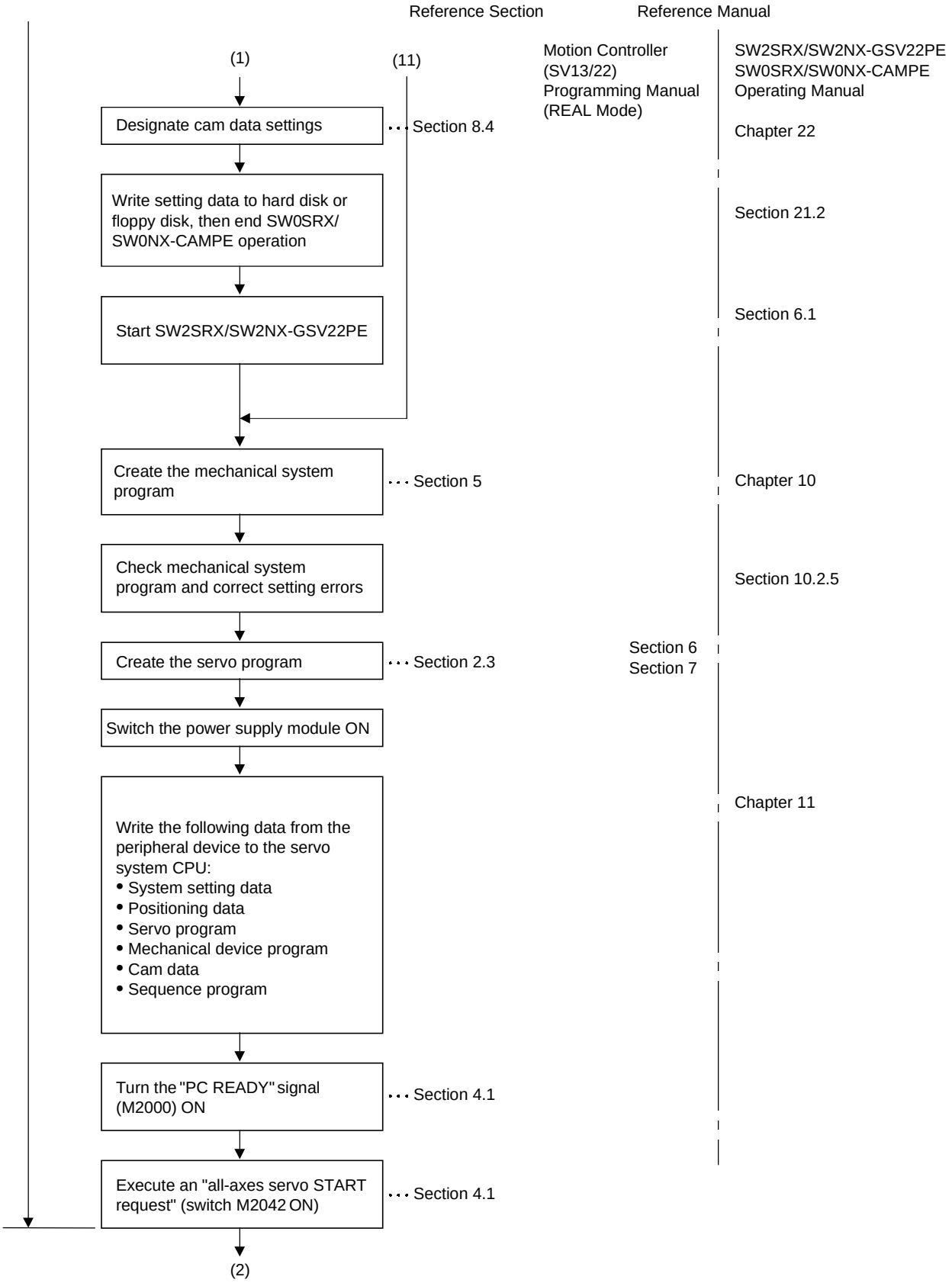
The procedure for VIRTUAL mode positioning control is discussed in this section.

2.1 System Start-Up

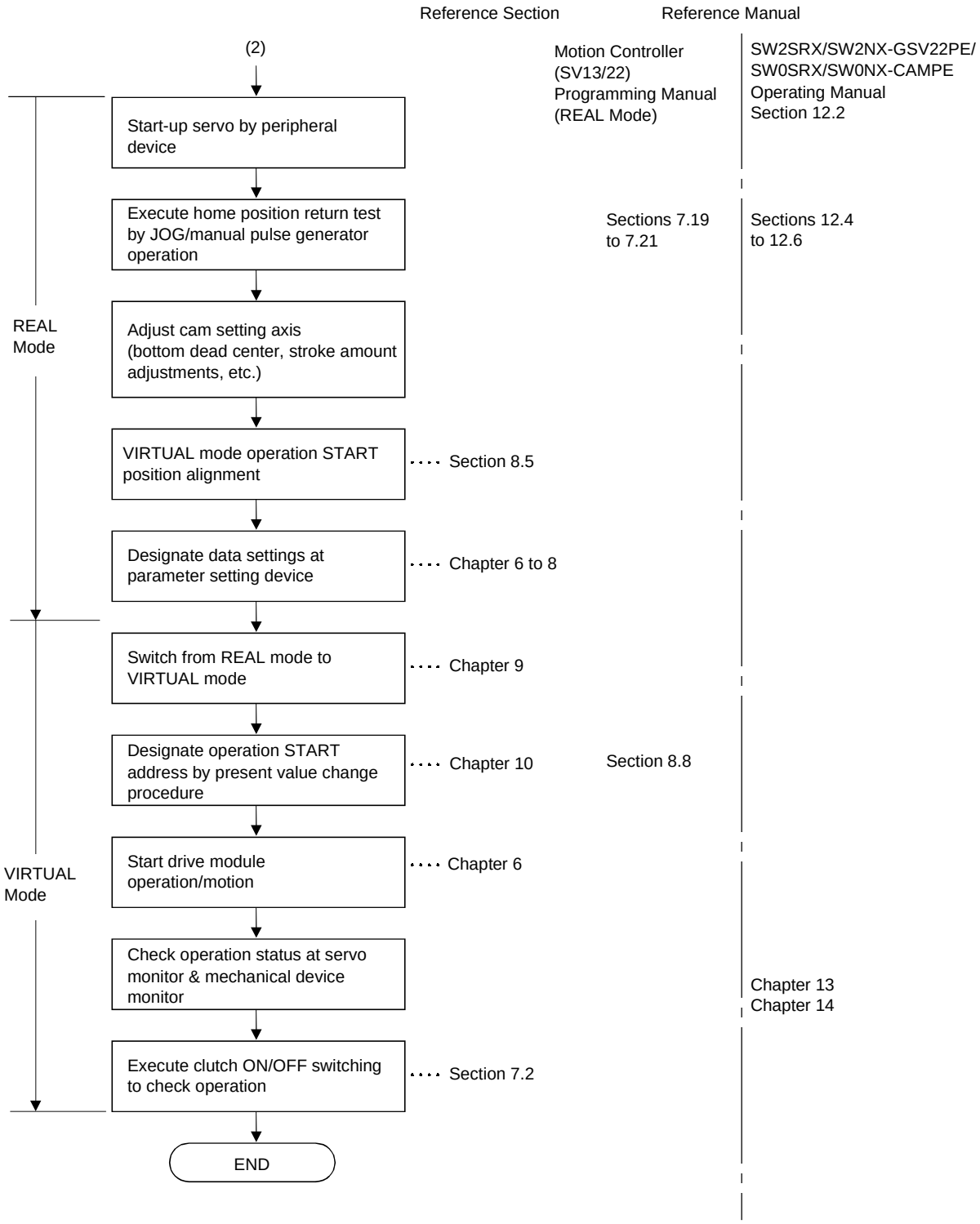
The procedure for a VIRTUAL mode system start-up is shown below.



2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL



2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL



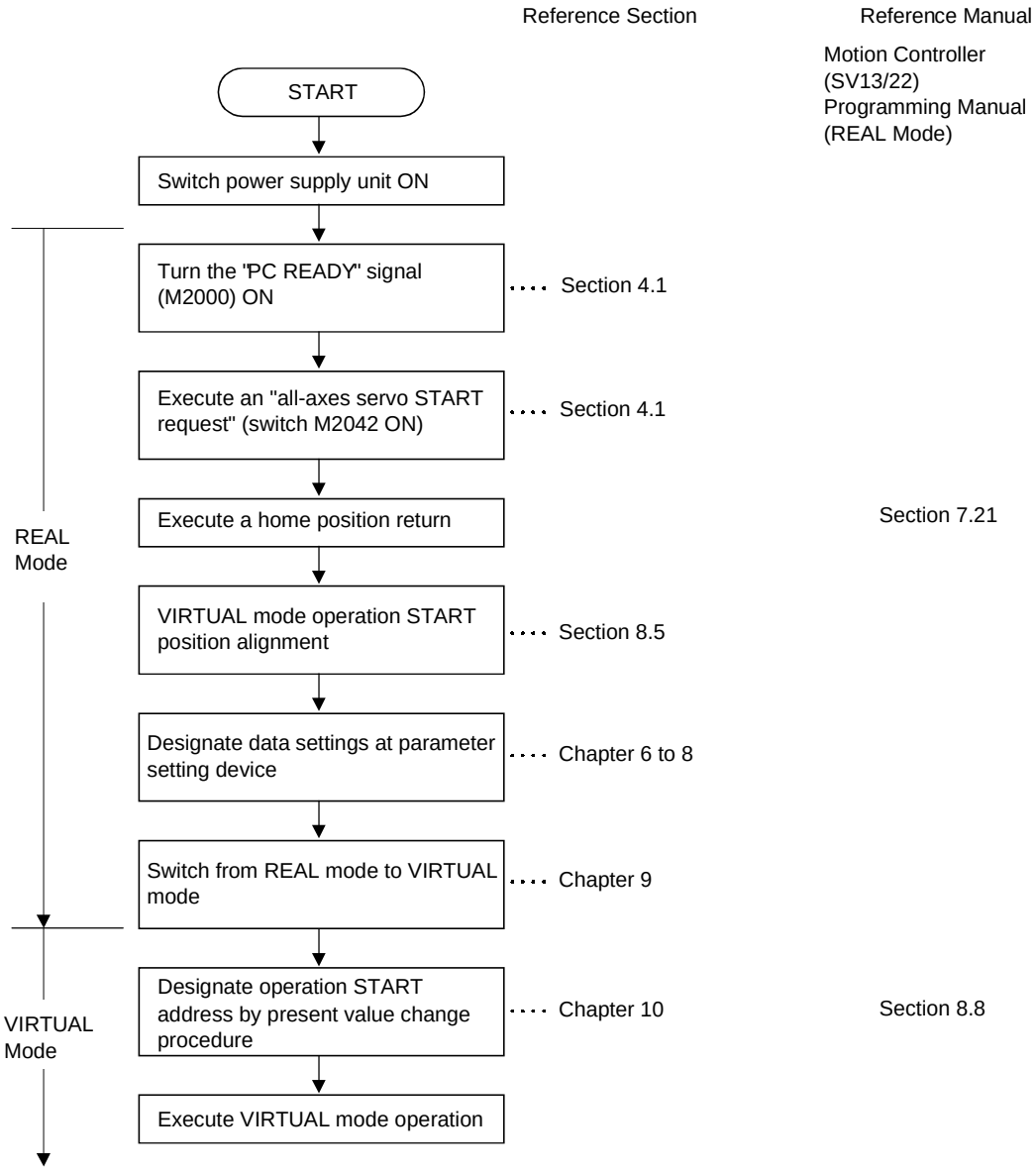
2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL

2.2 Operation

The preparation procedure for VIRTUAL mode operation is shown below.

2.2.1 Operation with incremental system

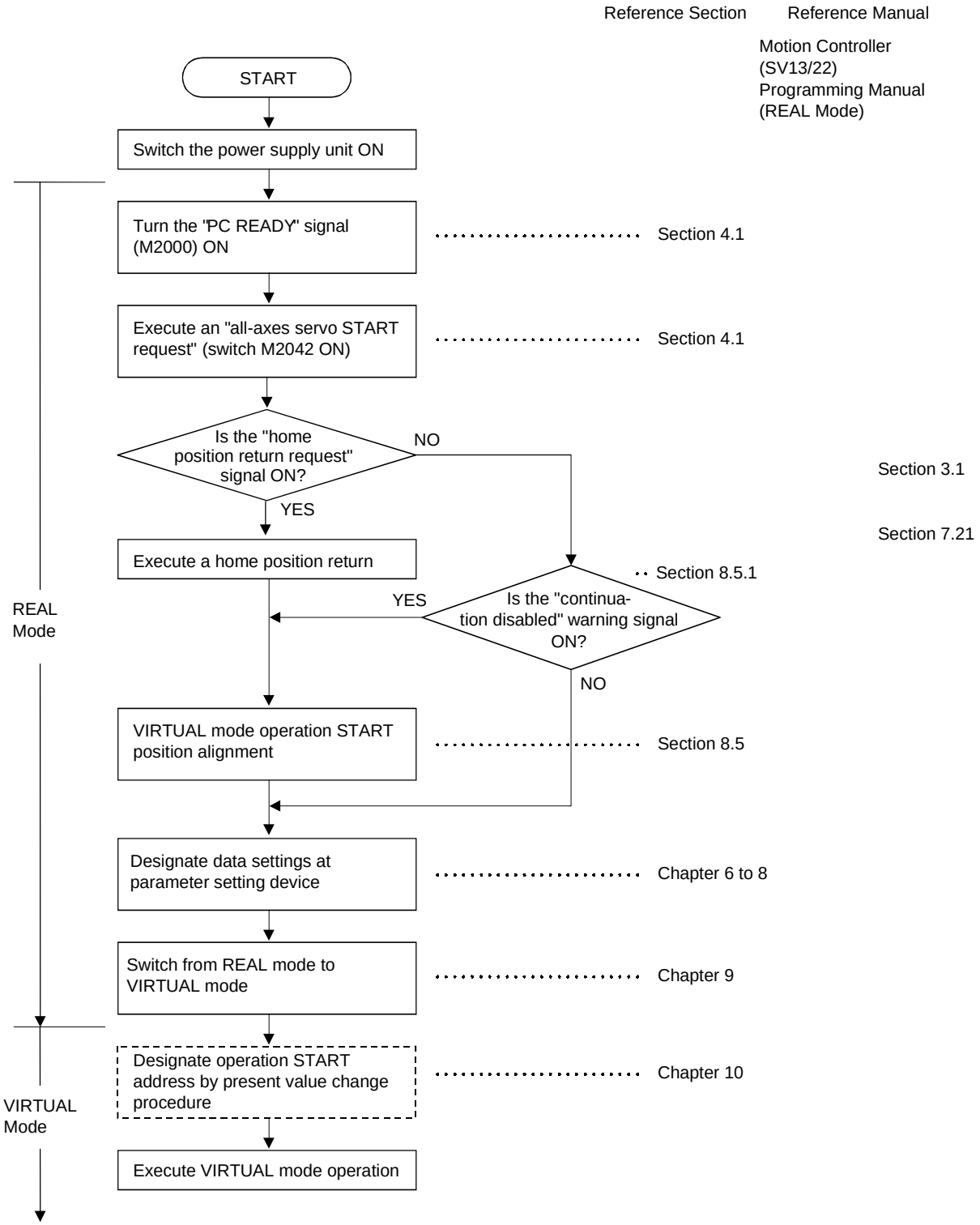
The operation procedure when an incremental system is used is shown below.



2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL

2.2.2 Operation with an absolute (absolute position) system

The operation procedure when an absolute system is used is shown below.



2. PROCEDURE FOR VIRTUAL MODE POSITIONING CONTROL

2.3 Differences Between The REAL and VIRTUAL Modes

Portions of the positioning data, positioning device, and servo programs, etc., used in REAL mode operations are different when used in VIRTUAL mode operations. The Motion Controller (SV13/22) Programming Manual (REAL Mode) should be read after acquainting yourself with these differences.

2.3.1 Positioning data

Positioning data used in the VIRTUAL mode is shown in Table 2.1 below.

Table 2.1 Positioning Data List

Item	REAL Mode	VIRTURL Mode	Remarks
System settings	○	○	
Fixed parameters	○		System-of-units varies according to the output module used
Servo parameters	○	○	
Parameter block	○		Use of "pulse"only
Home position return data	○	–	
JOG operation data	○	–	
Limit switch output data	○		

[○]:Used [ ]:Conditional use [–]:Not used

2.3.2 Positioning device

The operating ranges of VIRTUAL mode positioning devices are shown in Tables 2.2 below.

Table 2.2 Operating Range of Positioning Devices

Device Name	REAL Mode	VIRTURL Mode
Internal relays	M1600 to M2047	M1200 to M2047
Special relays	M9073 to M9079	
Data registers	D800 to D1023	D670 to D1023
Special registers	D9180 to D9199	

2.3.3 Servo program

(1) Servo program area
  (a) The same servo program No. cannot be used in both the REAL and VIRTUAL modes. For VIRTUAL mode operations, the servo program's range must be designated in advance.
  (The range setting is executed at an IBM PC running the SW2SRX/SW2NX-GSV22PE software.)

(2) Servo instructions
  (a) The home position return, speed control (II), speed/position switching functions, and high-speed oscillation functions are inoperative in the VIRTUAL mode.

  (b) The parameter block's control system-of-units and the torque limit value items (positioning data designated by the servo program) are not used.

(3) The servo instructions available in the TEST and VIRTUAL modes are shown in Table 2.5 below.

Table 2.5 Servo Instruction List for REAL & VIRTUAL Modes

Item			REAL Mode	VIRTURL Mode	Remarks
Servo instruction	Speed/ position control	VPF	○	×	
		VPR			
		VPSTART			
	Speed control(II)	VVF	○	×	
		VVR			
	Home position return	ZERO	○	×	Switch to VIRTUAL mode after home position return has been executed in the REAL mode
	High-speed oscillation	OSC	○	×	
Positioning data	Parameter block	Control system-of-units	○	–	Fixed as "pulse"
		Torque limit value	○	–	Designated at drive module's parameter setting

[○]:Used [×]:Unusable [–]:Not used

2.3.4 Control change (present value change & speed change)

When a control change is executed in the VIRTUAL mode, the drive module's feed present value and speed will change.
Control changes are not possible for the output module.
The differences between control changes in the REAL and VIRTUAL modes are shown in Table 2.6 below.

Table 2.6 Control Changes in the REAL & VIRTUAL Modes

Item	REAL Mode	VIRTUAL Mode						Remarks
		Drive Module		Output Module				
		VIRTUAL Servo motor	Synchronous Encoder	Roller	Ball Screw	Rotary Table	Cam	
Present value change	○	○	△	×	×	×	△	The programming method for a synchronous encoder "present value change" is different (See Appendix 10.1.1)
Speed change	○	○	×	×*				

REMARK

(1) The [○], [△], [×] symbols used in Table 2.6 indicate the following.
- [○] : Setting/execution possible
- [△] : Execution possible, but programming method is different
- [×] : Setting/execution impossible

(2) *: If the output module is a roller which uses a speed change gear, a speed change can be executed by changing the speed change gear ratio.

(3) For details regarding the drive and output modules, refer to the sections shown below.
- Drive module : Chapters 5 & 6
- Output module : Chapters 5 & 8

3. PERFORMANCE SPECIFICATIONS

3. Performance Specifications

Table 3.1 gives the performance specifications of the PCPU.

Table 3.1 PCPU Performance Specifications (VIRTUAL Mode)

Item			A172SHCPU		A171SHCPU	
Number of control axes			8 axes		4 axes	
Control modes			Synchronous control			
Control unit		Drive module	Virtual servo motor	Fixed as "PULSE"		
			Synchronous encoder			
		Output module	Roller	mm•inch		
			Ball screw			
			Rotary table	Fixed as "degree"		
			Cam	mm•inch•PULSE		
Programming language			Dedicated instructions (sequence ladders + servo programs + mechanical system programs) * SFC programming of servo programs is also possible.			
Servo program		Capacity	13k steps (13312 steps) * Capacity matching the servo program for the REAL mode			
		Number of points for positioning	Approx. 400 points/axis		Approx. 800 points/axis	
			(These values vary depending on the programs. Positioning data can be designated indirectly.)			
Mechanical system program			Number of modules that can be set per CPU			
	Drive modules	VIRTUAL module	8 axes		4 axes	
		Synchronous encoder	1 axis		1 axis	
	Virtual axes	Main shaft	8		4	
		Auxiliary input axis	8		4	
	Transmission modules	Gear	16		8	
		Clutch	16		8	
		Speed change gear	16		8	
		Differential gear	8		4	
		Differential gear for the main shaft	8		4	
	Output modules	Roller	8	Total of 8	4	Total of 4
		Ball screw	8		4	
		Rotary table	8		4	
		Cam	8		4	
Program setting method			Setting with an IBM PC, running the GSV22P software			
Cam	Types		Max. of 64			
	Resolution per cycle		256•512•1024•2048			
	Memory capacity		Approx. 32k bytes			
	Storage memory for cam data and cam rotation mode limit		RAM memory in CPU			
	Stroke resolution		32767			
	Control mode		Two-way cam/feed cam			
Cam data setting method			Setting with an IBM PC, running the CAMP software			

3. PERFORMANCE SPECIFICATIONS

Table 3.1 PCPU Performance Specifications (VIRTUAL Mode) (Continued)

<table>
<tr><th colspan="3">Item</th><th>A172SHCPU</th><th>A171SHCPU</th></tr>
<tr><td rowspan="9">Virtual servo motor</td><td colspan="2">Interpolation functions</td><td colspan="2">Linear interpolation (max. of 4 axes), circular interpolation (2 axes)</td></tr>
<tr><td colspan="2">Control modes</td><td colspan="2">PTP (point to point), speed control, fixed-pitch feed, constant speed control, position follow-up control, speed switching control</td></tr>
<tr><td rowspan="3">Positioning</td><td>Method</td><td colspan="2">PTP :Selection of absolute data method or incremental method
Fixed pitch feed :Selection of incremental method
Constant speed control, speed switching control
:The absolute method and incremental method can be used together
Position follow-up control :Absolute data method</td></tr>
<tr><td>Position command</td><td colspan="2">Address setting range –2147483648 to 2147483648 (PULSE)</td></tr>
<tr><td>Speed command</td><td colspan="2">Speed setting range 1 to 10000000 (PLS/S) (*1)</td></tr>
<tr><td rowspan="2">Acceleration/ deceleration control</td><td>Automatic trapezoidal acceleration/ deceleration</td><td colspan="2"><table><tr><th>Acceleration–fixed acceleration/deceleration</th><th>Time–fixed acceleration/deceleration</th></tr><tr><td>Acceleration time: 1 to 65535 ms</td><td>Acceleration/deceleration time: 1 to 5000 ms</td></tr><tr><td>Deceleration time: 1 to 65535 ms</td><td>(Only constant speed control is possible)</td></tr></table></td></tr>
<tr><td>S curve acceleration/ deceleration</td><td colspan="2">S curve ratio setting: 0 to 100%</td></tr>
<tr><td colspan="2">JOG operation function</td><td colspan="2">Provided</td></tr>
<tr><td colspan="2">M function</td><td colspan="2">M code output function provided, and M code completion wait function provided</td></tr>
<tr><td colspan="2">Skip function</td><td colspan="2">Provided</td></tr>
<tr><td colspan="2">Manual pulse generator operation function(test mode only)</td><td colspan="2">A maximum of one manual pulse generator can be connected
A maximum of three manual pulse generators can be operated
Setting of magnification: 1 to 100. It is possible to set the smoothing magnification</td></tr>
<tr><td colspan="3" rowspan="3">Limit switch output function</td><td>Number of output points</td><td>8 points/axis</td></tr>
<tr><td>Number of ON/OFF setting points</td><td>10 points/axis</td></tr>
<tr><td>Control mode</td><td>Present value mode/
Cam axis present value in one revolution mode</td></tr>
<tr><td rowspan="2">High-speed reading of designated data</td><td>Number of input points (*2)</td><td colspan="2">Max. of 9 points
(TREN input of A172SENC (1 point) + one motion slot PC input module (8 points))</td></tr>
<tr><td>Data latch timing</td><td colspan="2">At leading edge of the TREN input signal
Within 0.8ms of the signal leading edge for the PC input module</td></tr>
<tr><td colspan="3">Absolute position system</td><td colspan="2">Possible with a motor equipped with an absolute position detector
(Possible to select the absolute method or incremental method for each axis)</td></tr>
</table>

(*1) The setting range has been expanded from the previous range as a result of compatibility with the high resolution encoder.
(*2) When a TREN input signal is used as an "External input mode clutch" the high speed reading function can not be used.

4. SERVO SYSTEM CPU DEVICES

The servo system CPU devices for which positioning control is carried out using the VIRTUAL mode and the applications of these devices are explained in this chapter.
The signals which are sent from the PCPU to the SCPU indicate the PCPU device refresh cycle and the signals sent from the SCPU to the PCPU indicate the PCPU device fetch cycle.

4.1 Internal Relays

4.1.1 Internal relay list

A172SHCPU (○ Valid)

Device No.	Classification	REAL	VIRTUAL
M0	User devices (1200 points)		
M1200 (*1)	Virtual servo motor axes (*2) status (20 points × 8 axes) (3)	Back up	○
M1360 (*1)	Synchronous encoder axis status (4 points × 1 axis) (5)	○	○
M1364 (*1)	Unusable (37 points)		
M1400 (*1)	Virtual servo motor axes (*2) command signal (20 points × 8 axes) (4)	×	○
M1560 (*1)	Synchronous encoder axis command signal (4 points × 1 axis) (6)	×	○
M1564 (*1)	Unusable (36 points)		
M1600	Status of each axis (20 points × 8 axes) REAL mode .....Each axis VIRTUAL mode .....Output modules (1)	○	○
M1760	Unusable (40 points)		
M1800	Command signals of each axis (20 points × 8 axes) REAL mode .....Each axis VIRTUAL mode .....Output modules (2)	○	○
M1960	Common devices (88 points) (7)	○	○
M2000 M2047			

A171SHCPU (○ Valid)

Device No.	Classification	REAL	VIRTUAL
M0	User devices (1200 points)		
M1200 (*1)	Virtual servo motor axes (*2) status (20 points × 4 axes) (3)	Back up	○
M1280 (*1)	User devices (80 points)		
M1360 (*1)	Synchronous encoder axis status (4 points × 1 axis) (5)	○	○
M1364 (*1)	Unusable (37 points)		
M1400 (*1)	Virtual servo motor axes (*2) command signal (20 points × 4 axes) (4)	×	○
M1480 (*1)	User devices (80 points)		
M1560 (*1)	Synchronous encoder axis command signal (4 points × 1 axis) (6)	×	○
M1564 (*1)	Unusable(36 points)		
M1600	Status of each axis (20 points × 4 axes) REAL mode..... Each axis VIRTUAL mode ..... Output modules (1)	○	○
M1680	Unusable (120 points)		
M1800	Command signals of each axis (20 points × 4 axes) REAL mode..... Each axis VIRTUAL mode ..... Output modules (2)	○	○
M1880	Unusable (80 points)		
M1960	Common devices (88 points) (7)	○	○
M2000 M2047			

4. SERVO SYSTEM CPU DEVICES

POINTS

(*1) When the VIRTUAL mode is used do not set M1200 to M1599 in the latch range.

(*2) The virtual servo motor axis status signals/command signals occupy only the areas of the axes set in the mechanical system program. The area of an axis that is not set in the mechanical system program can be used by the user.

- Total number of points for the user devices

A172SHCPU	1200 points
A171SHCPU	1360 points

4.1.2 Each axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1600 to M1619	M1600 to M1619	(○ Valid)	
2	M1620 to M1639	M1620 to M1639		
3	M1640 to M1659	M1640 to M1659		
4	M1660 to M1679	M1660 to M1679		
5	M1680 to M1699			
6	M1700 to M1719			
7	M1720 to M1739			
8	M1740 to M1759			

	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball screw	Rotary table	Cam			
0	Positioning start completed	○	OFF	OFF	OFF	OFF	SCPU← PCPU	—	
1	Positioning completed	○	OFF	OFF	OFF	OFF			
2	In-position	○	○	○	○	○		3.5ms	
3	Command in-position	○	OFF	OFF	OFF	OFF		—	
4	Speed control in progress	○	OFF	OFF	OFF	OFF			
5	Speed/position switching latch	○	OFF	OFF	OFF	OFF			
6	Zero pass	○	○	○	○	○		3.5ms	
7	Error detection	○	○	○	○	○		Immedi-ately	
8	Servo error detection	○	○	○	○	○		3.5ms	
9	Home position return request	○	○	○	○	○		10ms	
10	Home position return completed	○	○	○	○	○		3.5ms	
11	External signal FLS	○	○	○	○	○		10ms	
12	External signal RLS	○	○	○	○	○			
13	External signal STOP	○	○	○	○	○			
14	External signal DOG/CHANGE	○	○	○	○	○			
15	Servo ON/OFF	○	○	○	○	○		3.5ms	
16	Torque control in progress	○	○	○	○	○			
17	Unusable	—	—	—	—	—		—	
18	Virtual mode intermittent actuation disabled warning	○	○	○	○	○		10ms	
19	M code output in progress	○	OFF	OFF	OFF	OFF		—	

4.1.3 Command signals of each axis

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1800 to M1819	M1800 to M1819	(○ Valid)	
2	M1820 to M1839	M1820 to M1839		
3	M1840 to M1859	M1840 to M1859		
4	M1860 to M1879	M1860 to M1879		
5	M1880 to M1899			
6	M1900 to M1919			
7	M1920 to M1939			
8	M1940 to M1959			

	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball screw	Rotary table	Cam			
0	Stop command	○	×	×	×	×	SCPU→ PCPU		—
1	Rapid stop command	○	×	×	×	×			
2	Forward JOG start	○	×	×	×	×			
3	Reverse JOG start	○	×	×	×	×			
4	End signal OFF command	○	×	×	×	×			
5	Speed/position switching enabled	○	×	×	×	×			
6	Limit switch output enabled	○	×	○	○	○			3.5ms
7	Error reset	○	○	○	○	○			10ms
8	Servo error reset	○	×	×	×	×			—
9	External STOP input valid/invalid when starting	○	×	×	×	×			
10	Unusable	—	—	—	—	—			
11	Unusable	—	—	—	—	—			
12	Feed present value update request command	○	×	×	×	×			
13	Address clutch reference setting	×	×	×	○	○			REAL to VIR-TUAL switch
14	Cam reference position setting	×	×	×	×	○			
15	Servo OFF	○	○	○	○	○			3.5ms
16	Unusable	—	—	—	—	—			—
17	Unusable	—	—	—	—	—			
18	Unusable	—	—	—	—	—			
19	FIN signal	○	×	×	×	×			—

4.1.4 Virtual servo motor axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1200 to M1219	M1200 to M1219	(○ Valid)	
2	M1220 to M1239	M1220 to M1239		
3	M1240 to M1259	M1240 to M1259		
4	M1260 to M1279	M1260 to M1279		
5	M1280 to M1299			
6	M1300 to M1319			
7	M1320 to M1339			
8	M1340 to M1359			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Positioning start completed	Backup	○	SCPU←PCPU	3.5ms	
1	Positioning completed		○			
2	Unusable		—		—	
3	Command in-position		○		3.5ms	
4	Speed control in progress		○			
5	Unusable		—		—	
6	Unusable		—			
7	Error detection		○		Immediately	
8	Unusable		—		—	
9	Unusable		—			
10	Unusable		—			
11	Unusable		—			
12	Unusable		—			
13	Unusable		—			
14	Unusable		—			
15	Unusable		—			
16	Unusable		—			
17	Unusable		—			
18	Unusable		—			
19	M code output in progress		○		3.5ms	

4.1.5 Virtual servo motor axis command signals

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1400 to M1419	M1400 to M1419	(○ Valid)	
2	M1420 to M1439	M1420 to M1439		
3	M1440 to M1459	M1440 to M1459		
4	M1460 to M1479	M1460 to M1479		
5	M1480 to M1499			
6	M1500 to M1519			
7	M1520 to M1539			
8	M1540 to M1559			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Stop command	×	○	SCPU→PCPU		3.5ms
1	Rapid stop command					
2	Forward JOG start					10ms
3	Reverse JOG start					
4	End signal OFF command					
5	Unusable	—	—			—
6	Unusable					
7	Error reset	×	○			10ms
8	Unusable	—	—			—
9	External STOP input valid/invalid when starting	×	○			Start timing
10	Unusable	—	—			—
11	Unusable					
12	Unusable					
13	Unusable					
14	Unusable					
15	Unusable					
16	Unusable					
17	Unusable					
18	Unusable					
19	FIN signal	×	○			3.5ms

4.1.6 Synchronous encoder axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1360 to M1363	M1360 to M1363	(○ Valid)	

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error detection	○	○	SCPU←PCPU	Immediately	
1	External signal TREN	○	○		10ms	
2	Virtual mode intermittent actuation disabled warning	○	○			
3	Unusable	—	—		—	

4.1.7 Synchronous encoder axis command signals

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	M1560 to M1563	M1560 to M1563	(○ Valid)	

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error reset	×	○	SCPU→PCPU		10ms
1	Unusable	—	—			—
2	Unusable					
3	Unusable					

4.1.8 Common devices

A172SHCPU

Device Number	Signal Name				(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
M1960	Unusable (24 points)				—	—		—	—
M1961									
M1962									
M1963									
M1964									
M1965									
M1966									
M1967									
M1968									
M1969									
M1970									
M1971									
M1972									
M1973									
M1974									
M1975									
M1976									
M1977									
M1978									
M1979									
M1980									
M1981									
M1982									
M1983									
M1984	Output axis 1	Main shaft side	Clutch status		Backup	○	SCPU← PCPU	3.5ms	
M1985		Auxiliary input axis side							
M1986	Output axis 2	Main shaft side							
M1987		Auxiliary input axis side							
M1988	Output axis 3	Main shaft side							
M1989		Auxiliary input axis side							
M1990	Output axis 4	Main shaft side							
M1991		Auxiliary input axis side							
M1992	Output axis 5	Main shaft side							
M1993		Auxiliary input axis side							
M1994	Output axis 6	Main shaft side							
M1995		Auxiliary input axis side							
M1996	Output axis 7	Main shaft side							
M1997		Auxiliary input axis side							
M1998	Output axis 8	Main shaft side							
M1999		Auxiliary input axis side							
M2000	PC READY flag				○	○	SCPU→ PCPU		10ms
M2001	Axis 1	Start accept flag (8 points)			○	○	SCPU← PCPU	10ms	
M2002	Axis 2								
M2003	Axis 3								
M2004	Axis 4								
M2005	Axis 5								
M2006	Axis 6								
M2007	Axis 7								
M2008	Axis 8								
M2009	All-axes servo ON accept flag								
M2010	Unusable (2 points)				—	—		—	—
M2011									
M2012	Manual pulse generator 1 enabled				○	×	SCPU→ PCPU		10ms
M2013	Unusable (2 points)				—	—		—	—
M2014									
M2015	JOG simultaneous start command				○	○	SCPU→ PCPU		10ms
M2016	Unusable (4 points)				—	—		—	—
M2017									
M2018									
M2019									
M2020	START buffer full				○	○	SCPU← PCPU	END	
M2021	Axis 1	Speed change in progress flag (8 points)							
M2022	Axis 2								
M2023	Axis 3								
M2024	Axis 4								
M2025	Axis 5								
M2026	Axis 6								
M2027	Axis 7								
M2028	Axis 8								
M2029	Unusable (6 points)				—	—		—	—
M2030									
M2031									
M2032									
M2033									
M2034	PC link communication error flag				○	○	SCPU← PCPU	END	
M2035	Unusable (5 points)				—	—		—	—
M2036									
M2037									
M2038									
M2039									

A171SHCPU

Device Number	Signal Name				(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle	Reference Item
M1960	Unusable (24 points)				—	—		—	—	
M1961										
M1962										
M1963										
M1964										
M1965										
M1966										
M1967										
M1968										
M1969										
M1970										
M1971										
M1972										
M1973										
M1974										
M1975										
M1976										
M1977										
M1978										
M1979										
M1980										
M1981										
M1982										
M1983										
M1984	Output axis 1	Main shaft side	Clutch status		Backup	○	SCPU← PCPU	3.5ms		
M1985		Auxiliary input axis side								
M1986	Output axis 2	Main shaft side								
M1987		Auxiliary input axis side								
M1988	Output axis 3	Main shaft side								
M1989		Auxiliary input axis side								
M1990	Output axis 4	Main shaft side								
M1991		Auxiliary input axis side								
M1992	Unusable (8 points)				—	—		—	—	
M1993										
M1994										
M1995										
M1996										
M1997										
M1998										
M1999										
M2000	PC READY flag				○	○	SCPU→ PCPU		10ms	Section 4.1.8
M2001	Axis 1	Start accept flag (4 points)			○	○	SCPU← PCPU	10ms		
M2002	Axis 2									
M2003	Axis 3									
M2004	Axis 4									
M2005	Unusable (4 points)				—	—		—	—	
M2006										
M2007										
M2008										
M2009	All-axes servo ON accept flag				○	○	SCPU← PCPU	10ms		
M2010	Unusable (2 points)				—	—		—	—	
M2011										
M2012	Manual pulse generator 1 enabled				○	×	SCPU→ PCPU		10ms	
M2013	Unusable (2 points)				—	—		—	—	
M2014										
M2015	JOG simultaneous start command				○	○	SCPU→ PCPU		10ms	
M2016	Unusable (4 points)				—	—		—	—	
M2017										
M2018										
M2019										
M2020	START buffer full				○	○	SCPU← PCPU	END		
M2021	Axis 1	Speed change in progress flag (4 points)								
M2022	Axis 2									
M2023	Axis 3									
M2024	Axis 4									
M2025	Unusable (9 points)				—	—		—	—	
M2026										
M2027										
M2028										
M2029										
M2030										
M2031										
M2032										
M2033										
M2034	PC link communication error flag				○	○	SCPU← PCPU	END		
M2035	Unusable (5 points)				—	—		—	—	
M2036										
M2037										
M2038										
M2039										

* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

A172SHCPU

Device Number	Signal Name	(O Valid)		Signal Direction	Refresh Cycle	Fetch Cycle
		REAL	VIRTUAL			
M2040	CPU completion point setting	○	○	SCPU→ PCPU		Start timing
M2041	System setting error flag	○	○	SCPU← PCPU	END	
M2042	All-axes servo ON command	○	○	SCPU→ PCPU		3.5ms
M2043	REAL/VIRTUAL mode switching request	○	○			10ms
M2044	REAL/VIRTUAL mode switching status	○	○	SCPU← PCPU	END	
M2045	REAL/VIRTUAL mode switching error	○	○			
M2046	Synchronization discrepancy warning	○	○			
M2047	Motion slot module error detection flag	○	○			

A171SHCPU

Device Number	Signal Name	(O Valid)		Signal Direction	Refresh Cycle	Fetch Cycle	Reference Item
		REAL	VIRTUAL				
M2040	CPU completion point setting	○	○	SCPU→ PCPU		Start timing	Section 4.1.8
M2041	System setting error flag	○	○	SCPU← PCPU	END		
M2042	All-axes servo ON command	○	○	SCPU→ PCPU		3.5ms	
M2043	REAL/VIRTUAL mode switching request	○	○			10ms	
M2044	REAL/VIRTUAL mode switching status	○	○	SCPU← PCPU	END		
M2045	REAL/VIRTUAL mode switching error	○	○				
M2046	Synchronization discrepancy warning	○	○				
M2047	Motion slot module error detection flag	○	○				

* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

(1) PC READY flag (M2000).....Signal sent from SCPU to PCPU

(a) This signal notifies the PCPU that SCPU operation is normal. It is switched ON and OFF by the sequence program.

1) When M2000 is ON, positioning or home position return functions can be executed by the servo program specified by the sequence program, and JOG operations can be executed by the sequence program.

2) When M2000 is OFF, and when a TEST mode has been established ("M9075" TEST mode in progress flag is ON)* from a peripheral device, the functions described at item (a) above will be inoperative even if M2000 is switched ON.

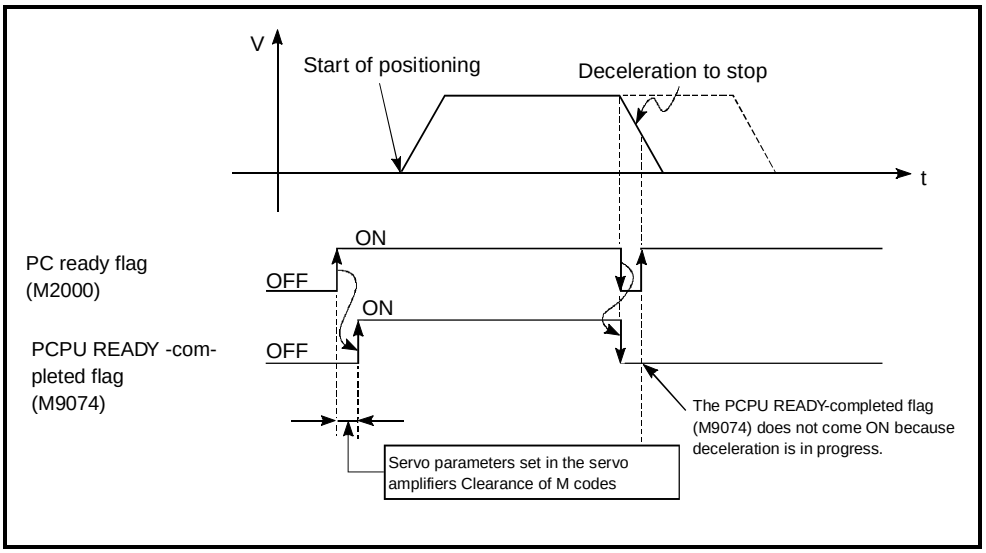
(b) The fixed parameters, servo parameters, and limit switch output parameters can only be changed using a peripheral device when M2000 is OFF.
If an attempt is made to change this data while M2000 is ON, an error will occur.

(c) When M2000 is switched from OFF to ON, the following processing occurs.

1) Processing details
- The servo parameters are transferred to the servo amplifier.
- The M code storage area for all axes is cleared.
- The default value of 300% is set in the torque limit value storage area.
- The PCPU READY-completed flag (M9074) * is turned ON.

2) If there is an axis currently being driven, an error occurs, and the processing in (3), (a) above is not executed.

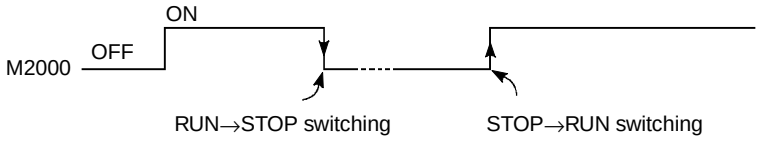
3) While the test mode is in effect, the processing in (3), (a) above is not executed.
When the test mode is cancelled, the processing in (3), (a) will be executed if M2000 is ON.



(d) When M2000 turns OFF, the following processing is executed.
1) Processing details
- The PCPU READY flag (M9074) is turned OFF.
- Operating axes are decelerated to a stop.

POINT

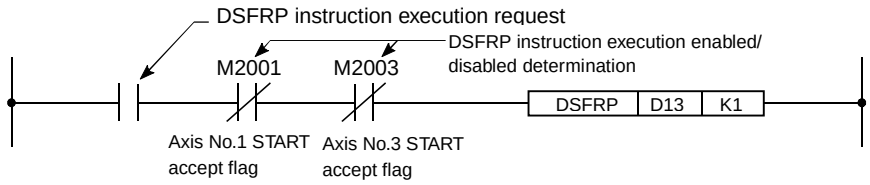
The PC READY flag (M2000) switches OFF when a servo system CPU "STOP" status exists. When the RUN status is resumed, the status which existed prior to the STOP will be re-established.



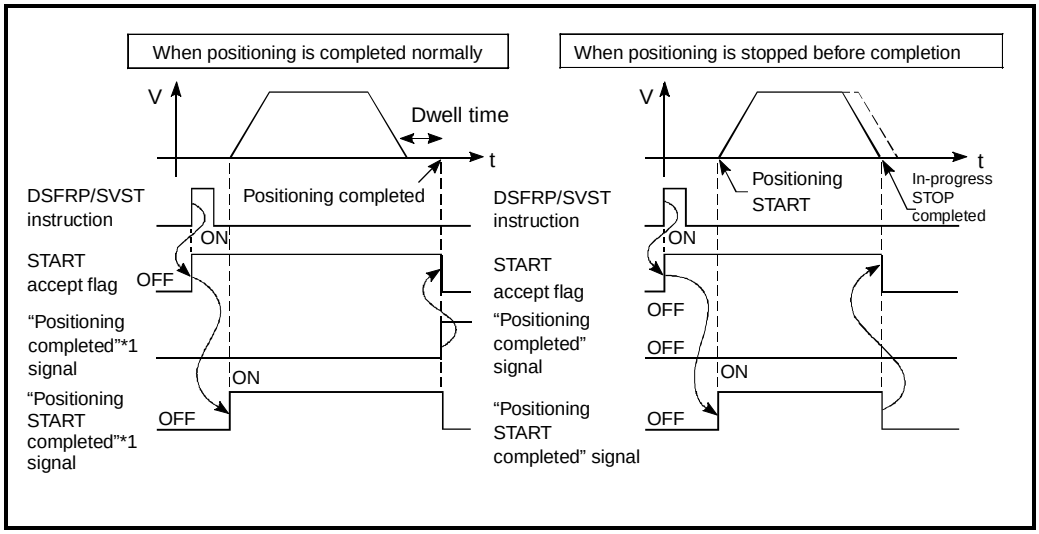
(2) Virtual servomotor START accept flags (M2001 + n)
.....Signals from PCPU to SCPU

(a) The START accept flag switches ON when the sequence program's positioning START instruction (DSFRP/SVST)*2 is executed, and should be used for DSFRP/SVST enabled/disabled interlock purposes.

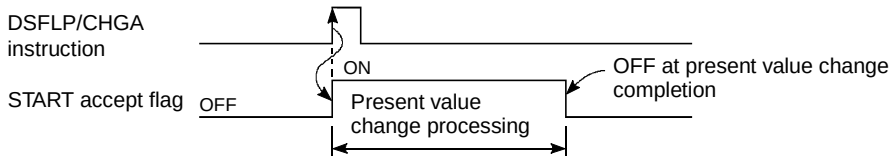
When requesting servo program execution for positioning at axes 1 and 3, the following START accept flags are used.



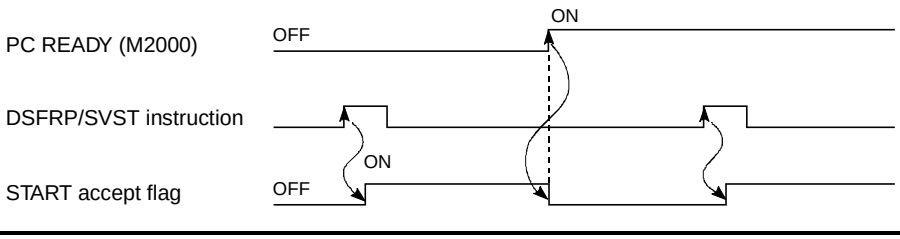
(b) START accept flag ON/OFF processing occurs as shown below.
1) When the sequence program's DSFRP/SVST instruction is executed, the START accept flag for the axis specified by the DSFRP/SVST instruction switches ON.
The START accept flag switches OFF when positioning is completed.
The START accept flag also switches OFF if positioning is stopped before completion.



2) When executing positioning by switching the JOG instruction ON, the START accept flag will switch OFF when positioning is stopped by a JOG instruction OFF.
3) The START accept flag is ON when the manual pulse generator is enabled (M2012:ON), and is OFF when the manual pulse generator is disabled (M2012:OFF).
4) The START accept flag is ON during a present value change being executed by a sequence program DSFLP/CHGA instruction.
The START accept flag will switch OFF when the present value change is completed.



5) When M2000 is OFF, execution of a DSFRP/SVST instruction *2 causes the start accept flag to come ON; the flag goes OFF when M2000 comes ON.



CAUTION

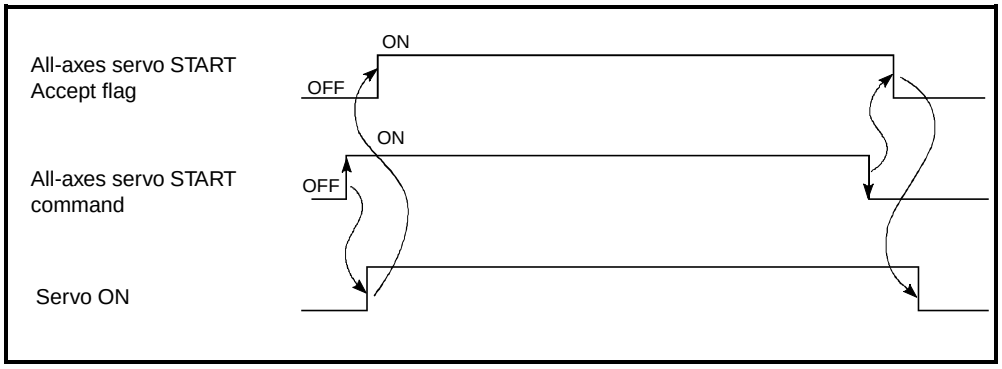
⚠ The user must not turn start accept flags ON/OFF.
- If a start accept flag that is ON is switched OFF with the sequence program or a peripheral device, no error will occur but the positioning operation will not be reliable. Depending on the type of machine, it might operate in an unanticipated manner.
- If a start accept flag that is OFF is switched ON with the sequence program or a peripheral device, no error will occur at that time, but the next time an attempt is made to start the axis a start accept flag ON error will occur and the axis will not start.

(3) All-Axes servo START accept flag (M2009)

.....Signal sent from PCPU to SCPU

The all-axes servo START flag indicates that servo operation is possible.

- ON.....Servo is operative.
- OFF.....Servo is inoperative.



(4) Manual pulse generator enabled flag (M2012)

.....Signal sent from SCPU to PCPU

The manual pulse generator flag designates the enabled/disabled status for positioning executed by pulse inputs from manual pulse generators connected to the A172SENC/A171SENC PULSER.

- ON.....Positioning control by manual pulse generator inputs is enabled.
- OFF.....Positioning control by manual pulse generator inputs is disabled (inputs are ignored).

(5) JOG simultaneous START command (M2015)

.....Signal sent from SCPU to PCPU

(a) When M2015 switches ON, a JOG simultaneous START will occur at the JOG execution axis (axes 1 to 8/axes 1 to 4) designated at the JOG Simultaneous START Axis Area(D1015).

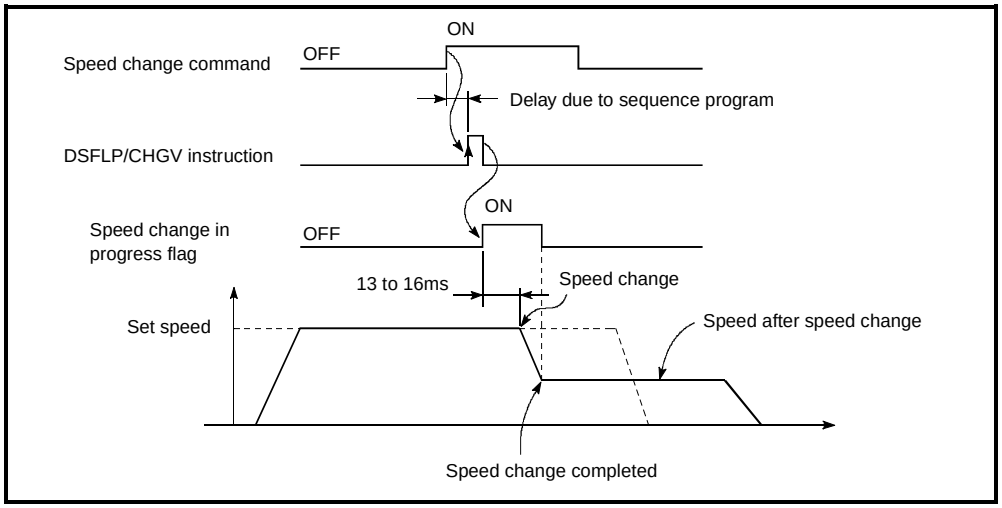
(b) When M2015 switches OFF, the JOG axis motion will decelerate and stop.

(6) START buffer full (M2020).....Signal sent from PCPU to SCPU

(a) This signal switches ON when the PCPU fails to process the specified data within 15 seconds following a positioning START (DSFRP/SVST) instruction or a control change (DSFLP/CHGA/CHGV) instruction from the sequence program.

(b) An M2020 reset must be executed from the sequence program.

(7) Speed change in progress flag (M2021 to M2028/M2021 to M2024)
.....Signal sent from PCPU to SCPU
This flag switches ON when a speed change (designated by a control change (DSFLP/ CHGV) instruction at the sequence program) is in progress. This flag should be used for speed change program interlock purposes.



(8) PC link communication error flag (M2034)
This flag comes ON when an error occurs during personal computer linking communication. When M2034 comes ON the error code is stored in the personal computer link communication error code storage register (D9196). The devices dedicated to personal computer communication are indicated below.

Table 9.1 PC link communication device list

Device Name	Contents	Device Number		
		A273UHCPU (32 axes)	A273UHCPU (8 axes)	A171SCPU-S3
PC link communication error flag	OFF: No PC link communication error ON : PC link communication error detected (Flag changes to OFF if normal communication is restored.)	M2034	M2034	M2034
PC link communication error codes	00: No error 01: Receiving timing error 02: CRC error 03: Communication response code error 04: Receiving frame error 05: Communication task start error (Error codes are reset to 00 by normal communication restart.)	D9196	D9196	D9196

Table 9.2 PC link communication error code list

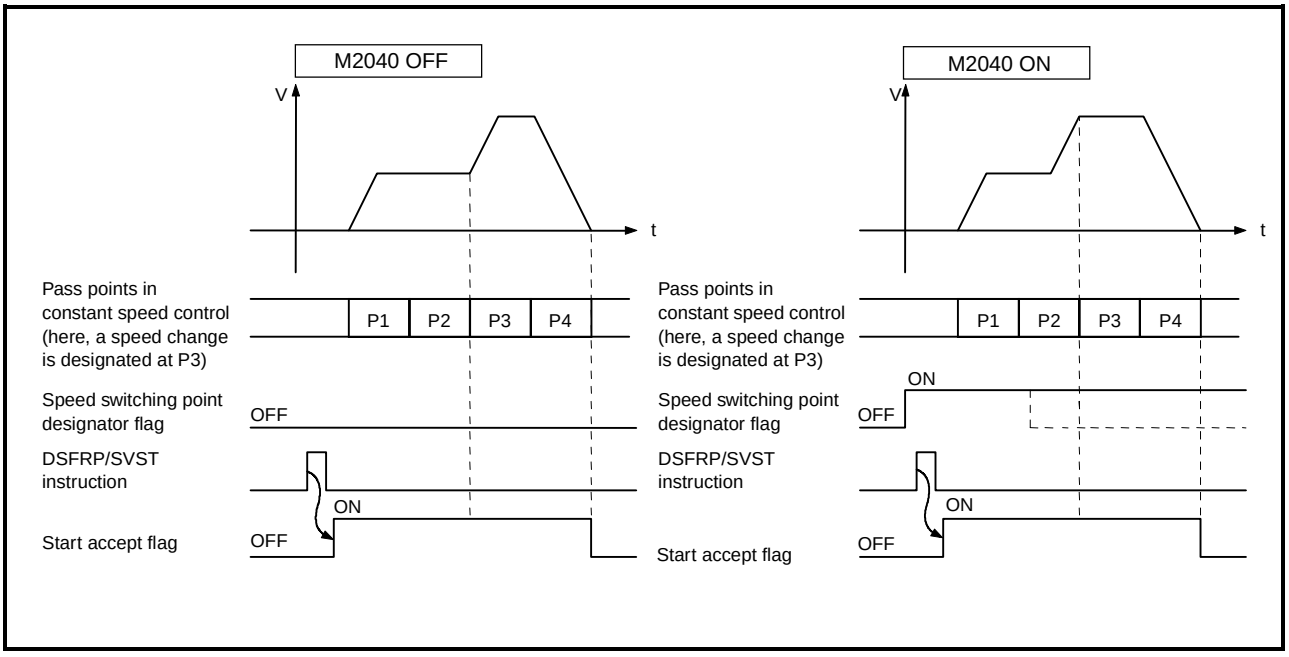
Error Codes stored in D9196	Error Contents	Correction Method
01	PC link communication receiving packet did not arrive. Receiving packet arrival timing was late.	· Confirm that the personal computer power is on. · Check the communication cable connection. · Check for communication cable burnout. · Confirm that A30BD-PCF/A30CD-PCF is properly placed.
02	The receiving packet CRC code is incorrect.	· Confirm that there is nothing causing noise in the vicinity. · Check the communication cable connection. · Check for communication cable burnout.
03	The receiving packet data ID is incorrect.	· Confirm that A30BD-PCF/A30CD-PCF is properly placed. · Replace the A30BD-PCF/A30CD-PCF.
04	The number of the frame received is incorrect.	· Check the communication cable connection. · Check for communication cable burnout. · Confirm that there is nothing causing noise in the vicinity.
05	The communication task on the personal computer side has not been started.	· Start the communication task on the personal computer side.

(9) Speed switching point designation flag (M2040)

.....Signal sent from SCPU to PCPU

The speed switching point designation flag is used when a speed change is designated at the pass point in constant speed control.

(a) By turning M2040 ON before the start of constant speed control (before the servo program is started using the DSFRP/SVST instruction), control can be executed with a speed change at the start of the pass point.



(b) After completion of start accept processing, the speed switching point designation flag can be turned OFF at any time.

(10) System setting error flag (M2041).....Signal sent from PCPU to SCPU
When the power is switched ON, or when the servo system CPU is reset, the system setting data set with a peripheral device is input, and a check is performed to determine if the set data matches the module mounting status (of the main base unit and extension base units).
- ON.....Error
- OFF.....Normal

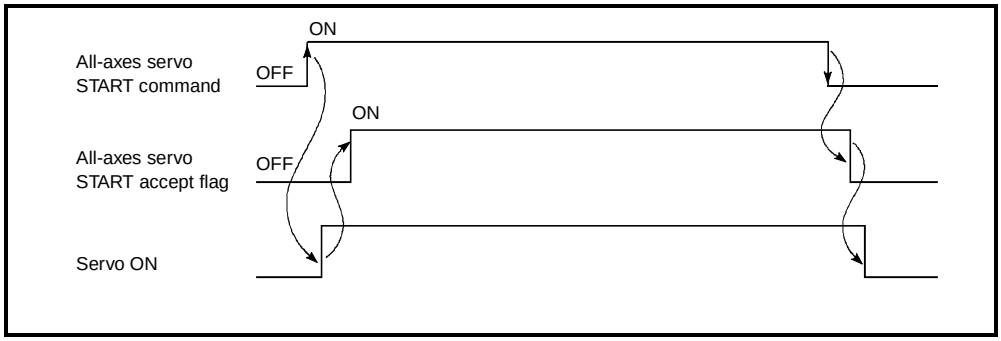
(a) The ERROR LED on the front of the CPU will switch ON when an error occurs. Moreover, a log of errors which have occurred can be referred to at a peripheral device (device running SW2SRX/SW2NX-GSV22P).

(b) Positioning cannot be started when M2041 is ON. To start the positioning operation, eliminate the error cause, and either switch the power back ON or execute a servo system CPU reset.

REMARK

A slot designated as "not used" at the system setting data will be regarded as "not used" even if loaded with a module.

(11) All-axes servo START command (M2042) .....Signal sent from SCPU to PCPU
This signal is used to enable servo operation.
- Servo operation ENABLED .....When M2042 is switched ON, the servo OFF signal is OFF, and there are no active servo errors.
- Servo operation DISABLED .....When M2042 switches ON, the servo OFF signal is ON, or a servo error is detected.



POINT

Once M2042 is switched ON, it will not switch OFF even if the CPU is stopped.

(12) REAL/VIRTUAL mode switching request flag (M2043)

.....Signal sent from SCPU to PCPU

This flag is used for switching between the REAL and VIRTUAL modes.

(a) To switch from the REAL to the VIRTUAL mode, turn M2043 ON after the M9074 PCPU READY flag comes ON.

- An error check occurs when M2043 is switched from OFF to ON. If no error is detected, switching to the VIRTUAL mode occurs, and the M2044 REAL/VIRTUAL Mode Determination flag switches ON.
- If an error is detected, switching to the VIRTUAL mode will not occur. In this case, the M2045 REAL/VIRTUAL Mode Switching Error flag will switch ON, and the error code will be stored at the D9195 error code storage error.

(b) To switch from the VIRTUAL to the REAL mode, turn M2043 OFF.

- If an "all-axes stopped" status exists at the virtual servomotors, switching to the REAL mode will occur, and M2044 will go OFF.
- Switching to the REAL mode will not occur if any of the virtual servomotor axes are in motion. In this case, M2045 will switch ON, and an error code will be stored at the D9195 error code storage error.

(c) For details regarding the procedure for switching between the REAL and VIRTUAL modes, see Chapter 9.

(13) REAL/VIRTUAL mode status flag (M2044)

.....Signal sent from PCPU to SCPU

This flag verifies that switching between the REAL and VIRTUAL modes is completed, and verifies the present mode.

- OFF when the REAL mode is in effect, and switching from the VIRTUAL to REAL mode is completed.
- ON when switching from REAL to VIRTUAL mode is completed.

This flag should be used as an interlock function when executing a servo program START or a control change (speed change, present value change).

(14) REAL/VIRTUAL mode switching error detection flag (M2045)

.....Signal sent from PCPU to SCPU

This flag indicates whether or not an error was detected when switching between the REAL and VIRTUAL modes.

- Remains OFF if no error was detected at mode switching.
- Switches ON if an error was detected at mode switching.

In this case, the error code will be stored at D9195.

(15) Synchronization discrepancy warning flag (M2046)
.....Signal sent from PCPU to SCPU

(a) This signal switches ON in the VIRTUAL mode when a discrepancy occurs between the drive module and output module synchronized positions. This signal status determines whether or not drive module operation can be resumed after it has stopped.
- M2046: ON .....Continued operation disabled
- M2046: OFF .....Continued operation enabled

(b) The synchronization discrepancy warning flag will switch ON when the following conditions occur.
- When operation is stopped by an external emergency stop (EMG) command.
- When a servo error occurs at the output module.

(c) When the synchronization discrepancy warning flag switches ON, operation can be resumed by the following procedure.
1) Return to the REAL mode and eliminate the error cause.
↓
2) Synchronize the axes.
↓
3) Switch the synchronization discrepancy warning flag (M2046) OFF.
↓
4) Switch to the VIRTUAL mode.
↓
5) Resume operation.

(16) Motion slot module error detection flag (M2047)
.....Signal sent from PCPU to SCPU

This flag indicates whether the status of modules mounted at the base unit and extension base units is normal or abnormal.
- ON.....Status of mounted module is abnormal
- OFF .....Status of mounted module is normal

Module information is checked for errors both when the power is switched ON and after the power has been switched ON.

(a) When M2047 switches ON, the A172SHCPU/A171SHCPU "ERROR" LED switches ON.

(b) Required processing when an error is detected (axis STOP, servo OFF, etc.) should be conducted at the sequence program.

POINT
Positioning control will continue even if an error is detected at an optional slot.

4. SERVO SYSTEM CPU DEVICES

4.2 Data Registers

4.2.1 Data register list

A172SHCPU (○ Valid)

Device No.	Classification	REAL	VIRTUAL
D0	User devices (670 points)		
D670	Virtual servo motor axes main shaft (*2) differential gear present value (2 points × 8 axes) (4)	Back up	○
D686	Synchronous encoder axis main shaft (*2) differential gear present value (2 points × 1 axis) (6)	Back up	○
D688	Unusable (12 points)		
D700	Virtual servo motor axes (*2) monitor devices (6 points × 8 axes) (3)	Back up	○
D748	Synchronous encoder axis (*2) monitor device (4 points × 1 axis) (5)	Back up	○
D752	Unusable (8 points)		
D760	Cam axis monitor devices (*2) (5 points × 8 axes) (7)	Back up	○
D800	Axis monitor device (20 points × 8 axes) REAL mode..... Each axis VIRTUAL mode ..... Output modules (1)	○	○
D960	Control change registers (6 points × 8 axes) (2)	○	○
D1008 D1023	Common devices (16 points) (8)	○	○

A171SHCPU (○ Valid)

Device No.	Classification	REAL	VIRTUAL
D0	User devices (670 points)		
D670	Virtual servo motor axes main shaft (*2) differential gear present value (2 points × 4 axes) (4)	Back up	○
D678	User devices (8 points)		
D686	Synchronous encoder axis main shaft (*2) differential gear present value (2 points × 1 axis) (6)	Back up	○
D688	Unusable (12 points)		
D700	Virtual servo motor axes (*2) monitor devices (6 points × 8 axes) (3)	Back up	○
D724	User devices (24 points)		
D748	Synchronous encoder axis (*2) monitor device (4 points × 1 axis) (5)	Back up	○
D752	Unusable (8 points)		
D760	Cam axis monitor devices (*2) (5 points × 4 axes) (7)	Back up	○
D780	User devices (20 points)		
D800	Axis monitor device (20 points × 4 axes) REAL mode.....Each axis VIRTUAL mode .....Output modules (1)	○	○
D880	Unusable (80 points)		
D960	Control change registers (6 points × 4 axes)	○	○
D984	Unable (24 points)		
D1008 D1023	Common devices (16 points) (8)	○	○

POINT

(*2) The virtual servo motor axis / synchronous encoder axis / cam axis monitor device occupy only the areas of the axes set in the mechanical system program. The area of an axis that is not set in the mechanical system program can be used by the user.

· Total number of points for the user devices

A172SHCPU	670 points
A171SHCPU	722 points

4.2.2 Monitor devices of each axis

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D800 to D819	D800 to D819	(○ Valid)	
2	D820 to D839	D820 to D839		
3	D840 to D859	D840 to D859		
4	D860 to D879	D860 to D879		
5	D880 to D899			
6	D900 to D919			
7	D920 to D939			
8	D940 to D959			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value/roller cycle	○	○	SCPU←PCPU	3.5ms	
2 3	Actual present value					
4 5	Deviation counter value					
6	Minor error code				Immediately	
7	Major error code					
8	Servo error code				10ms	
9 10	Travel value when the near-zero point DOG/CHANGE is ON	○	Backup		END	
11	Home position return second travel value				3.5ms	
12	Execution program Number	○	○			
13	M code					
14	Torque limit value	○	○			
15 16	Travel value change register	○	×	SCPU→PCPU		3.5ms
17 18	Actual present value when STOP is input	○	×	SCPU←PCPU	END	
19	Data set pointer for constant speed control	○	○		At driving or during driving	

4.2.3 Control change registers

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D960 to D965	D960 to D965	(○ Valid)	
2	D966 to D971	D966 to D971		
3	D972 to D977	D972 to D977		
4	D978 to D983	D978 to D983		
5	D984 to D989			
6	D990 to D995			
7	D996 to D1001			
8	D1002 to D1007			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Present value change register	○	○	SCPU→PCPU		CHGA execution
2 3	Speed change register					CHGV execution
4 5	JOG speed setting register (*1)					At driving

(*1) Represents a backup register.

*The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

4.2.4 Virtual servo motor axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D700 to D705	D700 to D705	(○ Valid)	
2	D706 to D711	D706 to D711		
3	D712 to D717	D712 to D717		
4	D718 to D723	D718 to D723		
5	D724 to D729			
6	D730 to D735			
7	D736 to D741			
8	D742 to D747			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
01	Feed present value	Backup	○	SCPU←PCPU	3.5 ms	
2	Minor error code				Immediately	
3	Major error code					
4	Execution program Number				3.5 ms	
5	M code					

4.2.5 Virtual servo motor axis main shaft differential gear present value

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D760 D671	D760 D671	(○ Valid)	
2	D672 D673	D672 D673		
3	D674 D675	D674 D675		
4	D676 D677	D676 D677		
5	D678 D679			
6	D680 D681			
7	D682 D683			
8	D684 D685			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
01	Virtual servo motor axis main shaft differential gear present value	Backup	○	SCPU←PCPU	3.5 ms	

4.2.6 Synchronous encoder axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D748 to D751	D748 to D751	•○ Valid•	

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value	Backup	○	SCPU←PCPU	3.5ms	
2	Minor error code	○ (*2)			Immediately	
3	Major error code					

(*2) Set when the controller power is turned on only in the case of an absolute synchronous encoder.

4.2.7 Synchronous encoder axis main shaft differential gear present value

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D686 D687	D686 D687	•○ Valid•	

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Synchronous encoder axis main shaft differential gear present value	Backup	○	SCPU←PCPU	3.5ms	

4.2.8 Cam axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name	Reference Item
1	D760 to D764	D760 to D764	•○ Valid•	
2	D765 to D769	D765 to D769		
3	D770 to D774	D770 to D774		
4	D775 to D779	D775 to D779		
5	D780 to D784			
6	D785 to D789			
7	D790 to D794			
8	D795 to D799			

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Execution cam No.	Backup	○	SCPU←PCPU	Every END	
1 2	Execution stroke value					
3 4	Cam axis present value within one revolution					

* "Every END" of the refresh cycle is referred to as the sequence program scan time.

4.2.9 Common devices

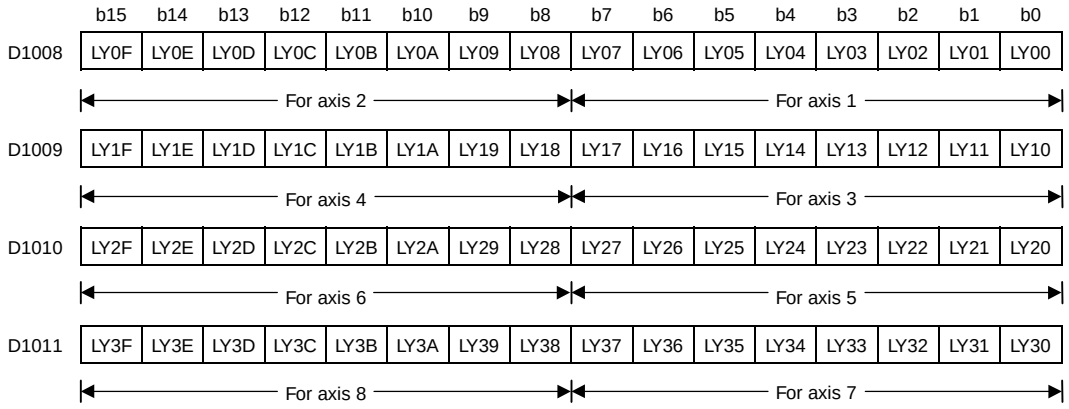
- A172SHCPU

Device No.	Signal Name		(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle	Reference Item
D1008	Limit switch output disabled setting register (4 points)		○	○	SCPU→PCPU		3.5ms	Section 4.2.9
D1009								
D1010								
D1011								
D1012	Setting Register for a axis number controlled with manual pulse generator 1						Manual pulse generator operation enabled	
D1013	Unusable (2 points)		——	——		——	——	
D1014								
D1015	JOG operation simultaneous start axis setting register		○	○	SCPU→PCPU		At driving	
D1016	Axis 1	1 pulse input modification setting register for manual pulse generators (8 points)					Manual pulse generator operation enabled	
D1017	Axis 2							
D1018	Axis 3							
D1019	Axis 4							
D1020	Axis 5							
D1021	Axis 6							
D1022	Axis 7							
D1023	Axis 8							

- A171SHCPU

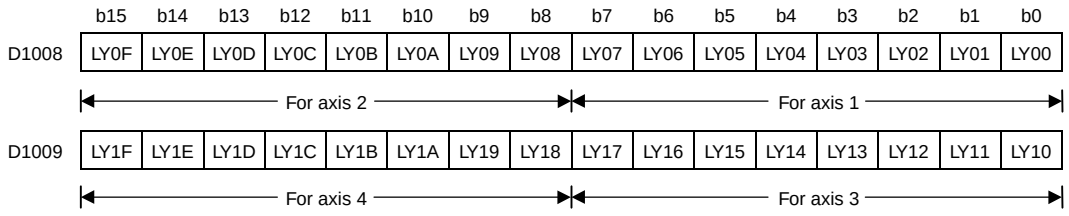
Device No.	Signal Name		(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle	Reference Item
D1008	Limit switch output disabled setting register (2 points)		○	○	SCPU→PCPU		3.5ms	Section 4.2.9
D1009								
D1010	Unusable (2 points)		——	——		——	——	
D1011								
D1012	Setting Register for a axis number controlled with manual pulse generator 1		○	○	SCPU→PCPU		Manual pulse generator operation enabled	
D1013	Unusable (2 points)		——	——		——	——	
D1014								
D1015	JOG operation simultaneous start axis setting register		○	○	SCPU→PCPU		At driving	
D1016	Axis 1	1 pulse input modification setting register for manual pulse generator (4 points)					Manual pulse generator operation enabled	
D1017	Axis 2							
D1018	Axis 3							
D1019	Axis 4							
D1020	Unusable (4 points)		——	——		——	——	
D1021								
D1022								
D1023								

(1) Limit switch output disabled setting registers (D1008 to D1011/D1008 to D1009)
..... Data sent from SCPU to PCPU
This register is used to disable (in 1-point units) external output of limit switch outputs.
Limit switch output is disabled by setting its corresponding bit to "1" (external output OFF).
(a) When A172SHCPU is used



(1) Each bit setting is designated as "1" or "0".
1: Disable ..... Limit switch output remains OFF.
0: Enable..... Limit switch output turns ON and OFF in accordance with the set data.
(2) The "LY" of LY00 to LY3F indicates the limit switch output.

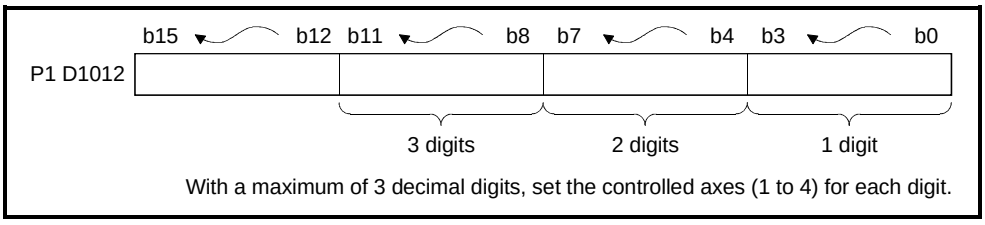
(b) When A171SHCPU is used



(1) Each bit setting is designated as "1" or "0".
1: Disable ..... Limit switch output remains OFF.
0: Enable ..... Limit switch output turns ON and OFF in accordance with the set data.
(2) The "LY" of LY00 to LY1F indicates the limit switch output.

(2) Register for setting virtual servo motor axis numbers controlled by manual pulse generators (D1012) ..... Data from the SCPU to the PCPU

(a) The register stores the virtual servo motor axis numbers controlled by manual pulse generators.

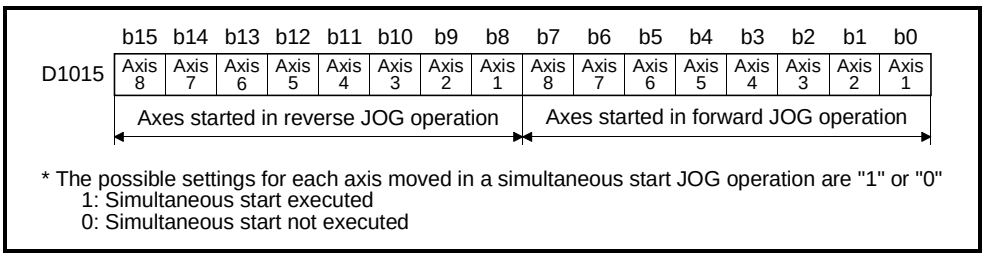


(b) For details on manual pulse generator operation, refer to section 7.20 of the Motion Controller (SV13/SV22 REAL mode) Programming Manual.

(3) JOG operation simultaneous start axes setting register (D1015) ..... Data from the SCPU to the PCPU

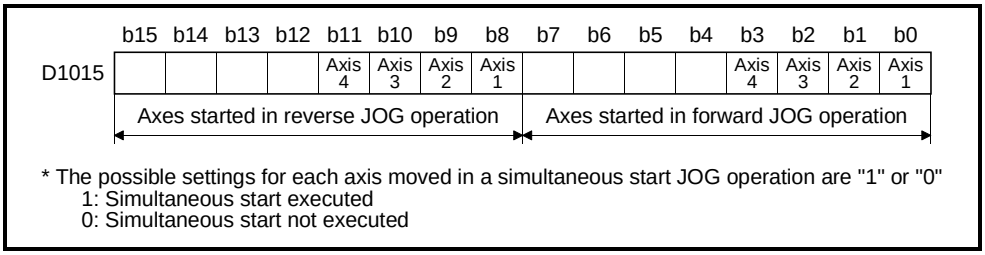
(a) This register is used to set the virtual servo motor axis numbers on which JOG operation is to be executed, and the direction of motion.

<A172SHCPU>



* The possible settings for each axis moved in a simultaneous start JOG operation are "1" or "0"
  1: Simultaneous start executed
  0: Simultaneous start not executed

<A171SHCPU>



* The possible settings for each axis moved in a simultaneous start JOG operation are "1" or "0"
  1: Simultaneous start executed
  0: Simultaneous start not executed

(b) For details on simultaneous starting in JOG operation, refer to section 7.19.3 of the Motion Controller (SV13/SV22 REAL mode) Programming Manual.

(4) 1 pulse input magnification setting registers for manual pulse generators (D1016 to D1023/D1016 to D1019) ..... Data from the SCPU to the PCPU

(a) This register is used to set the magnification (from 1 to 100) per pulse for the number of input pulses from a manual pulse generator in manual pulse generator operation.

<A172SHCPU>

1-pulse Input Magnification Setting Register	Corresponding Virtual Servo Motor Axis No.	Setting Range
D1016	Axis 1	1 to 100
D1017	Axis 2	
D1018	Axis 3	
D1019	Axis 4	
D1020	Axis 5	
D1021	Axis 6	
D1022	Axis 7	
D1023	Axis 8	

<A171SHCPU>

1-pulse Input Magnification Setting Register	Corresponding Virtual Servo Motor Axis No.	Setting Range
D1016	Axis 1	1 to 100
D1017	Axis 2	
D1018	Axis 3	
D1019	Axis 4	

(b) For details on the manual pulse generator operation, refer to section 7.20 of the Motion Controller (SV13/SV22 REAL mode) Programming Manual.

4.3 Special Relays/Special Registers List

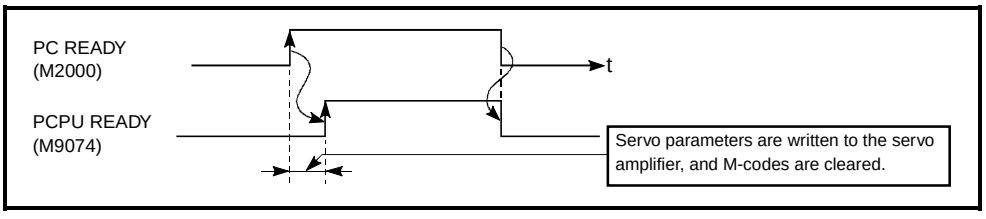
4.3.1 Special relays

Device No.	Signal Name	(O Valid)		Signal Direction	Refresh Cycle	Fetch Cycle
		REAL	VIRTUAL			
M9073	PCPU WDT error flag					
M9074	PCPU READY flag					
M9075	TEST mode ON flag					
M9076	External emergency stop input flag	O	O	SCPU←PCPU	END	
M9077	Manual pulse generator axis setting error flag					
M9078	TEST mode request flag					
M9079	Servo program setting error flag					

(1) WDT error flag (M9073).....Signal sent from PCPU to SCPU
This flag switches ON when a "watchdog timer error" is detected by the PCPU's self- diagnosis function. When the PCPU detects a WDT error, it executes an immediate stop without deceleration of the driven axes.
If the WDT error flag switches ON, press the servo system CPU's [RESET] key to execute a reset.
If M9073 remains ON after a reset occurs, there is a PCPU malfunction. The error cause is stored in the "PCPU error cause (D9184)" storage area (see Section 4.5.2).

(2) PCPU READY flag (M9074).....Signal sent from PCPU to SCPU
This flag is used to determine (at the sequence program) if the PCPU is normal or abnormal.
(a) When the PC READY flag (M2000) turns from OFF to ON, the fixed parameters, servo parameters, limit switch output data, etc., are checked, and if no error is detected the PCPU READY-completed flag comes ON. The servo parameters are written to the servo amplifiers and the M codes are cleared.

(b) The PCPU READY flag switches OFF when the PC READY (M2000) signal switches OFF.



(3) TEST mode ON flag (M9075).....Signal sent from PCPU to SCPU
(a) This flag status indicates whether a TEST mode established from a peripheral device is currently in effect. It can be used as an interlock function when starting the servo program by a sequence program DSFRP/SVST instruction.
- OFF..... TEST mode is not in effect.
- ON ..... TEST mode is in effect.

(b) If the TEST mode is not established in response to a TEST mode request from a peripheral device, the "TEST mode request error flag (M9078)" will switch ON.

(4) External emergency stop input flag (M9076)
.....Signal sent from PCPU to SCPU
This flag status indicates whether the external emergency stop input to the power module's EMG terminal is ON or OFF.
- OFF .....External emergency stop input is ON.
- ON .....External emergency stop input is OFF.

(5) Manual Pulse Generator Axis Setting Error Flag (M9077)
.....Signal sent from PCPU to SCPU
(a) This flag indicates whether the setting designated at the manual pulse generator axis setting register (D1012) is normal or abnormal.
- OFF..... All D1012 settings are normal.
- ON ..... At least one D1012 setting is abnormal.

(b) When M9077 switches ON, the error content is stored at the manual pulse generator axis setting error register (D9187).

(6) TEST Mode Request Error Flag (M9078).....Signal sent from PCPU to SCPU
(a) This flag switches ON if the TEST mode is not established in response to a TEST mode request from a peripheral device.

(b) When M9078 switches ON, the error content is stored at the manual pulse generator axis setting error register (D9188).

(7) Servo Program Setting Error Flag (M9079) .....Signal sent from PCPU to SCPU
This flag status indicates whether the positioning data at the servo program designated by the DSFRP/SVST instruction is normal or abnormal.
- OFF .....Normal
- ON .....Abnormal

The content of a servo program error is stored at D9189 and D9190.

4.3.2 Special registers

Device No.	Signal Name	(○ Valid)		Signal Direction	Refresh Cycle	Fetch Cycle
		REAL	VIRTUAL			
D9180	Limit switch output status storage area	○	○	SCPU←PCPU	3.5ms	
D9181						
D9182						
D9183						
D9184	PCPU WDT error cause				10ms	
D9185	Servo amplifier type					
D9186						
D9187	Manual pulse generator axis setting error				Manual pulse generator operation enabled	
D9188	Test mode request error				TEST mode request	
D9189	Error program number				At driving	
D9190	Error item information					
D9191	Servo amplifier loading information					
D9192	Area for setting the manual pulse generator smoothing magnification	○	○	SCPU→PCPU		Manual pulse generator operation enabled
D9193	Unusable				———	———
D9194	Unusable					
D9195	REAL/VIRTUAL mode switching error information	○	○	SCPU←PCPU	Mode switching	
D9196	PC link communication error codes					
D9197	Unusable				———	———
D9198	Unusable					
D9199	Unusable					

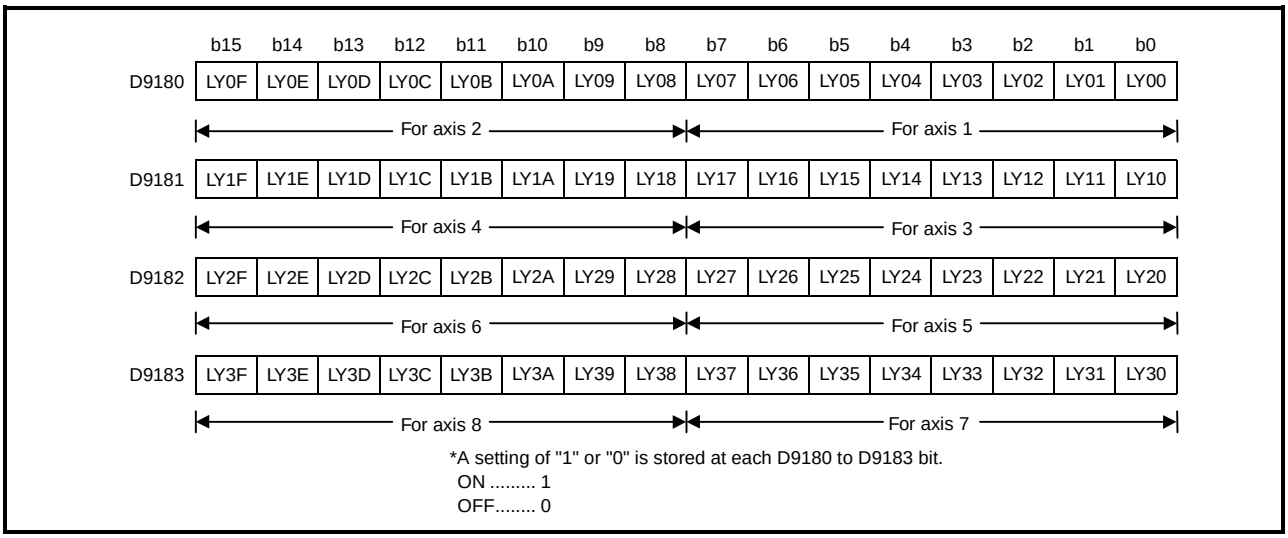
* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

(1) Limit switch output status storage area(D9180 to D9183/D9180 to D9181)
..... Data sent from PCPU to SCPU

(a) The status (ON/OFF) of limit switch outputs (designated from a peripheral device)to A1SY42 and AY42 are stored here as "1" or "0" data.
- ON 1
- OFF..... 0

(b) This area can be used to execute external outputs of limit switch output data, etc., from the sequence program.

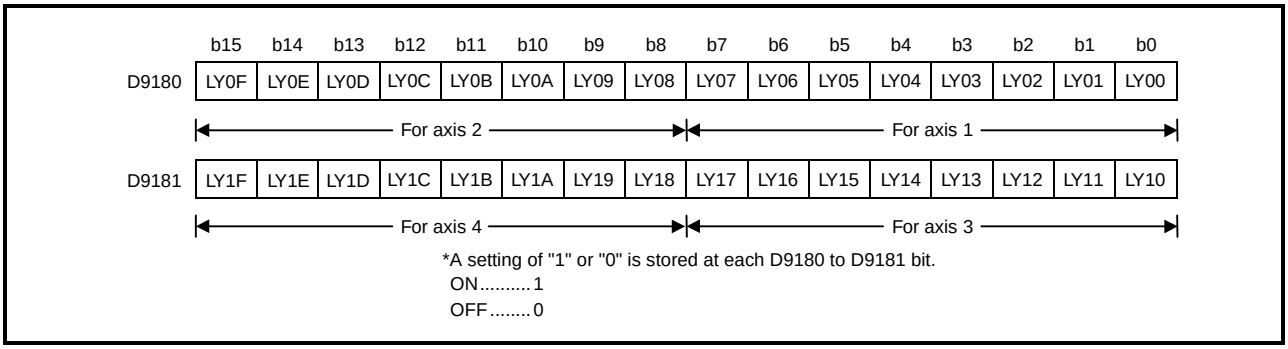
< When A172SCPU is used >



REMARK

The "LY" at the D9180 to D9183 LY [ ] [ ] items indicates a limit switch output.

< When A171SHCPU is used >



REMARK

The "LY" at the D9180-D9181 LY [ ] [ ] items indicates a limit switch output.

(2) PCPU error cause (D9184)..... Data sent from PCPU to SCPU
This register is used to identify the nature of errors occurring in the PCPU part of the servo system.

Error Code	Error Cause	Operation When Error Occurs	Action to Take
1	PCPU software error 1	All axes stop immediately, after which operation cannot be started.	Reset with the reset key.
2	PCPU operation period too long		
3	PCPU software error 2		
30	Hardware error between PCPU and SCPU		
200 201	Hardware error in module installed in the motion main base unit 2 [ ] [ ] Indicates the slot number (0 - 7) of the module where the error occurred. Base information for the module where the error occurred. 0: Main base unit		Reset with the reset key. If the error reoccurs after resetting, the relevant module or the relevant slot (base unit) is probably faulty: replace the module/ base unit.
250 251	Hardware error in SSCNET interface 2 5 [ ] SSCNET number where error occurred 0: SSCNET 1 (Amplifier connection interface) 1: SSCNET 2 (Personal computer link connection interface)		Replace the CPU unit.
300	PCPU software error 3		Reset with the reset key.
302	In defining the ROM operation mode, ROM data in the FLASH ROM is not correct (invalid registration code) when the CPU is switched on.	ROM data in the FLASH ROM is not loaded into the internal SRAM and the ROM operation mode is not set. The CPU is placed in the stopped state and is never initiated.	Check internal SPRM program parameters, then perform operations from ROM encoding to ROM operation mode setting again. If the same error recurs, the service life of the FLASH ROM is expired. Operate the CPU unit in the ROM operation mode or replace it.

(3) Servo amplifier type (D9185 · D9186)
..... Data sent from PCPU to SCPU
When a servo system CPU power ON or reset occurs, the servo amplifier type designated at the system settings will be stored.

(a) When A172SHCPU is used

	b15 to b12	b11 to b8	b7 to b4	b3 to b1
D9185	Axis 4	Axis 3	Axis 2	Axis 1
D9186	Axis 8	Axis 7	Axis 6	Axis 5

0: Unused axis
2: Separated amplifier

(b) When A171SHCPU is used

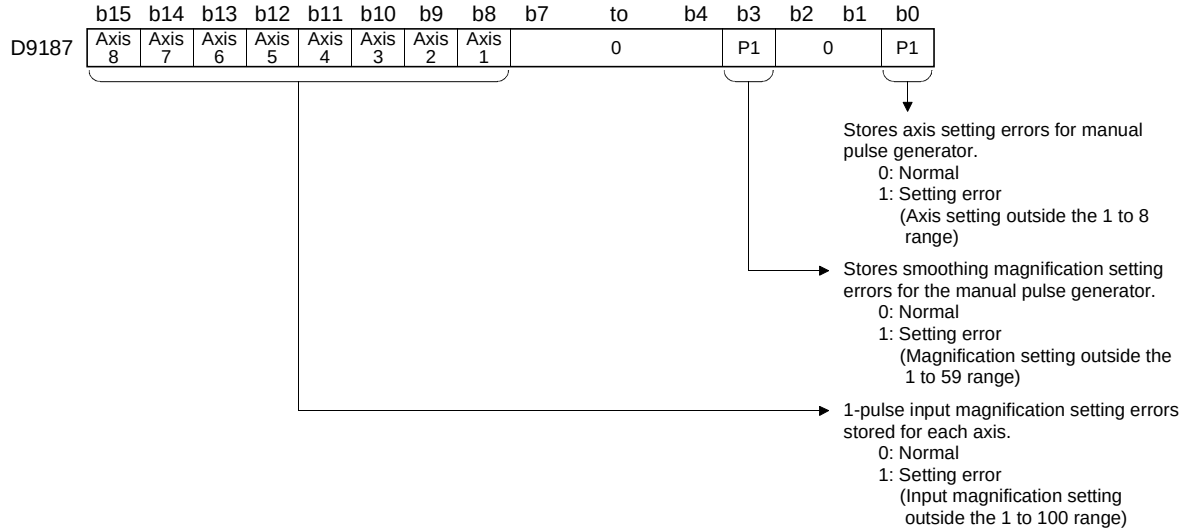
	b15 to b12	b11 to b8	b7 to b4	b3 to b1
D9185	Axis 4	Axis 3	Axis 2	Axis 1
D9186	0			

(4) Manual pulse generator axis setting error (D9187)

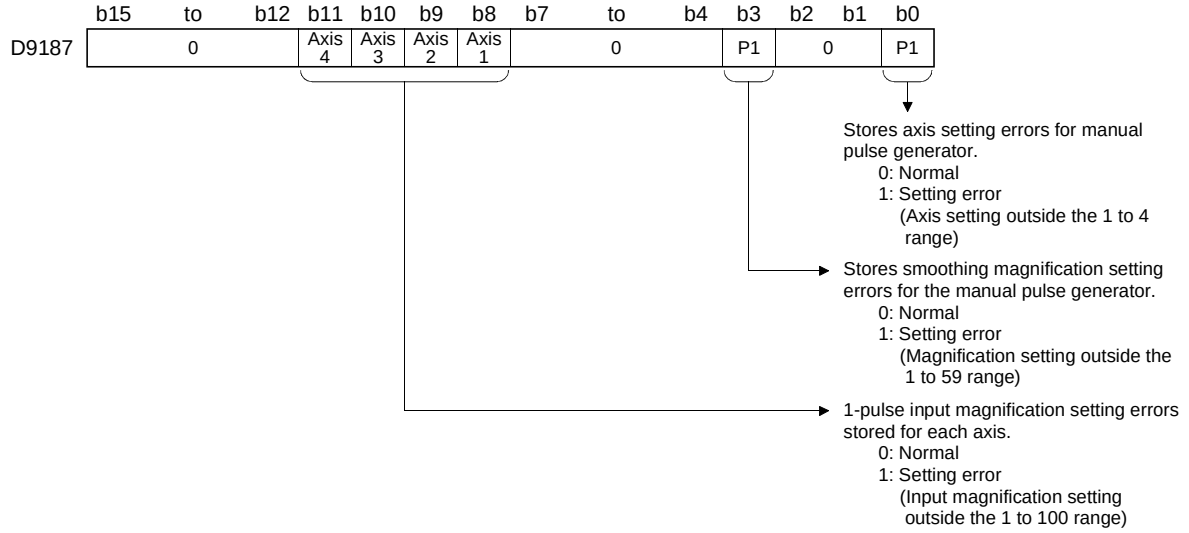
..... Data sent from PCPU to SCPU

When an error is detected in checking the setting at the leading edge of the manual pulse generator enable signal, the contents of the error are set in D9187 and the manual pulse generator axis setting error flag (M9077) comes ON.

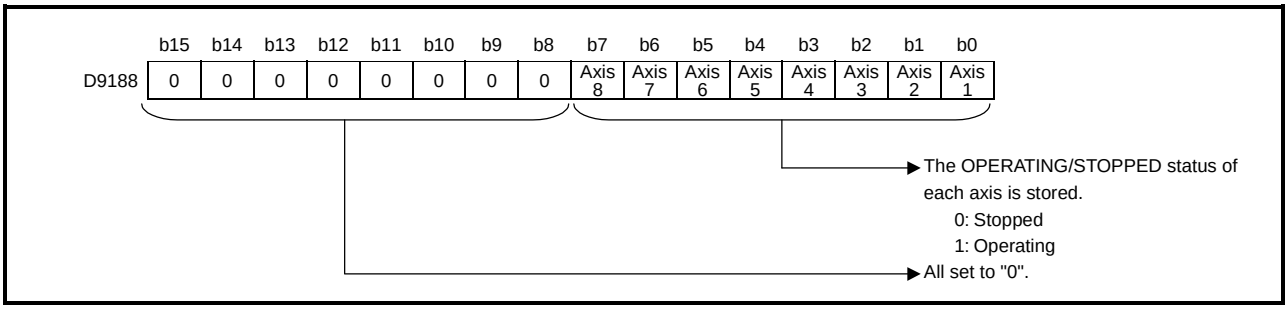
(a) When A172SHCPU is used



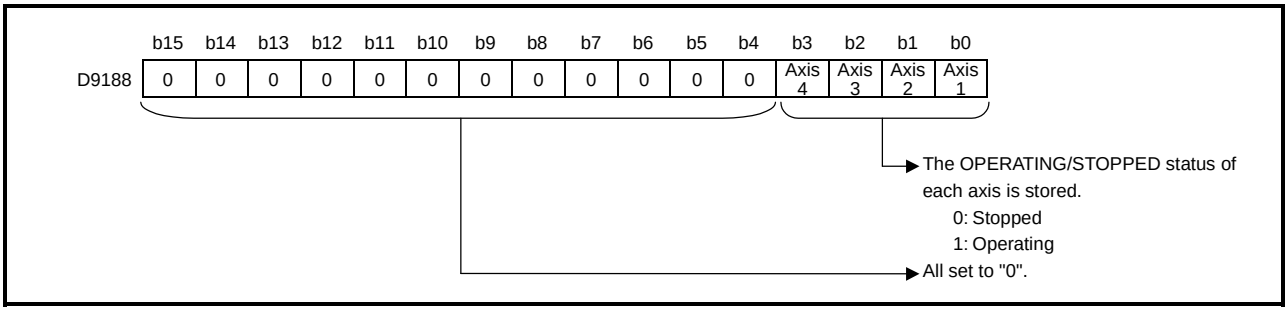
(b) When A171SHCPU is used



(5) TEST mode request error (D9188/D9188/D9182 to D9183)
..... Data sent from PCPU to SCPU
When the TEST mode request error flag (M9078) switches ON, the axis data for axes in motion at that time will be stored.
(a) When A172SHCPU is used



(b) When A171SHCPU is used



(6) Error program No. (D9189)..... Data sent from PCPU to SCPU
(a) When the servo program setting error flag (M9079) switches ON, the No. of the servo program (0 to 4095) where the error occurred is stored.

(b) Each time another error occurs at other servo programs, the stored servo program No. is replaced by the No. of the servo program where the most recent error occurred

(7) Error item information (D9190) ..... Data sent from PCPU to SCPU
When the servo program setting error flag (M9079) switches ON, the error code corresponding to the erroneous setting item will be stored.

Error Code	Error Description
900	The servo program designated by the DSFRP/SVST instruction does not exist.
901	The axis No. designated by the DSFRP/SVST instruction is different from the axis No. designated by the servo program.
902	The instruction code is unreadable (incorrect code).
904	A REAL mode servo program was started while in the VIRTUAL mode.
905	An instruction that cannot be executed in the VIRTUAL mode (VPF,VPR,VVF,VVR,VPSTART, ZERO) was designated.
906	An axis designated as "unused" at the system settings is used in the servo program designated by the DSFRP/SVST instruction.
Error item data	A setting item error exists in the servo program designated by the DSFRP/SVST instruction.*1

REMARK

*1: For details regarding error item data, see Section 6.3 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).

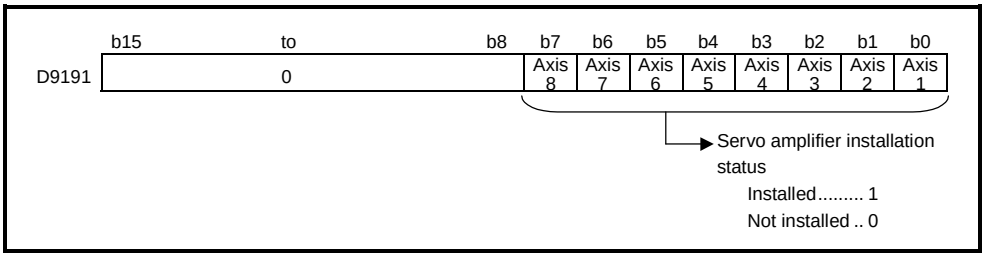
(8) Servo amplifier installation information (D9191)

..... Data sent from PCPU to SCPU

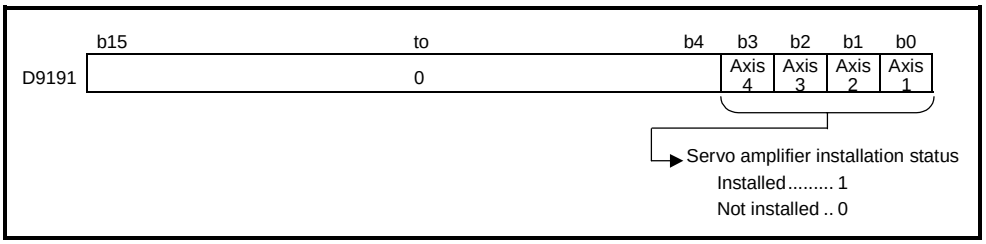
When a servo system CPU power ON or reset occurs, the servo amplifier installation status is checked, and the results are stored.

An INSTALLED status will be established at axes where the installation status changes from NOT INSTALLED to INSTALLED when power is switched ON. If the status changes from INSTALLED to NOT INSTALLED at power ON, the INSTALLED status will remain in effect.

(a) When A172SHCPU is used



(b) When A171SHCPU is used



Servo amplifier installation status

1) Installed/not installed status
   - Installed ..... MR-[ ]-B status is normal (normal communication with servo amplifier)
   - Not installed..... Servo amplifier is not installed. Servo amplifier power is OFF. Normal communication with the servo amplifier is impossible due to a connecting cable problem, etc.

2) The system settings and servo amplifier installation statuses are shown below.

System Settings	MR-[ ]-B	
	Installed	Not Installed
USED (axis No. setting)	"1" is stored	"0" is stored
NOT USED	"0" is stored	"0" is stored

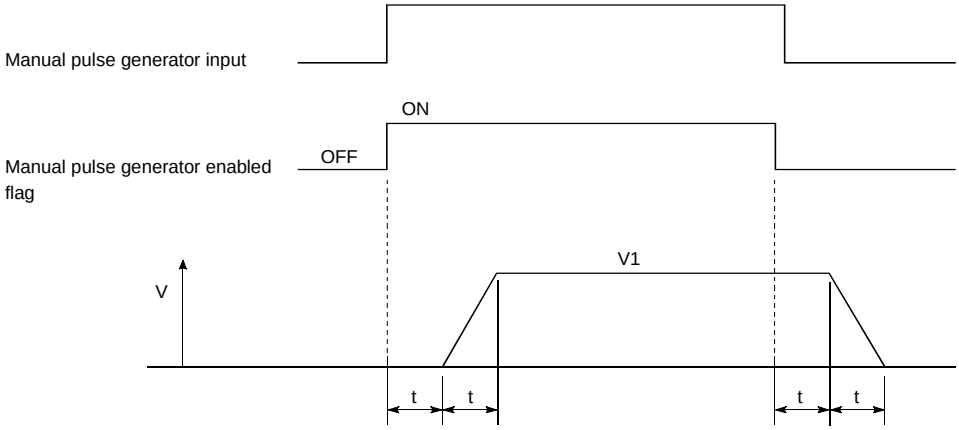
(9) Manual pulse generator smoothing magnification setting area(D9192)
..... Data sent from SCPU to PCPU

(a) This area is used for setting the manual pulse generator's smoothing time constant.

Manual Pulse Generator Smoothing Magnification Setting Register	Setting Range
D9192	0 to 59

(b) When the smoothing magnification setting is designated, the smoothing time constant is determined by the following formula.
Smoothing time constant (t) = [Smoothing magnification + 1] × 56.8 (ms)

(c) Operation



$$\text{Output speed (V1)} = \left[\text{Number of input pulses/ms}\right] \times \left[\text{Manual pulse generator's 1-pulse input magnification setting}\right]$$

$$\text{Travel value (L)} = \left[\text{Travel value per pulse}\right] \times \left[\text{Number of input pulses/ms}\right] \times \left[\text{Manual pulse generator's 1-pulse input magnification setting}\right]$$

REMARKS

(1) The following units are used for the "travel value per pulse" value.
Setting units:
- mm : 0.1 μm
- inch : 0.00001 inch
- degree : 0.00001 degree
- pulse : 1 pulse

(2) The smoothing time constant range is 56.8 ms to 3408 ms.

(10) REAL/VIRTUAL mode switching error information (D9195)
..... Data sent from PCPU to SCPU
When a mode switching error occurs in real-to -virtual or virtual-to-real mode switching, or a mode continuation error occurs in the virtual mode, its error information is stored.

(11) Personal computer communication error codes (D9196)
..... Data sent from PCPU to SCPU
One of the following error codes are stored when an error occurs during PC link communication.

Error Code stored in D9196	Error Contents	Correction Method
01	PC link communication receiving packet did not arrive. Receiving packet arrival timing was late.	· Confirm that the personal computer power is on. · Check the communication cable connection. · Check for communication cable burnout. · Confirm that A30BD-PCF/A30CD-PCF is properly placed.
02	The receiving packet CRC code is incorrect.	· Confirm that there is nothing causing noise in the vicinity. · Check the communication cable connection. · Check for communication cable burnout.
03	The receiving packet data ID is incorrect.	· Confirm that A30BD-PCF/A30CD-PCF is properly placed. · Replace the A30BD-PCF/A30CD-PCF.
04	The number of the frame received is incorrect.	· Check the communication cable connection. · Check for communication cable burnout. · Confirm that there is nothing causing noise in the vicinity.
05	The communication task on the personal computer side has not been started.	· Start the communication task on the personal computer side.

5. MECHANICAL SYSTEM PROGRAM

5 MECHANICAL SYSTEM PROGRAM

This section discusses the VIRTUAL mode's mechanical system program.

This program consists of a mechanical module connection diagram and the mechanical module parameters.

- The mechanical module connection diagram shows the virtual mechanical system consisting of connected virtual mechanical modules.

- The mechanical module parameters are the parameters used at the mechanical module connection diagram for control of the mechanical modules.

For details regarding the mechanical module parameters, refer to the mechanical module parameter lists shown in Chapters 6 to 8.

5. MECHANICAL SYSTEM PROGRAM

5.1 Mechanical Module Connection Diagram

The mechanical module connection diagram shows a virtual system consisting of mechanical modules.
The mechanical module connection configuration is shown in Fig. 5.1 below.

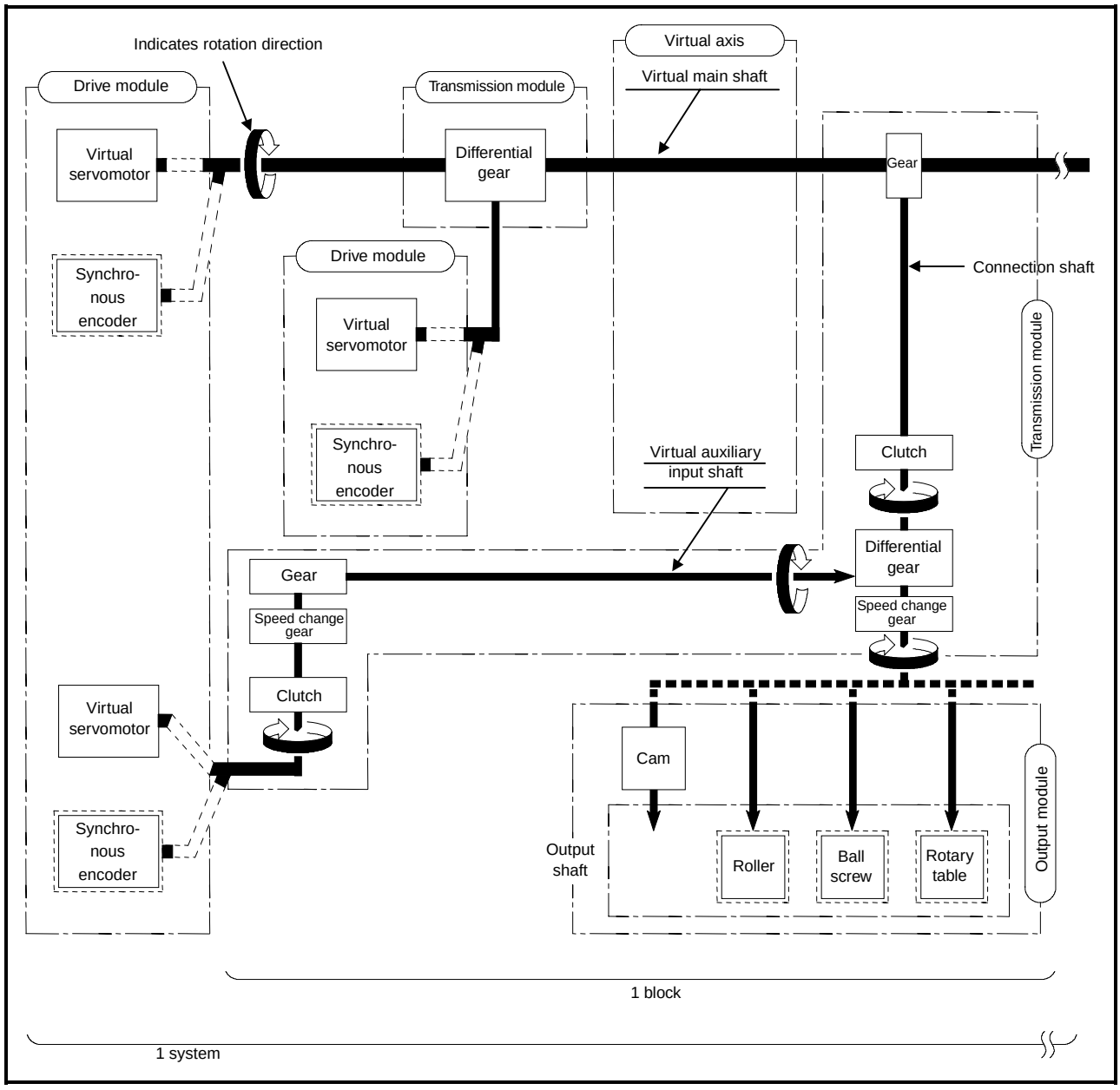


Fig. 5.1 Mechanical Module Connection Configuration

POINTS
(1) Either a virtual servomotor or a virtual synchronous encoder can be connected at the drive module. (2) One of the following can be connected at the output module: Cam, roller, ball screw, or rotary table.

5. MECHANICAL SYSTEM PROGRAM

(1) Block

The term "block" refers to a single series of elements between and including a virtual transmission module (gear connected to the virtual main shaft) and an output module.

Refer to Table 5.1 to determine the number of mechanical modules which can be connected in one block.

(2) System

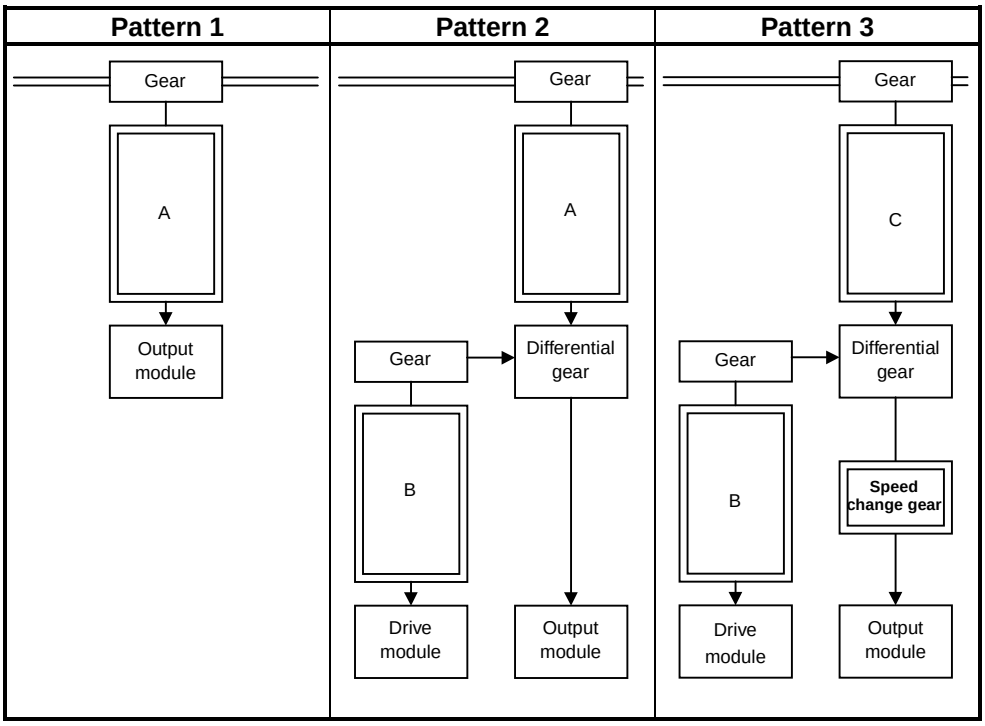
The term "system" refers to all the blocks which are connected to a single virtual main shaft.

One system can consist of up to 8 blocks.

(3) Transmission module connections

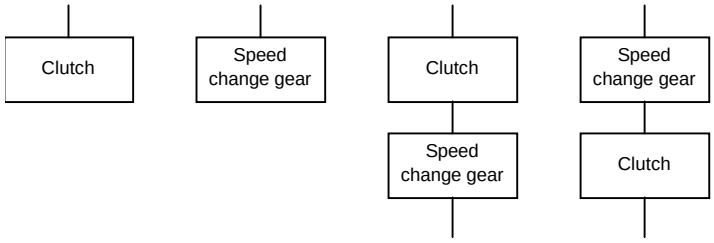
There are 3 transmission module connection patterns:

- Pattern 1 ..... Without a differential gear.
- Pattern 2 ..... Without a speed change gear at the output side of the differential gear.
- Pattern 3 ..... With a speed change gear at the output side of the differential gear.



(a) Transmission modules which can be connected at "A" and "B" above

1) A clutch, speed change gear, and clutch & speed change gear can be connected at "A" and "B".
2) If a clutch & speed change gear are used, there are no connection constraints.



(b) Transmission module which can be connected at "C"

Only a clutch can be connected at "C".

5. MECHANICAL SYSTEM PROGRAM

5.2 Mechanical Module List

Summaries of mechanical modules used in VIRTUAL mode mechanical module connection diagrams are given in Tables 5.1.
For details regarding each mechanical module, see Chapters 5 to 8.

Table 5.1 Mechanical Module List

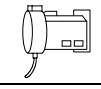
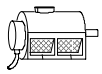
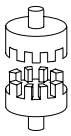
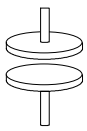
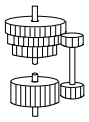
Classification	Mechanical Module		Max. Number Used A172SHCPU				Max. Number Used A171SHCPU				Function Description	Reference Section
	Name	Appearance	Number Per Servo System CPU	Number Per System	Number Per Block: Connection Shaft Side	Number Per Block: Auxiliary Input Shaft Side	Number Per Servo System CPU	Number Per System	Number Per Block: Connection Shaft Side	Number Per Block: Auxiliary Input Shaft Side		
Drive module	Virtual servo motor		8 (Total of 11)	8 (Total of 11)	—	—	4 (Total of 5)	4 (Total of 5)	—	—	• Used to drive the mechanical system program's virtual axis by servo program or JOG operation.	Section 6.1
	Synchronous encoder		3 (Total of 11)	3 (Total of 11)	—	—	1 (Total of 5)	1 (Total of 5)	—	—	• Used to drive the virtual axis by input pulses from an external synchronous encoder.	Section 6.2
Virtual axis	Virtual main shaft	—	8 (Total of 16)	1	—	—	4 (Total of 8)	1	—	—	• This is a virtual "link shaft". • Drive module rotation is transferred to the transmission module.	—
	Virtual auxiliary input shaft	—	8 (Total of 16)	8	—	—	4 (Total of 8)	4	—	—	• This is the auxiliary input shaft for input to the transmission module's differential gear. • This shaft is automatically displayed when a differential gear and gear are connected.	—
Transmission module	Gear		16	16	1	1	8	8	1	1	• Transfers the drive module's rotation to the output shaft. • The travel value (pulse) input from the drive module is adjusted according to the gear ratio setting value, and is then transmitted to the output shaft so that rotation occurs in the set direction.	Section 7.1
	Direct clutch		16	16	1	1	8	8	1	1	• Engages/ disengages the output module with the drive module rotation. • In response to clutch ON/OFF switching, there is a direct clutch for direct transfer, and a smoo-thing clutch for acceleration/ deceleration processing which occurs in accordance with the smoothing time constant setting. • The ON/OFF mode, address mode, or the external input mode can be used, depending on the application.	Section 7.2
	Smoothing clutch											
	Speed change gear		16	16	1	1	8	8	1	1	• Used to change the speed of the output module (roller). • The input shaft speed is adjusted according to the gear ratio setting value, and is then transmitted to the output shaft.	Section 7.3

Table 5.1 Mechanical Module List (Continued)

Classi-fication	Mechanical Module		Max. Number Used A172SHCPU				Max. Number Used A171SHCPU				Function Description	Referen-ce Section
	Name	Appearance	Number Per Servo System CPU	Number Per System	Number Per Block: Connect-ion Shaft Side	Number Per Block: Auxiliary Input Shaft Side	Number Per Servo System CPU	Number Per System	Number Per Block: Connect-ion Shaft Side	Number Per Block: Auxiliary Input Shaft Side		
Trans-mission module	Diffe-rential gear		8	8	1	—	4	4	1	—	• Auxiliary input shaft rotation is subtracted from virtual main shaft rotation and the result is transmitted to the output shaft.	Section 7.4
				1	—		1	1	—		• Auxiliary input shaft rotation is subtracted from virtual main shaft rotation and the result is transmitted to the output shaft. (For virtual main shaft connection)	
Output module	Roller		8	Total of 8	8	Total of 8	4	Total of 4	4	Total of 4	• Used when speed control occurs at the final output.	Section 8.1
	Ball screw		8		8		4		4		• Used when linear positioning occurs at the final output.	Section 8.2
	Rotary table		8		8		4		4		• Used when angle control occurs at the final output shaft.	Section 8.3
	Cam		8		8		4		4		• Used when control other than those shown above occurs at the final output shaft. Position control will occur in accordance with the cam pattern setting data. • There are 2 cam control modes: the two-way cam mode, and the feed cam mode.	Section 8.4

6. DRIVE MODULE

The drive module drives the virtual axis.
There are 2 types of drive module:

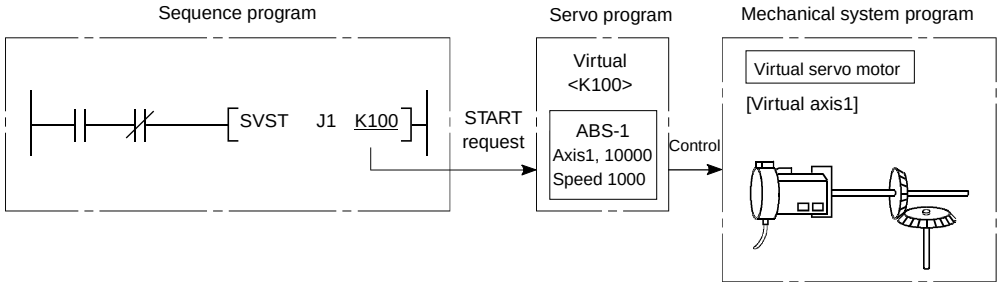
- Virtual servo motor.....See Section 6.1
- Synchronous encoder .....See Section 6.2

6.1 Virtual Servo Motor

The virtual servo motor is used to control the virtual axis by servo program or by JOG operation.
Virtual servo motor operation and parameters are discussed below.

6.1.1 Virtual servo motor operation

(1) START procedure
The virtual servo motor is started by the servo program or by JOG operation.
(a) START by servo program
The servo program is started by a sequence program DSFRP/SVST instruction.
The start accept flag [*1] (M2001 to M2008/M2001 to M2004) of the designated axis will then switch ON.



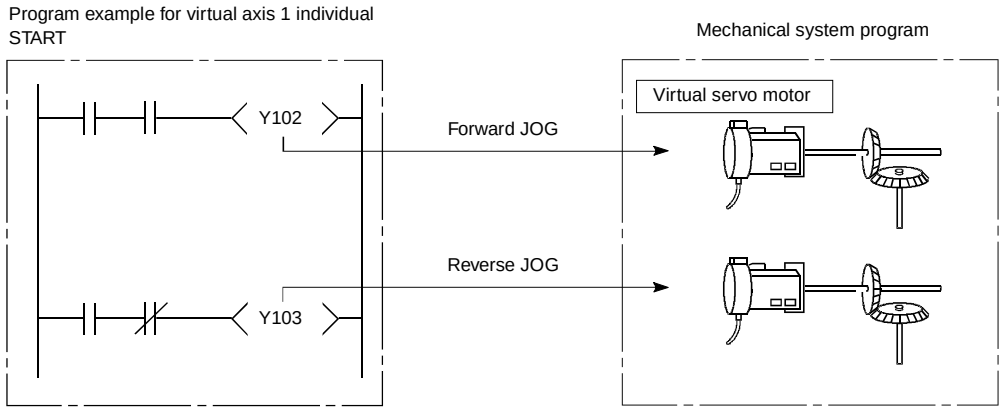
REMARK

*1.....For details regarding the START accept flag, see Section 4.1.8 (2).

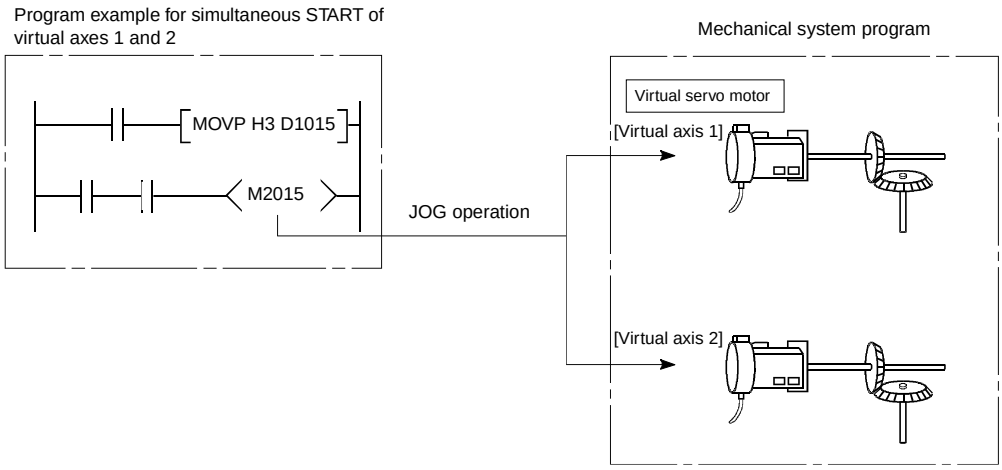
(b) START by JOG operation

An "individual" or "simultaneous" START can be executed at the JOG operation.[*1]

1) Individual START .....Each axis can be started by a forward/reverse JOG command [*2].



2) Simultaneous START.....The simultaneous START axis Nos. and rotation directions (forward/reverse) are designated at the JOG Simultaneous START Axis Setting Register (D1015)[*3], and the axes are started when the JOG Simultaneous START Command Flag (M2015)[*3] switches ON.



REMARKS

*1 For details regarding JOG operations refer to section 7.19 of the Motion Controller (SV13/SV22 REAL mode) Programming Manual.

*2 For details regarding the forward/reverse JOG commands, see Section 6.1.3.

*3 See Section 6.1.3 for details regarding the JOG Simultaneous START Register, and Section 4.1.8 (5) for details regarding the JOG Simultaneous START Command Flag.

(2) Procedure for stopping before completion
To stop virtual servo motor operation before positioning is completed, switch the stop/rapid stop command ON in the sequence program. (There are no external stop causes (STOP, FLS, RLS) for the virtual servo motor.)

(3) Control items
(a) During positioning control, the virtual servo motor backlash compensation amount is processed as "0".

(b) As the virtual servo motor has no feedback pulse, the deviation counter value and the present value are not stored.

(c) The virtual servo motor's feed present value is recorded in a backup memory, and is restored after switching from the REAL to VIRTUAL mode occurs following a power ON.
1) Operation continuation is possible when the output module is using the absolute position system (when position detection module/servo amplifier are used). However, if the servo motor for the output module which is connected to the virtual servo motor is operated while power is OFF, continuation will become impossible even if the absolute position system is being used.
If this occurs, a "VIRTUAL mode continuation disabled" warning signal[*1] will switch ON.
To continue operation, the virtual servo motor or the output module's servo motor must be moved to the position where synchronous operation is possible.
2) If the output module is not using the absolute position system, the feed present value must be corrected (using the "present value change" function) after switching from the REAL to the VIRTUAL mode occurs.

(4) Control change
The following virtual servo motor control items can be changed:
- Present value change
- Speed change

Present value changes are executed by the CHGA/DSFLP instruction, and speed changes are executed by the CHGV/DSFLP instruction. (See Section 10.1)
For details regarding the CHGA, CHGV, and DSFLP instructions, see Section 5.3 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).

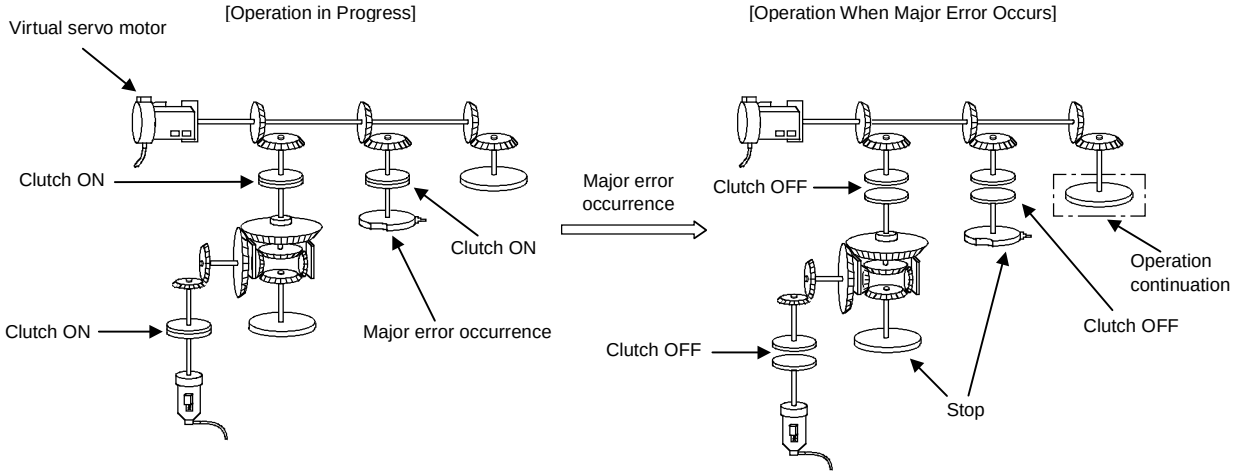
REMARK

*1.....For details regarding the "VIRTUAL mode continuation disabled" warning signal, see Section 6.3.1.

(5) Operation mode when error occurs
The operation method when major errors occur at the output modules of a given system can be designated as shown below.
Control occurs as shown below, based on the parameter settings (see Table 6.1) of the virtual servo motor which is connected to the virtual main shaft.

(a) Continuation ..... Output module operation continues even if a major output module error occurs. The error detection signal (M1607+ 20n) will switch ON at such times, and the corresponding error code will be recorded at the major error storage area.
The system and output module continuation/stop setting when a major output module error occurs is designated in the sequence program.

(b) Clutch OFF ..... When a major output module error occurs, that system's clutch will be switched OFF and all connected output modules will stop. At this time, the clutch ON/OFF command device will not switch OFF, but the clutch status storage device will switch OFF regardless of the clutch ON/OFF command device's ON/OFF status.
Operation will continue at axes where no clutch is connected.
The drive module can be stopped from the sequence pro-gram, if required. To resume operation, eliminate the error cause, then switch the clutch ON/OFF command device ON.

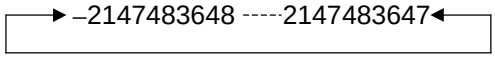


Operation With "Clutch OFF" Setting

(6) Virtual servo motor axis continuous operation

By setting the virtual servo motor stroke limit upper and lower limit parameters such that the upper stroke limit = lower stroke limit, the stroke limit can be disabled thereby allowing operation to continue indefinitely.

When the stroke limit is disabled it is also possible for the startup of the feed present value to take place in a direction that exceeds 32 bits. In such a case the feed present value is converted to a 32 bit ring address.



The following operations are possible depending on the control mode.

Control Mode	Control Contents
Positioning (Linear)	• When the ABS command is used for startup it proceeds in a direction within the 32 bit range. Startup will not proceed in a direction that exceeds the 32 bit range. • When the INC command is used for startup it proceeds in the direction that has been set thus also making it possible to move in a direction that exceeds 32 bits.
Speed switching	
Constant speed (Linear)	
Fixed pitch feed	• Startup proceeds in the set direction and thus it is possible to proceed in a direction that exceeds 32 bits.
Position follow-up	• The set address is controlled by the absolute method so that startup in a direction that exceeds 32 bits is not possible.
High speed oscillation	
Speed	• Stroke is disabled. Moves in the set direction.
JOG	
Manual pulse generation	
Positioning (Circular)	• A start error (107, 108, 109) accompanies the ABS or INC command and startup is not possible.
Constant speed (Circular)	

(7) Reverse return during positioning

By setting a negative speed and carrying out a speed change request using the CHGV (or DSFLP) instruction while startup is in progress, it is possible to initiate deceleration at that point and return in the reverse direction once deceleration is completed.

The following operations are possible via use of servo commands.

Control Mode	Servo Command	Operation
Linear control	ABS-1 INC-1 ABS-2 INC-2 ABS-3 INC-3 ABS-4 INC-4	The direction of movement is reversed when deceleration is complete, the servo returns to the positioning starting point using the absolute value of the set speed, and then stops (stand by). In the case of circular interpolation the servo returns along the circular orbit.
Circular interpolation control	ABS circular INC circular	
Fixed pitch feed	FEED-1 FEED-2 FEED-3	
Constant speed control	CPSTART 1 CPSTART 2 CPSTART 3 CPSTART 4	The direction of movement is reversed when deceleration is complete, the servo returns to the previous point using the absolute value of the set speed, and then stops (stand by).
Speed control (I)	VF VR	Deceleration is completed and the direction of movement is reversed using the absolute value of the set speed. It does not stop until the stop command is input.
Position follow-up control	PFSTART	Reverse return is not possible. This should be viewed as a normal speed change request. The minor error 305 results and the speed limit value is used for control.
Speed switching control	VSTART	
JOG operation		

(Remarks) Minor error 305: The set speed is out of range the from 0 to the speed limit.

[Control contents]

(1) If a speed change is made to a negative speed, control is carried out as indicated in the previous table in accordance with the control mode during startup.

(2) The command speed during return becomes the absolute value of the changed speed. If the speed limit value is exceeded the minor error 305 will result and control will use the speed limit value.

(3) The following hold true when the servo is in the stand by status at the return position.
   (a) Status of each signal
   - Start received (M2001+ n) ON (No change prior to CHGV execution)
   - Positioning start completed (M1600+ 20n) ON (No change prior to CHGV execution)
   - Positioning completed (M1601+ 20n) OFF
   - In-position (M1602+ 20n) ON
   - Command in-position (M1603+ 20n) OFF
   - Speed change "0" receiving in progress flag (—) ON

   (b) In the case of a restart carry out a speed change to the normal speed.

   (c) When positioning is completed set the stop command to ON.

   (d) If a negative speed change is carried out a second time it is ignored.

(4) The following are true during reverse return using the speed control mode.
   (a) If the direction of movement is returned a second time, carry out a speed change to the normal speed.

   (b) To stop set the stop command to ON.

   (c) If a negative speed change is carried out a second time, carry out speed change using the reverse return direction.

[Error contents]

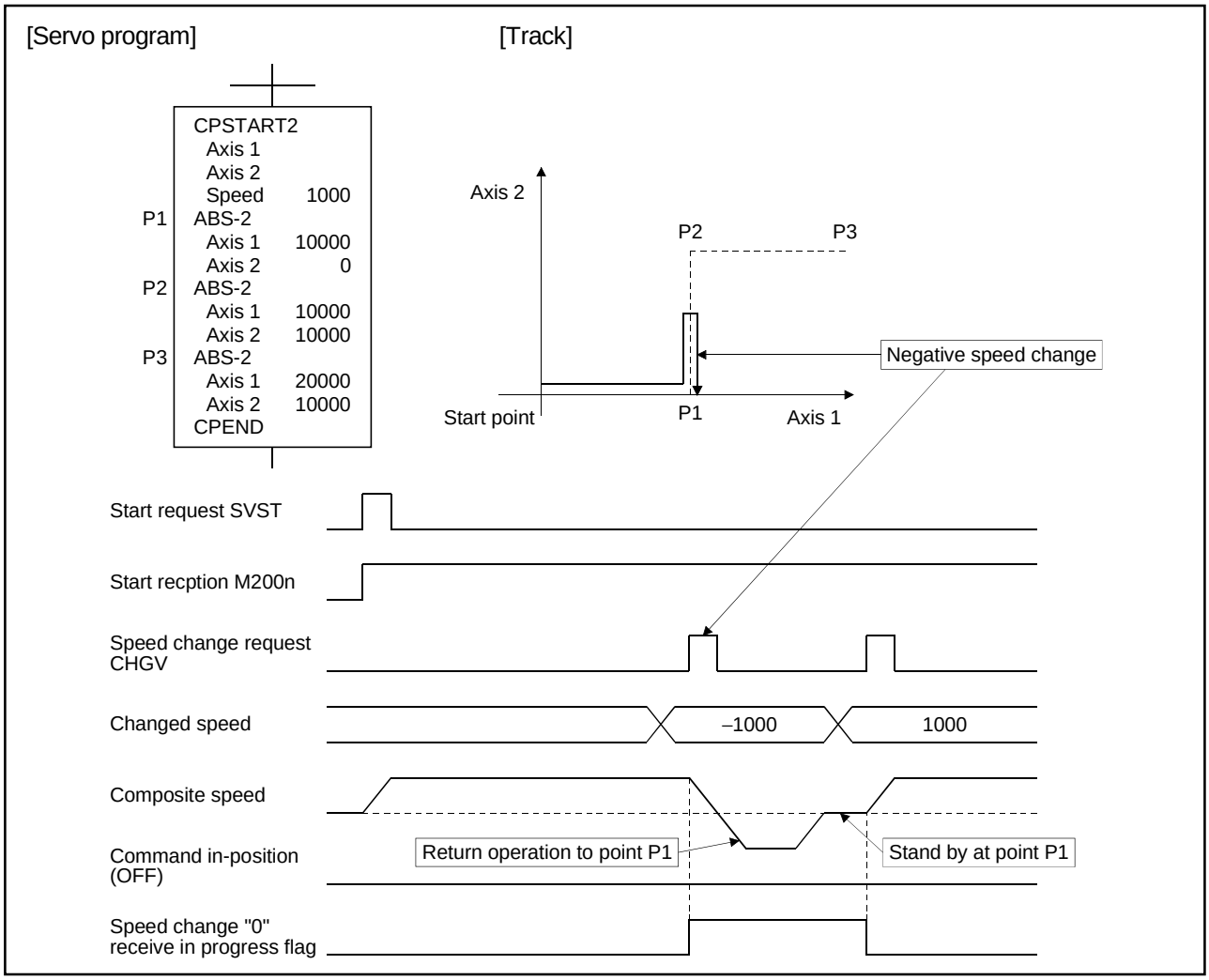
(1) During startup of reverse return in a valid control mode, if the absolute value of the negative changed speed exceeds the speed limit, the minor error 305 will occur and reverse return will be carried out using the speed limit value.

(2) During constant speed control if the absolute value of the negative changed speed exceeds the speed set in the servo program, reverse return will be carried out using the speed set in the program. (Speed clamp control in relation to a speed change during constant speed control) An error will not occur at this time.

(3) Not enabled after the initial automatic deceleration. Minor error 303 results.

[Operation example of constant speed control]

The diagram below shows an example of operation when a reverse return request is carried out in relation to constant speed control.



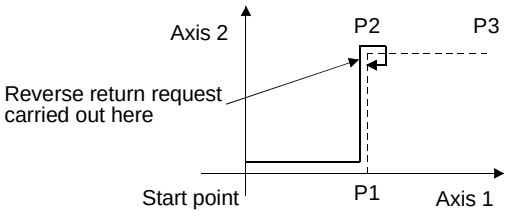
As shown above, when a speed change is carried out to a negative speed while execution of positioning at P2 is in progress, the system returns to P1 in accordance with the start set in the program and waits in stand by at P1.

POINTS

(1) If the M code FIN wait function is used in constant speed control and a reverse return request is carried out during FIN wait stoppage, the request will be ignored.

(2) In the above example, if the reverse return request return is carried out just prior to P2 and P2 is passed during deceleration, the system will return to P2.

(3) A172SHCPU and A171SHCPU have no dedicated positioning device for the speed change "0" receiving in progress flag.



6.1.2 Parameter list

The virtual servo motor parameters are shown in Table 6.1. Parameters shown in this table are explained in items (1) to (4) below.
For details regarding the virtual servo motor parameter setting procedure, refer to the SW2SRX-GSV22PE/SW0IX-CAMPE Operating Manual.

Table 6.1 Parameter List

No.	Setting Item		Default Value		Setting Range		
1	Virtual axis No.		——	——	A172SHCPU	1 to 8	——
					A171SHCPU	1 to 4	——
2	Stroke limit upper limit		2147483647	PLS	–2147483648 to 2147483647		PLS
3	Stroke limit lower limit		0	PLS	–2147483648 to 2147483647		PLS
4	Command in-position range		100	PLS	1 to 32767		PLS
5	JOG operation data	JOG speed limit	20000	PLS/s	1 to 10000000 (*1)		PLS/s
6		Parameter block	1	——	1 to 16		——
7	Operation mode when error occurs		Continuation	——	Continuation/Clutch OFF		——

(*1): The setting range has been expended from the previous range as a result of compatibility with the high resolution encoder.

(1) Virtual axis No. setting
The virtual axis No. is designated by the servo program during VIRTUAL mode operation. The number of the virtual servo motor which is connected to the virtual main shaft or the virtual auxiliary input shaft is designated.

(2) Stroke limit UPPER/LOWER limit settings
Designates the stroke range of the virtual servo motor axis.
(a) When the stroke limit lower limit is made effective:
Designate the stroke range in such a way that the stroke limit lower limit is less than the stroke limit upper limit.
The stroke limit check during start and its control take place as follows at start time.

Control Mode		Error check				Remarks
		startup	startup in progress			
		106	207	208	220	
Positioning	Linear	○	——	——	——	Startup in the return direction in a stroke from the stroke range is possible.
	Circular	○	○	○	——	
Fixed pitch feed		○	——	——	——	
Speed switching		○	○	○	——	
Constant speed		○	○	○	——	
Position follow-up		○	○	——	○	
Speed		——	——	——	——	The stroke is disabled. The feed present value does not become "0".
JOG		——	○	——	——	Startup in the return direction in a stroke from outside the stroke range is possible.
Manual pulse generation		——	○	○	——	

<Error check at startup>

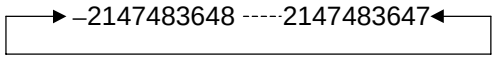
Error Code	Contents	Operation
106	Command position is outside of the stroke limit range at startup.	Does not start

<Error check with startup in progress>

Error Code	Contents	Operation
207	Feed present value is outside of the stroke limit range during startup.	Deceleration stop is initiated.
208	The feed present value of another axis is outside of the stroke limit range when circular interpolation starts.	
220	The command address is outside of the stroke limit range during position follow-up control.	

(b) When the stroke limit is disabled

Set such that the stroke limit lower limit = stroke limit upper limit.
When the stroke limit is disabled, feed present value startup in a direction that exceeds 32 bits is possible.
In such a case the feed present value is converted to a 32 bit ring address.



The following operations are possible depending on the control mode.

Control Mode	Control Contents
Positioning (Linear)	• When the ABS command is used for startup it proceeds in a direction within the 32 bit range. Startup will not proceed in a direction that exceeds the 32 bit range. • When the INC command is used for startup it proceeds in the direction that has been set thus also making it possible to move in a direction that exceeds 32 bits.
Speed switching	
Constant speed (Linear)	
Fixed pitch feed	• Startup proceeds in the set direction and thus it is also possible to proceed in a direction that exceeds 32 bits.
Position follow-up	• The set address is controlled by the absolute method so that startup in a direction that exceeds 32 bits is not possible.
High speed oscillation	
Speed	• Stroke is disabled. Moves in the direction set.
JOG	
Manual pulse generation	
Positioning (Circular)	• A start error (107, 108, 109) accompanies the ABS or INC command and startup is not possible.
Constant speed (Circular)	

(3) Command in-position range
The term "command in-position" refers to the difference between the positioning address (command position) and present feed value.
The "command in-position" signal switches ON when the difference between the command position and the feed present value enters the setting range ([command in-position] – [feed present value] ≤ [command in-position range]).
The command in-position range is checked constantly during positioning control. (The command in-position range is not checked during speed control and JOG operation.)

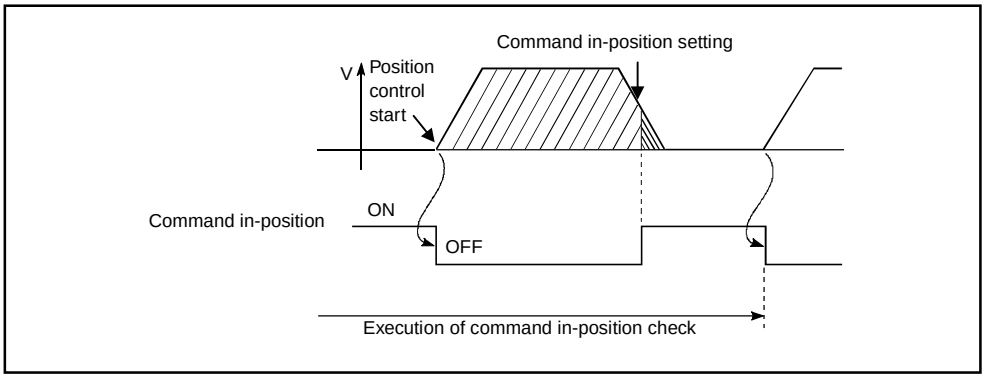


Fig. 6.1 Command In-position Range

(4) JOG speed limit and parameter block settings
The speed limit and parameter block used for JOG operations are explained below.
(a) JOG speed limit
Designates the maximum JOG speed for the virtual axis. If the JOG speed is set higher than the JOG speed limit value, the JOG speed is restricted to the JOG speed limit value.

(b) Parameter block setting
Designates the parameter block No. which is used for the JOG operation. The following parameter block data items are valid during a JOG operation: acceleration time, deceleration time, rapid stop deceleration time, and deceleration processing on STOP input.

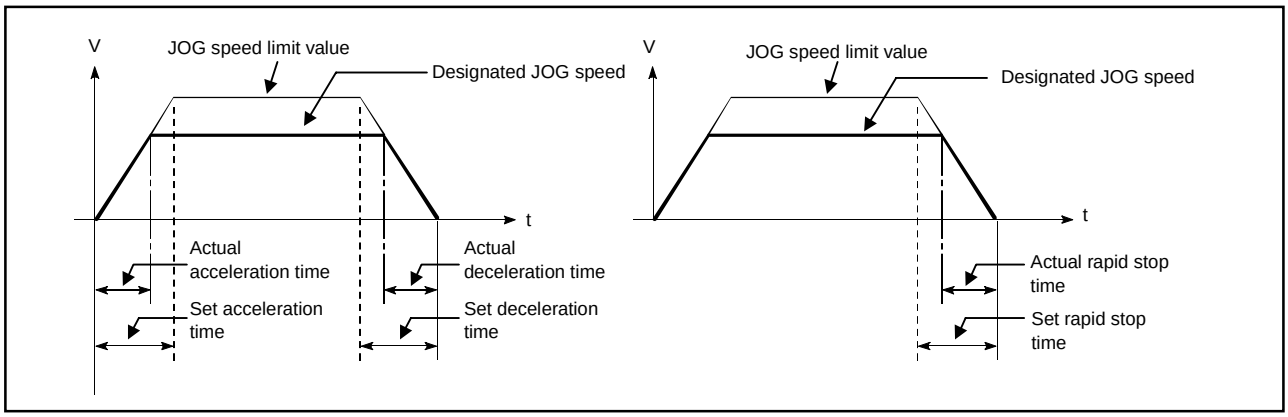


Fig. 6.2 Relationships between the JOG Speed Limit, Acceleration Time, Deceleration Time, and Rapid Stop Time

POINT

The parameter block system-of-units for interpolation control during a JOG operation is fixed as "pulses", regardless of the system-of-units setting.

6.1.3 Virtual servo motor axis devices (internal relays, data registers)

(1) Virtual servo motor axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name

(○ Valid)

	Signal Name	Real	Virtual	Signal Direction	Refresh Cycle	Fetch Cycle
0	Positioning start completed	Backup	○	SCPU ←PCPU	3.5ms	
1	Positioning completed		○			
2	Unusable		——		——	
3	Command in-position		○		3.5ms	
4	Speed control in progress		○			
5	Unusable		——		——	
6	Unusable		——			
7	Error detection		○		Immediately	
8	Unusable		——		——	
9	Unusable		——			
10	Unusable		——			
11	Unusable		——			
12	Unusable		——			
13	Unusable		——			
14	Unusable		——			
15	Unusable		——			
16	Unusable		——			
17	Unusable		——			
18	Unusable		——			
19	M code output in progress		○		3.5ms	

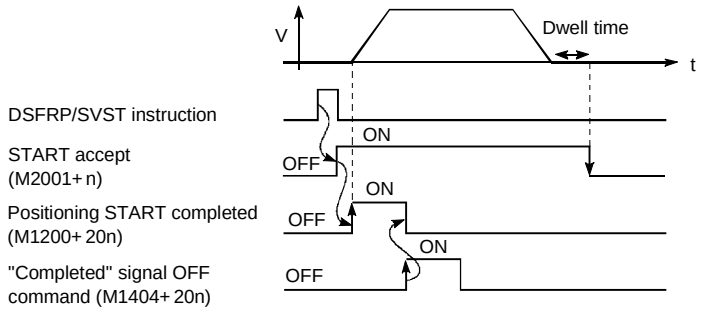
Axis No.	A172SHCPU Device Number	A171SHCPU Device Number
1	M1200 to M1219	M1200 to M1219
2	M1220 to M1239	M1220 to M1239
3	M1240 to M1259	M1240 to M1259
4	M1260 to M1279	M1260 to M1279
5	M1280 to M1299	
6	M1300 to M1319	
7	M1320 to M1339	
8	M1340 to M1359	

(a) Positioning START completed signal (M1200+ 20n)*1

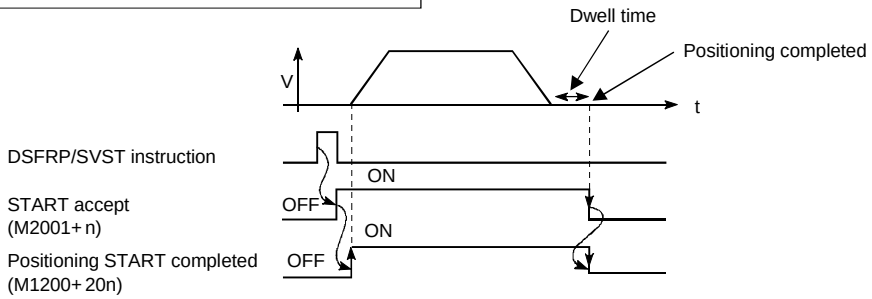
1) This signal switches ON when a positioning START is completed at the axis designated by a DSFRP/SVST instruction in the sequence program. This signal is inoperative during JOG and speed control operations. This signal can be used for M-code readouts, etc., when positioning is started.

2) The positioning START completed signal will switch OFF at the leading edge (OFF→ON) of the "completed" signal OFF command (M1404+ 20n)[*1], or when positioning is completed.

1) At leading edge of "completed" signal OFF command (OFF →ON)



2) When positioning is completed



REMARK

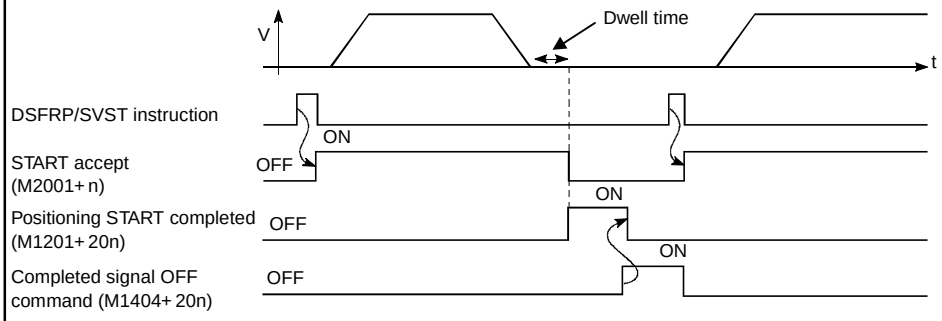
(1) *1: The "n" of M2000+n, M1200+20n, M1404+20n represents the numerical value corresponding to the virtual axis No.

n		0	1	2	3	4	5	6	7
Virtual axis No.	A172SHCPU	1	2	3	4	5	6	7	8
	A171SHCPU	1	2	3	4	—	—	—	—

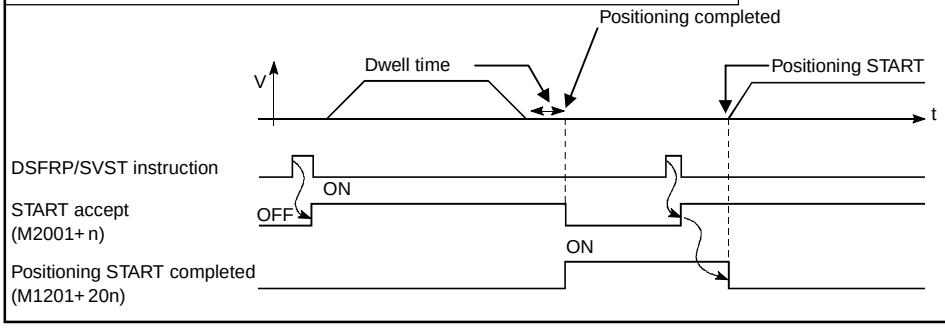
(b) Positioning completed signal (M1201+20n)

1) This signal switches ON when positioning is completed at the axis designated by a DSFLP/SVST instruction in the sequence program. This signal will not switch ON when JOG or speed control operations are started, or when they are stopped while in progress. This signal can be used for M-code readouts when positioning is completed.
2) The positioning completed signal will switch OFF at the leading edge (OFF→ON) of the "completed" signal OFF command (M1404+20n) or when a positioning START is completed.

1) At leading edge of Yn4 completed signal OFF command (OFF→ON)

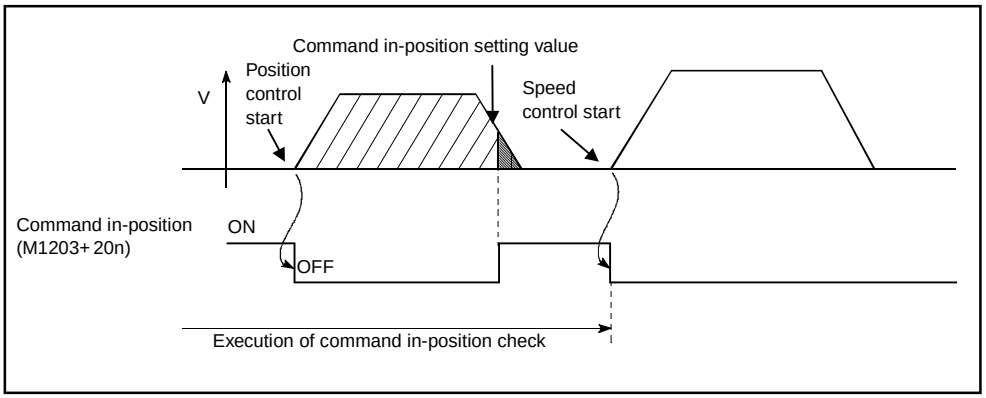


2) When next positioning control START is completed



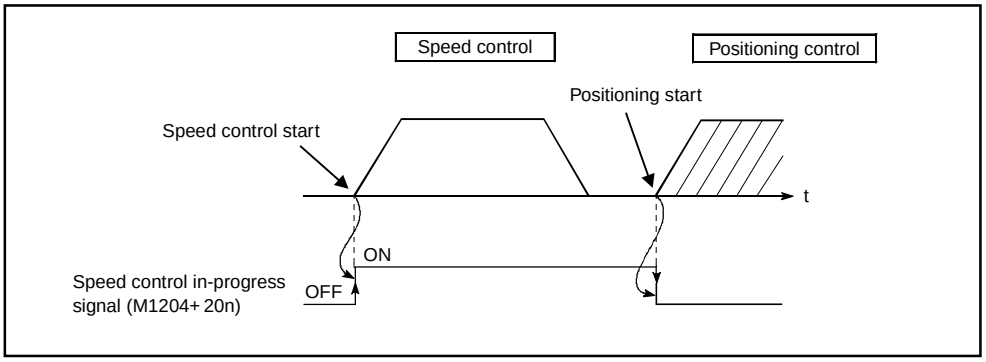
(c) Command in-position command (M1203+20n)

1) This signal switches ON when the absolute difference between the command position and the present value is less than the "command in-position range" designated by the virtual servo motor parameter setting (see Section 6.1.2).
   This signal switches OFF when the following occur:
   - Positioning control START
   - Speed control
   - JOG operation
2) A command in-position check occurs constantly during position control, but does not occur during speed control.



(d) Speed control in-progress signal (M1204+20n)

1) Since the speed control in progress signal is ON while speed control is in progress this signal can be used to determine whether speed control is in progress or positioning is in progress.
   The speed control in progress signal that comes ON during speed control will go OFF when the next positioning control operation starts.
2) When the power is turned on or positioning control is in progress this signal will be OFF.



(e) Error detection signal (M1207+20n)

1) The error detection signal comes ON when a minor error or major error is detected in a virtual servo motor or output module connected to a virtual servo motor.
The ON/OFF status of the error detection signal is used to distinguish whether or not an error exists.

2) When the error detection signal comes ON the corresponding error code is then stored in the error code storage area.
- Minor error code[*1] .....Stored in the minor error code storage area[*2].
- Major error code[*1] .....Stored in the major error code storage area[*2].

The distinction as to whether the detected error is a virtual servo motor error or an output module error can be confirmed by the contents of the error code or by the ON/OFF status of the output module error detection signal.

3) When the virtual servo motor or output module connected to the virtual servo motor is in its normal status the error reset command (M1407 + 20n) is ON and the error detection signal is OFF.

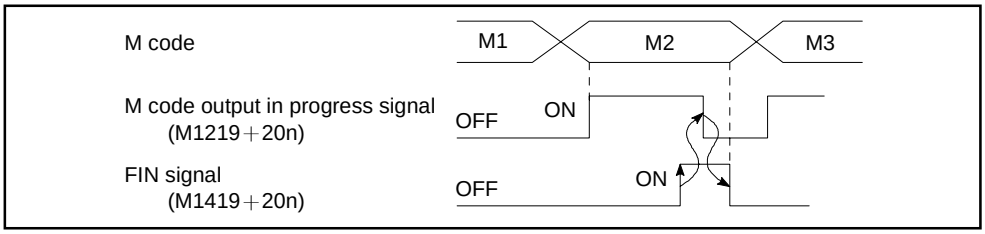
REMARKS

(1) *1: Refer to section 11.3 for details regarding virtual servo motor minor/major error codes.
Refer to section 11.5 for details regarding output module minor/major error codes.

(2) *2: Refer to section 6.1.3 for details concerning the minor error code storage area and major error code storage area.

(f) M code output in progress signal (M1219+20n)

1) Signal indicating that M code output is in progress.
2) This will be OFF when a stop command, cancel signal, skip signal, or FIN signal has been input.



POINTS

(1) The M code output in progress signal is the signal for the FIN signal wait function.

(2) The M code output in progress signal is only enabled when the FIN acceleration/deceleration speed has been set in the servo program. If it is not set the FIN signal wait function is disabled and the M code output in progress signal does not come ON.

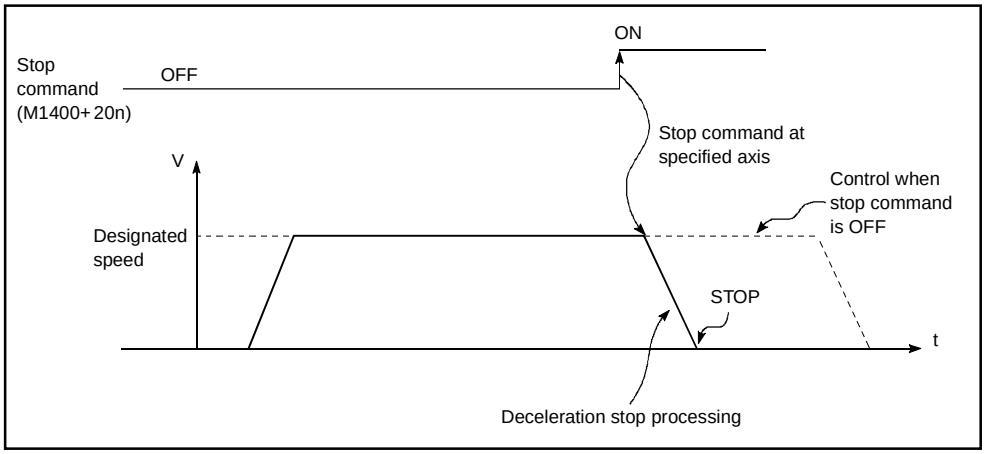
(2) Virtual servo motor axis command signals

Axis No.	A172SHCPU Device No.	A171SHCPU Device No.	Signal Name
1	M1400 to M1419	M1400 to M1419	(○: Valid)
2	M1420 to M1439	M1420 to M1439	
3	M1440 to M1459	M1440 to M1459	
4	M1460 to M1479	M1460 to M1479	
5	M1480 to M1499		
6	M1500 to M1519		
7	M1520 to M1539		
8	M1540 to M1559		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Stop command	×	○	SCPU→ PCPU		3.5ms
1	Rapid stop command					
2	Forward JOG start					10ms
3	Reverse JOG start					
4	End signal OFF command					
5	Unusable	——	——			——
6	Unusable					
7	Error reset	×	○			10ms
8	Unusable	——	——			——
9	External STOP input valid/invalid when starting	×	○			Start timing
10	Unusable	——	——			——
11	Unusable					
12	Unusable					
13	Unusable					
14	Unusable					
15	Unusable					
16	Unusable					
17	Unusable					
18	Unusable					
19	FIN signal	×	○			3.5ms

(a) Stop command (M1400+ 20n)[*1]

1) The stop command is used to stop operation at an axis where motion is in progress, and it becomes effective at the leading edge (OFF→ON) of the signal. (Operation cannot be started at axes where the stop command is ON.)



2) The stop command can also be used during speed control. (For details regarding speed control, see Section 7.12 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).
3) STOP processing which occurs in response to the stop command is shown in Table 6.2 below.

Table 6.2 Stop Processing at Stop Command ON

Control in Progress	Processing at Stop Command ON	
	When Control is in progress	When Deceleration to Stop is in Progress
Position control	Deceleration to a stop occurs within the deceleration time designated in the servo program or parameter block.	Stop command is ignored, and the deceleration stop processing continues.
Speed control		
JOG operation		

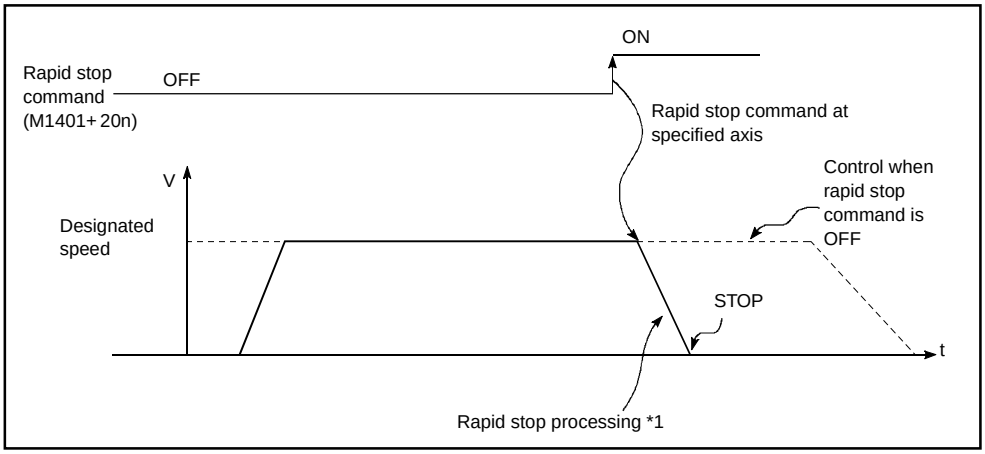
REMARK

*1: The "n" in M1400+ 20n represents the numerical value corresponding to the virtual axis No.

n		0	1	2	3	4	5	6	7
Virtual axis No.	A172SHCPU	1	2	3	4	5	6	7	8
	A171SHCPU	1	2	3	4	—	—	—	—

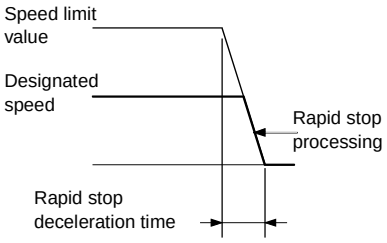
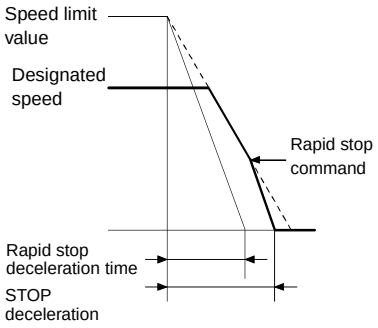
(b) Rapid stop command (M1401+ 20n)

1) This command is used to execute a rapid stop at an axis which is in motion, and it becomes effective at its leading edge (OFF→ON). (Operation cannot be started at axes where the rapid stop command is ON.)



2) The rapid stop processing which occurs when the rapid stop command switches ON is shown in Table 6.3 below.

Table 6.3 Rapid Stop Processing When Rapid Stop Command is Switched ON

Control in Progress	Processing at Stop command ON	
	When Control is in Progress	When Deceleration to Stop is in Progress
Position control Speed control JOG operation	Rapid stop occurs 	Deceleration processing is aborted, and rapid stop processing begins. 

REMARKS

*1: Rapid stop processing results in deceleration to a stop within the rapid stop deceleration time designated at the parameter block or servo program.

(c) Forward JOG start command (M1402+ 20n)/Reverse JOG start command (M1403+ 20n)

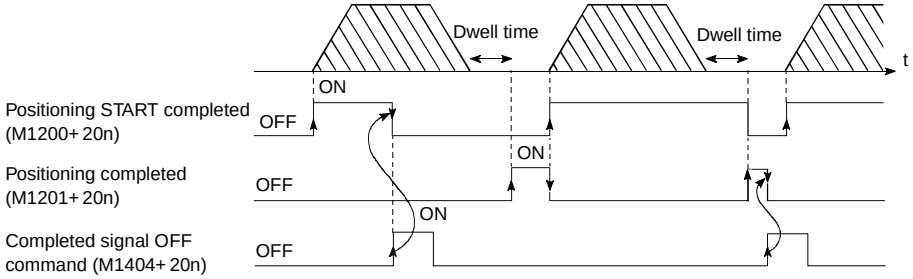
1) When the forward JOG start command (M1402+ 20n) is ON in the sequence program, JOG operation occurs in the forward direction (direction in which the address increases).
When the forward JOG start command (M1402+ 20n) is switched OFF, a deceleration and STOP will occur within the deceleration time designated at the parameter block.

2) When the reverse JOG start command (M1403+ 20n) is ON in the sequence program, JOG operation occurs in the reverse direction (direction in which the address decreases).
When the reverse JOG start command (M1403+ 20n) is switched OFF a deceleration and STOP will occur within the deceleration time designated at the parameter block.

POINT

The sequence program features an interlock function which prevents the forward (M1402+ 20n) and reverse (M1403+ 20n) JOG start commands from being switched ON simultaneously.

(d) Completed signal OFF command (M1404+ 20n)
This command is used to switch the "positioning START completed signal" (M1200+ 20n) and the "positioning completed signal" (M1201+ 20n) OFF in the sequence program.



POINT

Do not switch the "completed signal OFF command" ON by a PLS instruction. Such an action will make it impossible to switch the "positioning START completed signal"(M1200+ 20n) and the "positioning completed signal" (M1201+ 20n) OFF.

(e) Error reset command (M1407+ 20n)
1) The error reset command is used to clear the minor or major error code storage area of the virtual servo motor for which an error has been detected and to reset the error detection signal.
2) The following processing is carried out when the error reset command comes ON.
- If the virtual servo motor and output module are normal the minor and major error code storage areas are cleared and the error detection signal is reset.
- If the virtual servo motor and output module error has not been canceled, the error code is again stored in the minor/major error code storage area.
In this case the error detection signal (M1207+ 20n) remains ON.

POINT

Do not turn the error reset command (M1407+ 20n) ON using the PLS command.
If it is set to ON using the PLS command it may not be possible to carry out error reset.

(f) External STOP input invalid command at START (M1409+ 20n)
This command is used to designate a valid/invalid setting for the external STOP input.
- ON ..... The external STOP input will be invalid, and axes where the STOP input is ON can be started.
- OFF ..... The external STOP input will be valid, and axes where the STOP input is ON cannot be started.

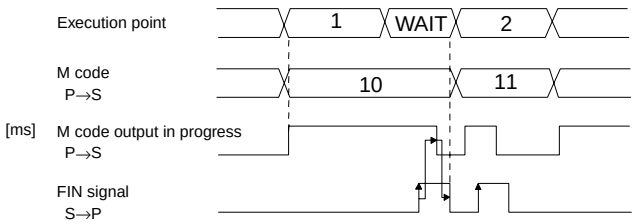
POINTS

After operation has been started by switching external STOP input invalid command at START (M1409+ 20n) ON, switch the STOP input from OFF to ON to stop the operation by an external STOP input. (If the STOP input is ON when the START occurs, switch the STOP input ON → OFF → ON.)

(g) FIN signal (M1419+ 20n)
When an M code is set in a point during positioning, travel to the next block does not take place until the FIN signal state changes as follows:
OFF→ON→OFF
Positioning to the next block begins after the FIN signal state changes as above.

VIRTUAL
<K1000>

```
CPSTART2
  Axis                1
  Axis                2
  Speed                                10000
  FIN acceleration/deceleration          100
1 ABS-2
  Axis                1,               200000
  Axis                2,               200000
  M code                                   10
2 ABS-2
  Axis                1,               300000
  Axis                2,               250000
  M code                                   11
3 ABS-2
  Axis                1,               350000
  Axis                2,               300000
  M code                                   12
4 ABS-2
  Axis                1,               400000
  Axis                2,               400000
CPEND
```



Timing Chart for Operation Description

1. Once positioning to point 1 begins, M code 10 is output and the M code output in progress signal goes ON.
2. After the PC takes appropriate action, the FIN signal goes ON. Travel to the next point does not take place unless the FIN signal goes ON.
3. When the PC's action causes the FIN signal to go ON, the M code output in progress signal goes OFF.
4. After the M code output in progress goes OFF, the PC takes appropriate action so that the FIN signal goes OFF. Positioning to the next point 2 begins through the above steps.

POINTS

(1) The FIN signal and M code output in progress signal are for the FIN signal wait function.
(2) The FIN signal and M code output in progress signal are only enabled when the FIN acceleration/deceleration speed has been set in the servo program. If it is not set the FIN signal wait function is disabled and the M code output in progress signal does not come ON.

(3) Virtual servo motor axis monitor device

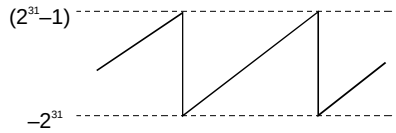
Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M700 to M705	M700 to M705	(○: Valid)
2	M706 to M711	M706 to M711	
3	M712 to M717	M712 to M717	
4	M718 to M723	M718 to M723	
5	M724 to M729		
6	M730 to M735		
7	M736 to M741		
8	M742 to M747		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value	Backup	○	SCPU← PCPU	3.5ms	
2	Minor error code				Immediately	
3	Major error code					
4	Execution program Number				3.5ms	
5	M code					

(a) Feed present value storage register(D700+ 6n)[*1]

..... Data sent from PCPU to SCPU

1) The target address which was output to the virtual servo motor in accordance with the servo program's positioning address and travel value is stored at this register.
2) This feed present value data is subjected to a stroke range check.
3) A "-2^{31} pulse to $(2^{31}-1)$ pulse" ring address is established.



4) Data in the feed present value storage register is stored in a backup memory when a power OFF or servo system CPU reset occurs.

(b) Minor error code storage register (D702+ 6n)

..... Data sent from PCPU to SCPU

1) When a minor error occurs at the virtual servo motor or at the output module, the corresponding error code (see Section 11.3) is stored in this register.
   Each time a minor error occurs, the previous error code stored in this register will be overwritten by the new error code.
2) To clear error codes for minor errors which occurred at the virtual servo motor or synchronous encoder, execute the drive module error reset command[*2].
   To clear error codes for minor errors which occurred at the output module, execute the output module error reset command[*3].

REMARKS

(1) *1: The "n" in D700+6n represents the number corresponding to the virtual axis No.

n		0	1	2	3	4	5	6	7
Virtual axis No.	A172SHCPU	1	2	3	4	5	6	7	8
	A171SHCPU	1	2	3	4	—	—	—	—

(2) *2: For details regarding the drive module error reset command, see Section 6.1.3.

(3) *3: For details regarding the output module error reset command, see Section 8.5.1.

(c) Major error code storage register (D703+6n)
..... Data sent from PCPU to SCPU

1) When a major error occurs at the virtual servo motor or at the output module, the corresponding error code (see Section 11.3) is stored in this register.
Each time a major error occurs, the previous error code stored in this register will be overwritten by the new error code.
2) To clear error codes for major errors which occurred at the virtual servo motor or synchronous encoder, execute the drive module error reset command[*1].
To clear error codes for major errors which occurred at the output module, execute the output module error reset command[*2].

(d) Execution program No. storage register.....Data sent from PCPU to SCPU

1) The No. of the program being run is stored in this register when the DSFRP/SVST instruction is executed.
2) When the DSFRP/SVST instruction is not executed, the following value are stored in this register.
- JOG operation.....FFFFH
- At power ON FF00H
- When REAL → VIRTUAL mode switching occurs.....FF00H

(e) M-code storage register (D705+6n) .....Data sent from PCPU to SCPU

1) The M-code settings in the servo program being run are stored in this register when positioning is started.
If the servo program contains no M-codes, "0" will be stored.
2) The stored data will not be changed if positioning is started by a means other than a servo program.
3) The stored data will revert to "0" when REAL to VIRTUAL mode switching occurs at the leading edge of the programmable controller READY signal (M2000).

REMARKS

(1) *1: For details regarding the drive module error reset command, see Section 6.3.1.

(2) *2: For details regarding the output module error reset command, see Section 8.5.1.

(4) Virtual servo motor axis main shaft differential gear present value

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M670 M671	M670 M671	(○: Valid)
2	M672 M673	M672 M673	
3	M674 M675	M674 M675	
4	M676 M677	M676 M677	
5	M678 M679		
6	M680 M681		
7	M682 M683		
8	M684 M685		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Virtual servo motor axis main shaft differential gear present value	Backup	○	SCPU← PCPU	3.5ms	

(a) Virtual servo motor axis main shaft differential gear present value storage register (D670+ 2n)[*1] ..... Data sent from PCPU to SCPU

1) When switching the virtual mode the present value will be the same as the main shaft side drive module present value.
2) When a present value change is carried out in relation to the main shaft side drive module, the present value of the main shaft differential gear will also be changed to the set present value at the same time.
3) If the differential gear is not connected to the main shaft, the main shaft drive module present value will always be stored in the main shaft differential gear present value storage register.

REMARKS

(1) *1: The "n" in D670+ 2n represents the number corresponding to the virtual axis No.

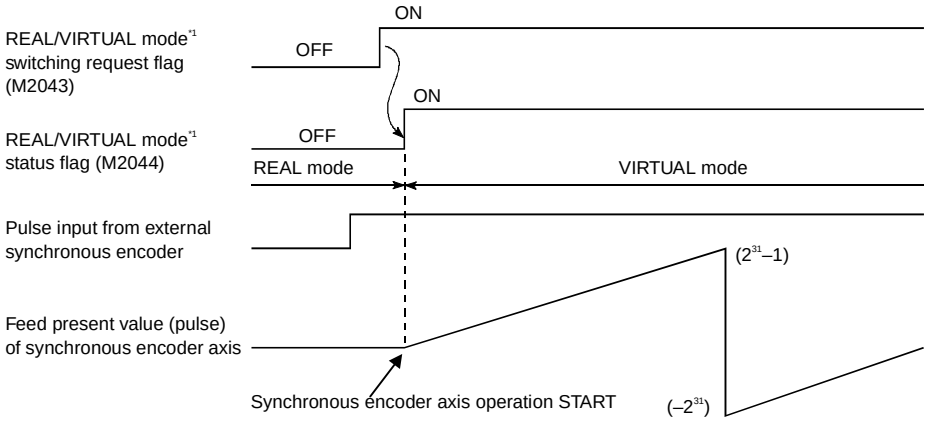
n		0	1	2	3	4	5	6	7
Virtual axis No.	A172SHCPU	1	2	3	4	5	6	7	8
	A171SHCPU	1	2	3	4	—	—	—	—

6.2 Synchronous Encoder

The synchronous encoder is used to execute virtual axis operation by pulse inputs from an external source.
Synchronous encoder operation and parameters are discussed below.

6.2.1 Synchronous encoder operation

(1) Operation START
A synchronous encoder axis START occurs when the reception of the pulse inputs from the external synchronous encoder begins. Pulse input reception occurs when switching from the REAL to the VIRTUAL mode is executed, and when the external signal (TREN: synchronous encoder input START signal)[*2] input occurs.
(a) Pulse input reception at REAL to VIRTUAL mode switching occurs as follows
1) Reception of pulse inputs from the external synchronous encoder begins from the point when REAL to VIRTUAL mode switching occurs.

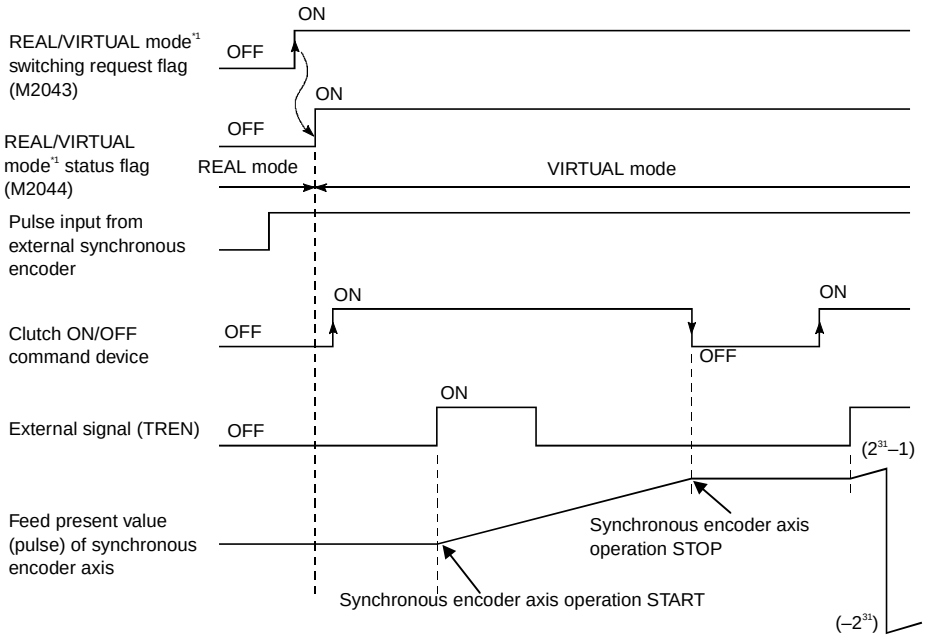


2) The clutch control mode[*3] operation will be identical to its operation in the ON/OFF mode and the address mode, and can be used with incremental or absolute type synchronous encoders.
3) Transmission of synchronous encoder operation to the output module will or will not occur depending on the ON/OFF status of the connected clutch.
- When clutch is ON..... Transmission to the output module occurs.
- When clutch is OFF..... Transmission to the output module does not occur.

⚠ CAUTION

⚠ If the mode is switched from REAL mode to VIRTUAL mode while the clutch is ON, use the smoothing clutch.
If the direct clutch is used and the mode is switched from REAL mode to VIRTUAL mode while the clutch is ON, rapid acceleration will occur at the output module axis, causing a servo error, and the machine will be subjected to a jolt.

(b) Pulse input reception at an external signal input occurs as follows
1) Reception of pulse inputs from the external synchronous encoder begins when the clutch is switched ON.



2) The clutch control mode*3 operation will be identical its operation at the external input mode. The synchronous encoder and clutch operations occur in a corresponding manner.

(2) Operation END
(a) Operation at the synchronous encoder axis is ended when the REAL mode is established in response to a VIRTUAL to REAL mode switching request (M2043 switched from ON to OFF).
(b) The procedure for ending operation at the synchronous encoder axis is as follows.
1) Stop the output module
Stop the external synchronous encoder.
Switch the connected clutch OFF.
2) Switch from the VIRTUAL to REAL mode.

CAUTION

Switching to the REAL mode while synchronous encoder axis and output module operation is in progress will cause a sudden stop at the output module, resulting in a servo error, and the machine will be subjected to a jolt.

REMARKS

(1) *1: For details regarding the REAL/VIRTUAL mode switching request flag and the REAL/VIRTUAL mode switching status flag, see Section 4.2.

(2) For details regarding switching between the REAL and VIRTUAL modes, see Chapter 9.

(3) *2: The synchronous encoder input START signal is input to the A172SENC/A171SENC "TREN" terminal.
For details regarding the A172SENC/A171SENC "TREN" terminal, refer to the Motion Controller [A172SHCPU/A171SHCPU] User's Manual.

(4) *3: For details regarding the clutch control mode, see Section 7.2.1.

(3) STOP procedure

The synchronous encoder can be stopped by stopping the external synchronous encoder.

[There are no external inputs (FLS, RLS, STOP), sequence program stop commands, or rapid stop commands for the synchronous encoder.]

(4) Control items

(a) As the synchronous encoder has no feedback pulse, the "deviation counter value" and "actual present value" are not stored in memory.

(b) The synchronous encoder's feed present value is recorded in a backup memory, and is restored after switching from the REAL to VIRTUAL mode occurs following a power ON.

1) Operation continuation is possible when the output module is using the absolute position system (when position detection module/servo amplifier are used). However, if the servo motor for the output module which is connected to the synchronous encoder is operated while power is OFF, or if the synchronous encoder is operated while power is OFF, continuation will become impossible even if the absolute position system is being used.
If this occurs, a "VIRTUAL mode continuation disabled" warning signal will switch ON.
To continue operation, the output module's servo motor must be moved to the position where synchronous operation is possible.

2) If the output module is not using the absolute position system, the feed present value must be corrected (using the "present value change" function) after switching from the REAL to the VIRTUAL mode occurs.

(5) Control change

The following synchronous encoder control item can be changed:

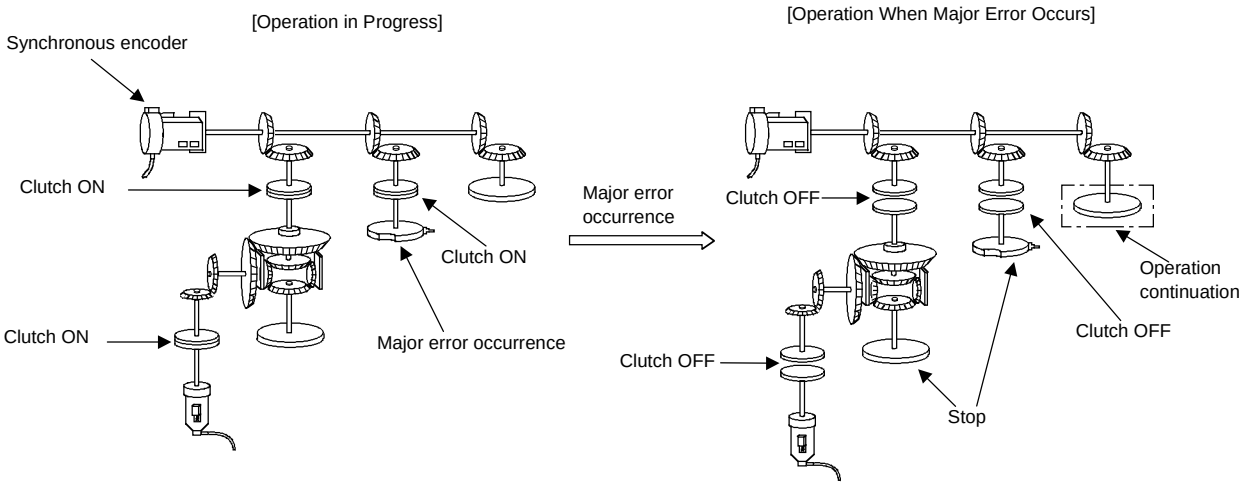
- Present value change

Present value changes are executed by the CHGA instruction.
For details regarding the CHGA and DSFLP instructions, see Section 5.3 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).

(6) Operation mode when error occurs
The operation method when major errors occur at the output modules of a given system can be designated as shown below.
Control occurs as shown below, based on the parameter settings (see Table 6.2) of the synchronous encoder which is connected to the synchronous encoder main shaft.

(a) Continuation ..... Output module operation continues even if a major output module error occurs. The error detection signal (M1607+ 20n) will switch ON at such times, and the corresponding error code will be recorded at the major error storage area.
The system and output module continuation/stop setting when a major output module error occurs is designated in the sequence program.

(b) Clutch OFF ..... When a major output module error occurs, that system's clutch will be switched OFF and all connected output modules will stop. At this time, the clutch ON/OFF command device will not switch OFF, but the clutch status storage device will switch OFF regardless of the clutch ON/OFF command device's ON/OFF status.
Operation will continue at axes where no clutch is connected.
The drive module can be stopped from the sequence program, if required. To resume operation, eliminate the error cause, then switch the clutch ON/OFF command device ON.



Operation With "Clutch OFF" Setting

6.2.2 Parameter list

The synchronous encoder parameters are shown in Tables 6.4.
For details regarding the synchronous encoder parameter setting procedure, refer to the SW2SRX-GSV22PE/SW0IX-CAMPE Operating Manual.

Table 6.4 Synchronous Encoder Parameter List (for A171SCPU)

No.	Setting Item	Default Value	Setting Range
1	Encoder No.	—	1
2	Operation mode when error occurs	Continuation	Continuation/Clutch OFF

(a) Encoder No.
Designates the number of the synchronous encoder which is connected to the manual pulse generator and synchronous encoder interface.

Manual Pulse Generator/Synchronous Encoder Interface Unit's	Encoder No.
P1/E1	1

P1: Connected to the manual pulse generator's input interface. This is for incremental type synchronous encoders.
E1: Connected to the serial synchronous encoder interface. This is for absolute type synchronous encoders.

6.2.3 Synchronous encoder axis device (internal relay, data register)

(1) Synchronous encoder axis device

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M1360 to M1363	M1360 to M1363	(○: Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error detection	○	○	SCPU← PCPU	Immediately	
1	External signal TREN	○	○		10ms	
2	VIRTUAL mode continuation disabled warning	○	○			
3	Unusable	—	—		—	

(a) Error detection signal (M1360)

1) The error detection signal switches ON when a minor or major error occurs at the drive module, or at an output module which is connected to the drive module. ON/OFF switching of this signal permits error valid/invalid identification processing.
2) When the error detection signal switches ON, the corresponding error code is recorded at the error code storage area.
   - Minor error code[*1] .....Stored at minor error code storage area[*2].
   - Major error code[*1] .....Stored at major error code storage area[*2].

   The error code or the output module error detection signal's ON/OFF status indicates whether the error occurred at the drive module or the output module.
3) When a normal status is restored at the drive module and output module, and the error reset command (M1560) is switched ON, the error detection signal will switch OFF.

(b) External signal TREN (M1361)

1) The external signal TREN is used for clutch control in the external input mode. This signal switches ON when input occurs at the A172SENC/ A171SENC "TREN" input terminal, and indicates the TREN terminal's input ON/OFF status.

(c) VIRTUAL mode continuation disabled warning signal (M1362)

1) As happens when the absolute type synchronous encoder is moved while power is OFF, this signal will switch ON when the present value read at power ON differs from that which was stored at power OFF (final present value of VIRTUAL mode operation).
   This signal status indicates whether VIRTUAL mode operation can be continued following a power ON or servo system CPU reset.

REMARKS

(1) *1: For details regarding drive module major and minor errors, see Section 11.3.
For details regarding output module major and minor errors, see Section 11.5.

(2) *2: For details regarding the minor and major error code storage areas, see Section 6.1.3.

(2) Synchronous encoder axis command signal

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M1560 to M1563	M1560 to M1563	(○: Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error reset	×	○	SCPU→ PCPU		10 ms
1	Unusable	—	—			—
2	Unusable					
3	Unusable					

(a) Error reset command (M1560)

1) The error reset command is used to clear minor and major error code storage areas for the drive module of the axis where the error occurred, and to reset the error detection signal.

2) When the error reset command switches ON, the following processing occurs.

- When the drive module and output module statuses are normal, the minor or major error code storage area is cleared, and the error detection signal is reset.
- If an error status still exists at the drive module and output module, the error code will again be recorded at the minor or major error code storage area.
  In this case, the error detection signal (M1360) will remain ON.

POINT

Do not switch the error reset command (M1560) ON with a PLS instruction since this can disable the error reset function.

(3) Synchronous encoder axis monitor device

Axis No.	SV22C Device Number	SV22F Device Number	Signal Name
1	M748 to M751	M748 to M751	(○: Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value	Backup	○	SCPU← PCPU	3.5ms	
2	Minor error code	○ (*2)			Immediately	
3	Major error code					

(*2) Set when the controller power is turned on only in the case of an absolute synchronous encoder.

(a) Present value storage register (D748, D749)

..... Data sent from PCPU to SCPU

1) The virtual drive module and synchronous encoder present values are stored in this register.
2) A "–2147483648 (-2^{31}) pulse to 2147483647 ($2^{31}-1$)" ring address is established.
3) Data in the present value storage register is stored in a backup memory when a power OFF or servo system CPU reset occurs.

(b) Minor error code storage register (D750)

..... Data sent from PCPU to SCPU

1) When a minor error occurs at the synchronous encoder or at the output module, the corresponding error code (see Section 11.3) is stored in this register.
   Each time a minor error occurs, the previous error code stored in this register will be overwritten by the new error code.
2) To clear error codes for minor errors which occurred at the virtual servo motor or synchronous encoder, execute the drive module error reset command[*1].
   To clear error codes for minor errors which occurred at the output module, execute the output module error reset command[*2].

REMARKS

(1) *1: For details regarding the drive module error reset command, see Section 6.1.3.
(2) *2: For details regarding the output module error reset command, see Section 8.5.1.

(c) Major error code storage register (D751)

..... Data sent from PCPU to SCPU

1) When a major error occurs at the synchronous encoder or at the output module, the corresponding error code (see Section 11.3) is stored in this register.
   Each time a major error occurs, the previous error code stored in this register will be overwritten by the new error code.
2) To clear error codes for major errors which occurred at the virtual servo motor or synchronous encoder, execute the drive module error reset command.
   To clear error codes for major errors which occurred at the output module, execute the output module error reset command.

(4) Synchronous encoder axis main shaft differential gear present value

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	D686 D687	D686 D687	(○: Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Synchronous encoder axis main shaft differential gear present value	Backup	○	SCPU← PCPU	3.5ms	

(a) Synchronous encoder axis main shaft differential gear present value storage registers (D686, D687) ..... PCPU→SCPU data
1) When switching the virtual mode the present value will be the same as the main shaft side drive module present value.
2) When a present value change is carried out in relation to the main shaft side drive module, the present value of the main shaft differential gear will also be changed to the set present value at the same time.
3) If the differential gear is not connected to the main shaft, the main shaft drive module present value will always be stored in the main shaft differential gear present value storage register.

6.3 Virtual Servo Motor/Synchronous Encoder Control Change

This section provides explanations regarding virtual servo motor present value changes, speed change JOG speed changes, and synchronous encoder present value changes.
Present value changes are carried out using the CHGA instruction/DSFLP instruction and speed changes are conducted using the CHGV instruction/DSFLP instruction. Refer to the Motion Controller (SV13/SV22 REAL Mode) Programming Manual for details regarding the CHGA instruction/CHGV instruction/DSFLP instruction.

6.3.1 Virtual servo motor control change

(1) Control change registers

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M960 to M965	M960 to M965	(○: Valid)
2	M966 to M971	M966 to M971	
3	M972 to M977	M972 to M977	
4	M978 to M983	M978 to M983	
5	M984 to M989		
6	M990 to M995		
7	M996 to M1001		
8	M1002 to M1007		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Present value change register	○	○	SCPU→ PCPU		DSFLP execution
2 3	Speed change register					DSFLP execution
4 5	JOG speed setting register (*1)					At driving

(*1) ▭ represents a backup register.

(a) Present value change register (D960+ 6n)
..... Data sent from SCPU to PCPU
1) When the feed present value of an axis that is stopped is changed, the feed present value after the change is stored in the register.
2) The setting range of the present value change register is –2147483648 (-2^{31}) pulse to 2147483647 ($2^{31}-1$) pulse.
3) When the positioning control change instruction (DSFLP/CHGA)[*1] is executed, the value set in the present value change register becomes the feed present value.

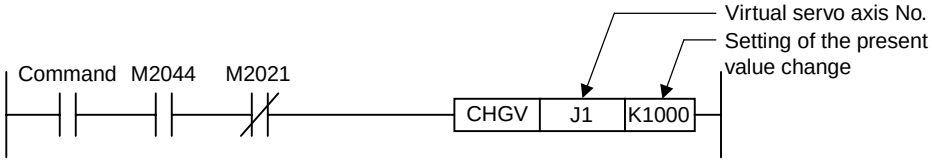
(b) Speed change register (D962+ 6n) ..... Data sent from SCPU to PCPU
1) When a speed change occurs at an axis in motion, the new speed is stored in this register.
2) The speed change register's setting range is "1 to 1000000 pulse/s".
3) When a positioning control change instruction (DSFLP/CHGV)*1 is executed, the value designated in the speed change register will become the positioning speed value.

REMARK

*1: For details regarding the positioning control change instructions, see Section 5.4 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).

(c) JOG speed setting register (D964+ 6n) ..... Data sent from SCPU to PCPU
1) The JOG speed which is used at JOG operations is stored in this register.
2) The JOG speed setting range is 1 to 1000000 pulse/s.
3) The JOG speed setting stored in this register is adopted at the leading edge (OFF→ON) of the JOG START signal.
Even if the JOG speed setting is changed while a JOG operation is in progress, the JOG speed will remain unchanged.
4) For details regarding JOG operation, see Section 7.19 of the Motion Controller (SV13/22) Programming Manual (REAL Mode).

(2) Present value change
(a) Present value change by the CHGA instruction
A program example is illustrated below.
Virtual servo motor present value change program (when the virtual servo motor axis 1 feed present value is changed to 1000 pulses)

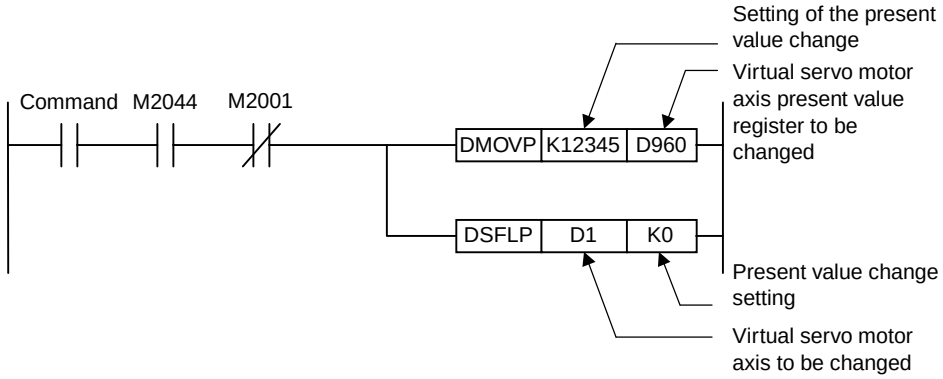


REMARK

(1) M2001: Start accept flag (see section 4.2.2)

(2) M2044: REAL mode/VIRTUAL mode status flag (see section 4.2.20)

(b) Present value change by the DSFLP instruction
A program example is illustrated below.
Virtual servo motor present value change program (when the virtual servo motor axis 1 feed present value is changed to 12345 pulses)



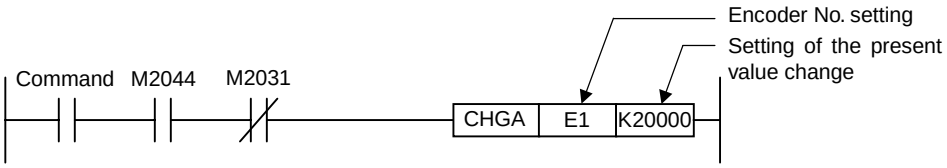
REMARKS

(1) M2001: Start accept flag (see section 4.1.8 (2))

(2) M2044: REAL mode/VIRTUAL mode status flag (see section 4.1.8 (13))

6.3.2 Synchronous encoder control change

(1) Present value change by the CHGA instruction
A program example is given below.
Synchronous encoder present value change program (when encoder No. 1 is changed to a value of 20000 pulses)



(a) The change in the present value and speed are set using the devices described below.
- Indirect setting ..... Data register (D), Link register (W), File register (R) } Double word
- Direct setting ..... Decimal constant (K)

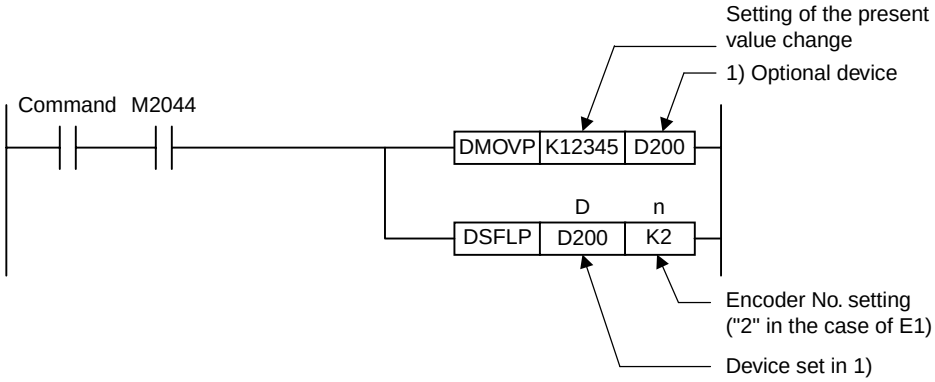
(b) The encoder No. setting range is described below.
- Encoder No. 1 ..... E1

(c) Precautions
- When a synchronous encoder present value change is carried out in the REAL mode an error will occur and the present value change will not be carried out.
- A synchronous encoder present value change can be executed in the VIRTUAL mode even while operation is in progress (during pulse input from the synchronous encoder).
  When the present value is changed the synchronous encoder present value will be continued from the changed value.
- Even if a synchronous encoder present value change is carried out, it will have no effect on the output module present value.

REMARK

(1) M2044: REAL mode/VIRTUAL mode status flag (see section 4.1.8 (13))

(2) Present value change by the DSFLP instruction
Synchronous encoder present value change program (when encoder No. 1 is changed to a value of 12345 pulses)



(a) The devices that can be used in "D" and "n" described above are given below.
- D..... Data register (D)
  Link register (W)
  File register (R)
  Timer (T)
  Counter (C)
- n ..... Decimal constant (K)
  Hexadecimal constant (H)

(b) The encoder No. setting method is given below.
- Encoder No. 1 .....K2/H2

(c) Precautions

- When a synchronous encoder present value change is carried out in the REAL mode an error will occur and the present value change will not be carried out.
- A synchronous encoder present value change can be executed in the VIRTUAL mode even while operation is in progress (during pulse input from the synchronous encoder).
  When the present value is changed the synchronous encoder present value will be continued from the changed value.
- Even if a synchronous encoder present value change is carried out, it will have no effect on the output module present value.

REMARK

(1) M2044: REAL mode/VIRTUAL mode status flag (see section 4.1.8 (13))

7. TRANSMISSION MODULE

There are the following four types of transmission module.

- Gear..... Section 7.1
- Clutch..... Section 7.2
- Speed change gear ..... Section 7.3
- Differential gear ..... Section 7.4

The following describes the device range and procedure for indirect setting of items by devices among transmission module parameters.

(1) Device range

The following shows the number of device words and device range during indirect setting.

<table>
<tr><th rowspan="2">Module</th><th rowspan="2">Item</th><th rowspan="2">Number of device words</th><th colspan="2">Device setting range</th><th rowspan="2">Remark</th></tr>
<tr><th>A172SHCPU</th><th>A171SHCPU</th></tr>
<tr><td rowspan="6">Clutch</td><td>Clutch ON/OFF command device</td><td>Bit</td><td colspan="2"><table><tr><th>Device</th><th>Range</th></tr><tr><td>X</td><td>000 to 7FF</td></tr><tr><td>Y</td><td>000 to 7FF</td></tr><tr><td>M/L</td><td>0 to 2047</td></tr><tr><td>B</td><td>000 to 3FF</td></tr><tr><td>F</td><td>0 to 255</td></tr><tr><td>TT (timer contact)</td><td>0 to 255</td></tr><tr><td>TC (timer coil)</td><td>0 to 255</td></tr><tr><td>CT (counter contact)</td><td>0 to 255</td></tr><tr><td>CC (counter coil)</td><td>0 to 255</td></tr></table></td><td></td></tr>
<tr><td>Mode setting device</td><td>1</td><td colspan="2" rowspan="5"><table><tr><th>Device</th><th>Range</th></tr><tr><td>D</td><td>0 to 799</td></tr><tr><td>W</td><td>000 to 3FF</td></tr></table></td><td rowspan="5"></td></tr>
<tr><td>Clutch ON address setting device</td><td>2</td></tr>
<tr><td>Clutch OFF address setting device</td><td>2</td></tr>
<tr><td>Slippage setting device</td><td>2</td></tr>
<tr><td rowspan="2">Gear</td><td>Number of input axis gear teeth</td><td>1</td></tr>
<tr><td>Number of output axis gear teeth</td><td>1</td></tr>
<tr><td>Speed change gear</td><td>Speed change ratio setting device</td><td>1</td></tr>
</table>

POINTS

- For items set using two words, always set an even numbered device. In addition, when setting data in the sequence program for that device, always use the DMOV (P) command.
- When a two word monitor device leads the sequence program, always acquire it in the user device using the DMOV (P) command. Use the fetched device for carrying out such things as upper/lower comparison and calculations.

(2) Device data fetch
When the data of a device that has been set indirectly is switched from the REAL to VIRTUAL mode, first acquire everything as default values and thereafter carry out fetch control during virtual mode operation for the corresponding module.
Shown in the table below are the fetch timing of each device and the refresh cycle of the set device. The device fetch timing and device refresh cycle are the same for both A172SHCPU and A171SHCPU.

Module	Item	Fetch Device	Refresh Device	Device Fetch Timing		Device Refresh Cycle
				REAL→ VIRTUAL Mode Switching	During VIRTUAL Mode Operation	
Clutch	Clutch ON/OFF command device	○	——	○	Fetched every 3.5 ms (calculation cycle)	——
	Mode setting device	○	——	○		
	Clutch ON address setting device	○	——	○		
	Clutch OFF address setting device	○	——	○		
	Slippage setting device	○	——	○	——	
Gear	Number of input axis gear teeth	○	——	○	Fetched when the present value change of the connection source drive module (virtual servo motor axis/synchronous encoder axis) is executed (CHGA) and the gear ratio change is carried out	
	Number of output axis gear teeth	○	——	○		
Speed change gear	Speed change ratio setting device	○	——	○	Fetched every 3.5 ms (calculation cycle)	

7. TRANSMISSION MODULE

7.1 Gear

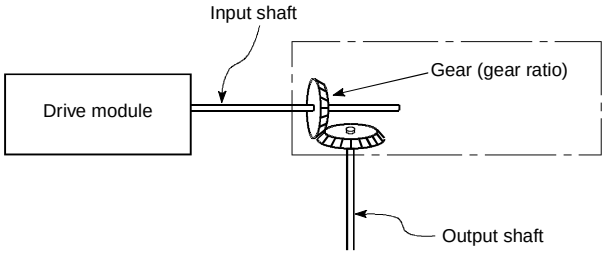
The operation of the gear and the parameters required to use a gear are explained here.

7.1.1 Gear operation

(1) The gear transfers a number of pulses which is the travel value (number of pulses) of the drive module (virtual servo motor, synchronous encoder) multiplied by the gear ratio set in the parameters, to the output shaft

[Number of output shaft pulses] = [Number of input shaft pulses] × [gear ratio] (Units: pulses)

(2) The direction of rotation of the output shaft is set in the gear parameters.



REMARK

See Section 7.1.2 for details on the gear parameters.

7.1.2 Parameters

The gear parameters are presented in Table 7.1, and the items in this table are explained in (1) and (2) below. (For the method for setting gear parameters, refer to the SW2SRX-GSV22PE/SW0IX-CAMPE Operating Manual.)

Table 7.1 Parameter List

No.	Setting Item		Setting Default Value	Setting Range	
				Direct Setting	Indirect Setting
1	Gear ratio	Number of gear teeth at input shaft (GI)	1	1 to 65535	D0 to D799 W0 to W3FF
		Number of gear teeth at output shaft (GO)	1	1 to 65535	D0 to D799 W0 to W3FF
2	Direction of rotation of output shaft		Forward	Forward Reverse	——

7. TRANSMISSION MODULE

(1) Gear ratio

(a) The gear ratio is the setting which determines the number of output pulses that are transmitted to the output shaft for every pulse from the drive module.

(b) The gear ratio is determined by the settings for the number of gear teeth at the input shaft (GI) and the number of gear teeth at the output shaft (GO).

$$\text{Gear ratio} = \frac{\text{Number of gear teeth at input shaft (GI)}}{\text{Number of gear teeth at output shaft (GO)}}$$

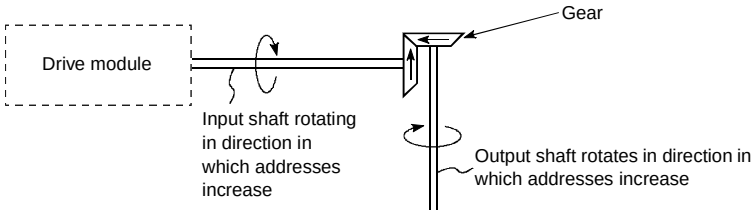
(2) Direction of rotation of output shaft

(a) This is the setting for the direction of rotation of the output shaft with respect to the direction of rotation of the input shaft.

(b) There are two directions of rotation for the output shaft: forward and reverse.

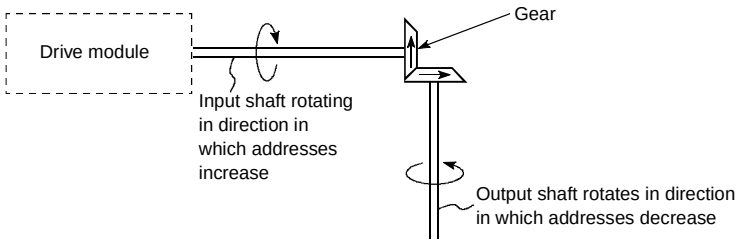
1) Forward

When the input shaft rotates in the direction in which addresses increase, the output shaft also rotates in the direction in which addresses increase.



2) Reverse

When the input shaft rotates in the direction in which addresses increase, the output shaft rotates in the direction in which addresses decrease.



7.2 Clutch

There are two types of clutch: the smoothing clutch and the direct clutch. These two clutches operate in the same way; the difference is that with the smoothing clutch, acceleration and deceleration processing by smoothing processing is executed when the clutch is switched ON and OFF but this does not happen with the direct clutch.

(1) Comparison of smoothing clutch and direct clutch

(a) Smoothing clutch

When the clutch is switched ON/OFF, the output to the output shaft is executed by acceleration and deceleration processing (smoothing processing) in accordance with the smoothing time constant or amount of slip set in the clutch parameters.

(b) Direct clutch

When the clutch is switched ON/OFF, output to the output shaft is executed without acceleration and deceleration processing.

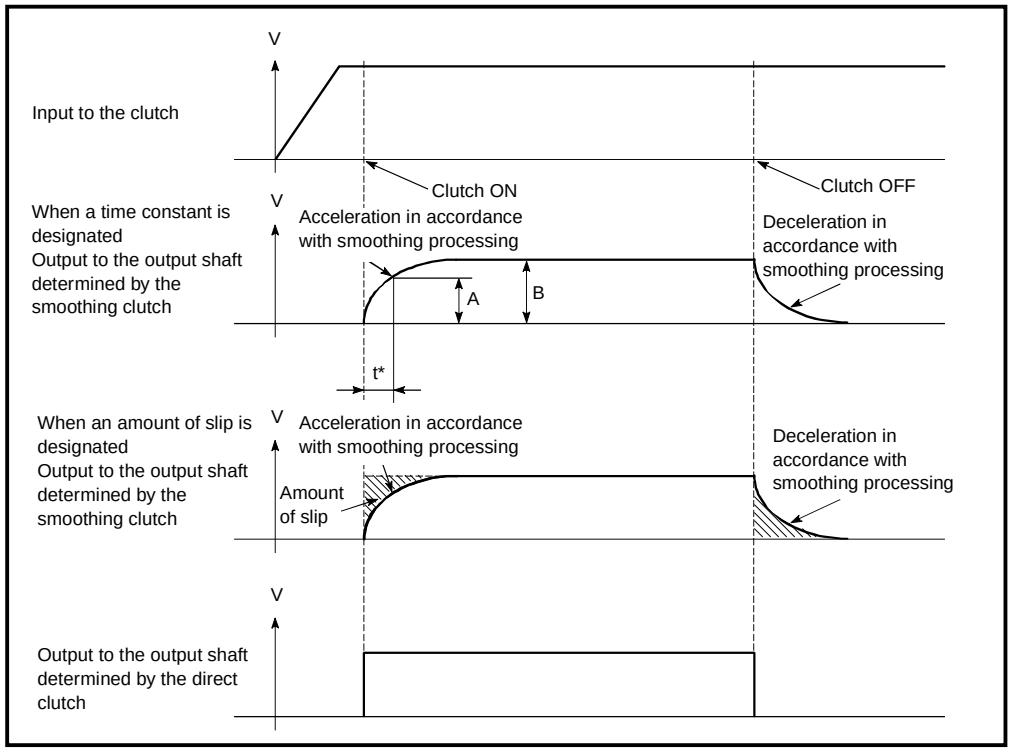
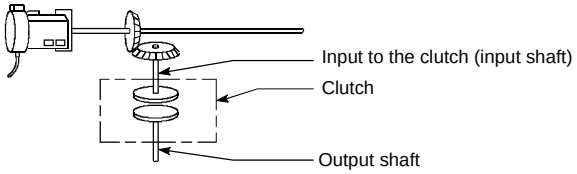


Fig. 7.1 Output to the Output Shaft Determined by the Smoothing Clutch and Direct Clutch

REMARKS

(1) Clutch ON/OFF status
- Clutch ON status.....The status in which pulses input to the clutch are output to the output shaft.
- Clutch OFF status.....The status in which pulses input to the clutch are not output to the output shaft.



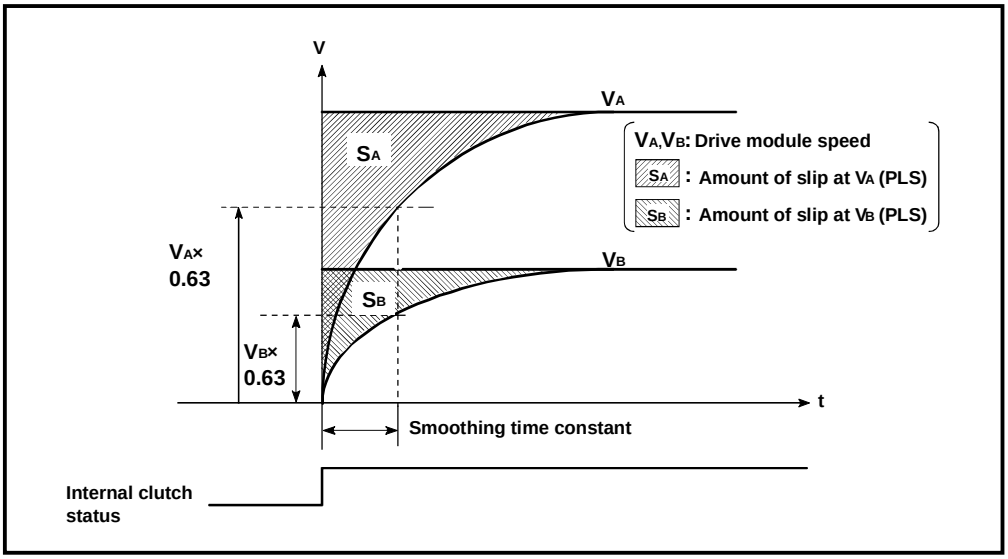
(2) ∗..... t: Smoothing time constant "t" is the time taken to reach the following condition:

$$t = \frac{A}{B} \times 100 = 63\%$$

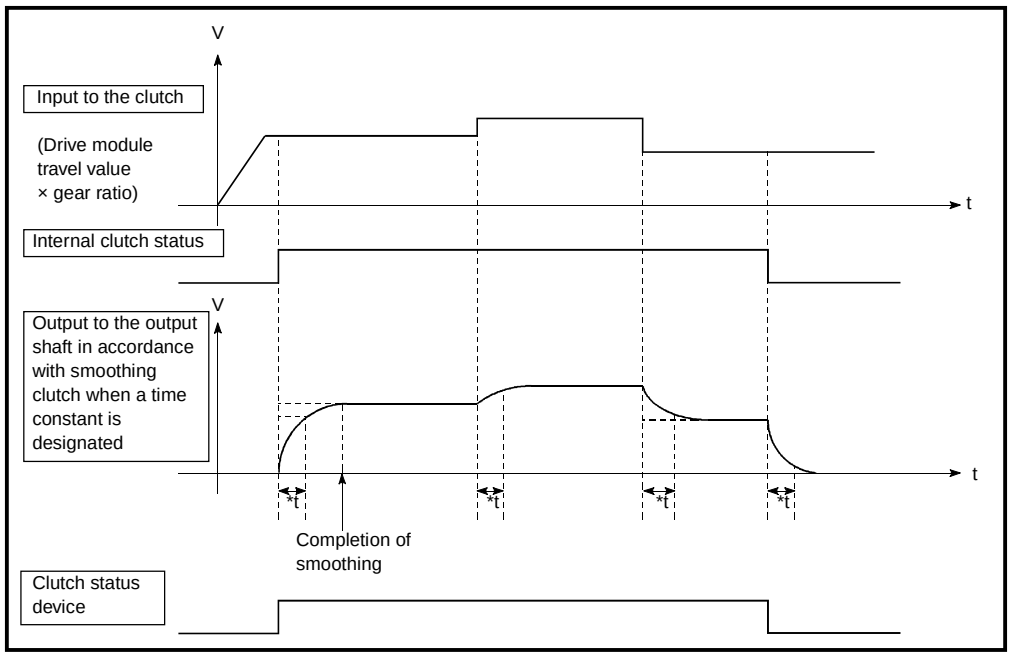
(2) Smoothing processing

(a) Method in which a smoothing time constant is designated

1) Since the time constant is fixed, the amount of slip of the clutch changes according to the speed of the drive module.



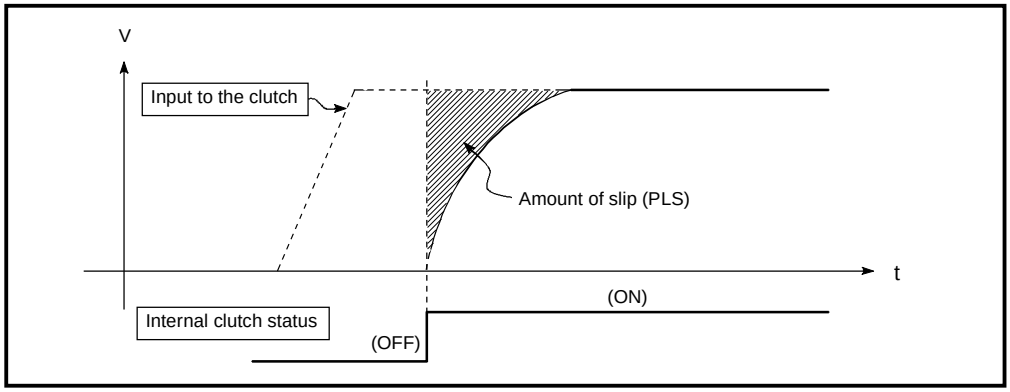
2) If the input to the clutch (drive module travel value × gear ratio) changes after completion of smoothing, smoothing processing is executed at that point also.



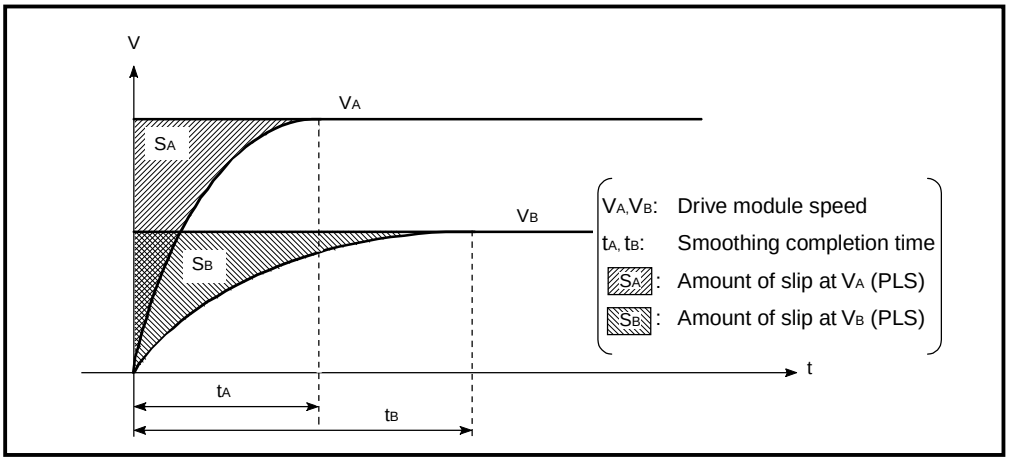
*t: Smoothing time constant

(b) Method in which the amount of slip is designated

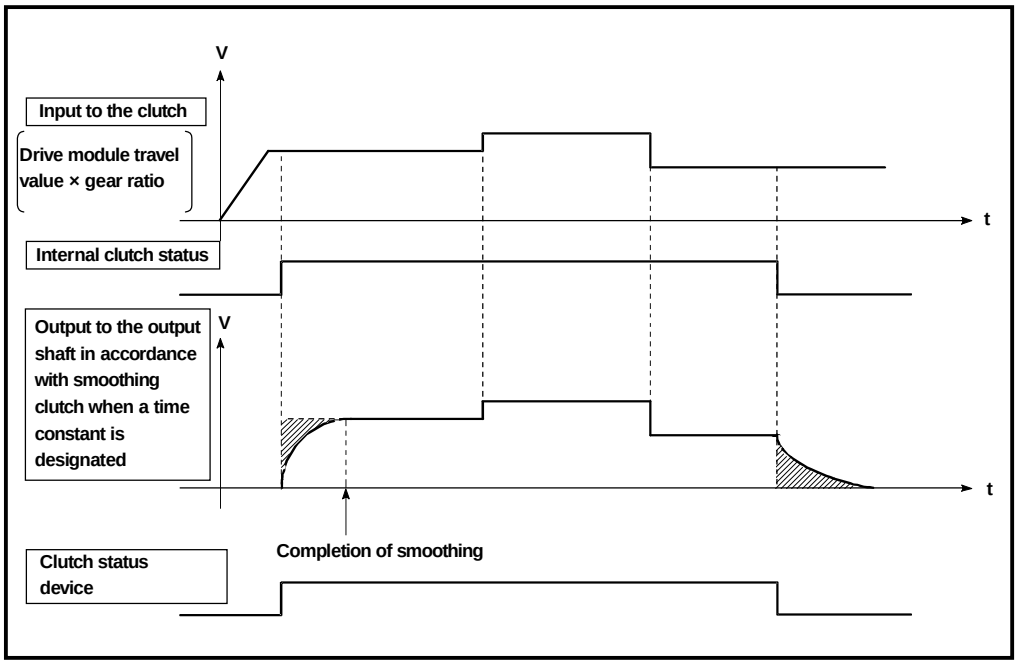
1) Designate the amount of slip indicated by the shaded area in the diagram below. You are recommended to designate an amount of slip that is greater than the input to the clutch (drive module travel value × gear ratio).



2) Since the amount of slip remains constant even if the drive module speed changes, the clutch ON/OFF position can be controlled without any influ-ence from speed changes.



3) If the input to the clutch (drive module travel value × gear ratio) changes after completion of smoothing, smoothing processing is not executed at that point and direct output continues.



7.2.1 Explanation of clutch operation

There are three clutch modes:
- ON/OFF mode
- Address mode
- External input mode

Each of these modes is explained below.

(1) ON/OFF mode

(a) In this mode, the clutch is turned ON and OFF in accordance with the ON/OFF status of the clutch ON/OFF command device.
1) When the clutch ON/OFF command device comes ON, the clutch is set to the ON status.
2) When the clutch ON/OFF command device goes OFF, the clutch is set to the OFF status.

(b) In the ON/OFF mode, there is a maximum time lapse of 7.1 ms between the ON/OFF of the clutch ON/OFF device and the clutch being set to the ON/OFF status.
If greater accuracy is required, use the "address mode".

(c) The clutch ON/OFF status can be checked by means of the clutch ON/OFF status device.

Connected Module		Corresponding Device	
		A172SHCPU	A171SHCPU
Output module for axis 1	Drive shaft	M1984	M1984
	Auxiliary input shaft	M1985	M1985
Output module for axis 2	Drive shaft	M1986	M1986
	Auxiliary input shaft	M1987	M1987
Output module for axis 3	Drive shaft	M1988	M1988
	Auxiliary input shaft	M1989	M1989
Output module for axis 4	Drive shaft	M1990	M1990
	Auxiliary input shaft	M1991	M1991
Output module for axis 5	Drive shaft	M1992	——
	Auxiliary input shaft	M1993	——
Output module for axis 6	Drive shaft	M1994	——
	Auxiliary input shaft	M1995	——
Output module for axis 7	Drive shaft	M1996	——
	Auxiliary input shaft	M1997	——
Output module for axis 8	Drive shaft	M1998	——
	Auxiliary input shaft	M1999	——

(d) See Appendix 2 for details about the refresh period of the clutch ON/OFF status device.

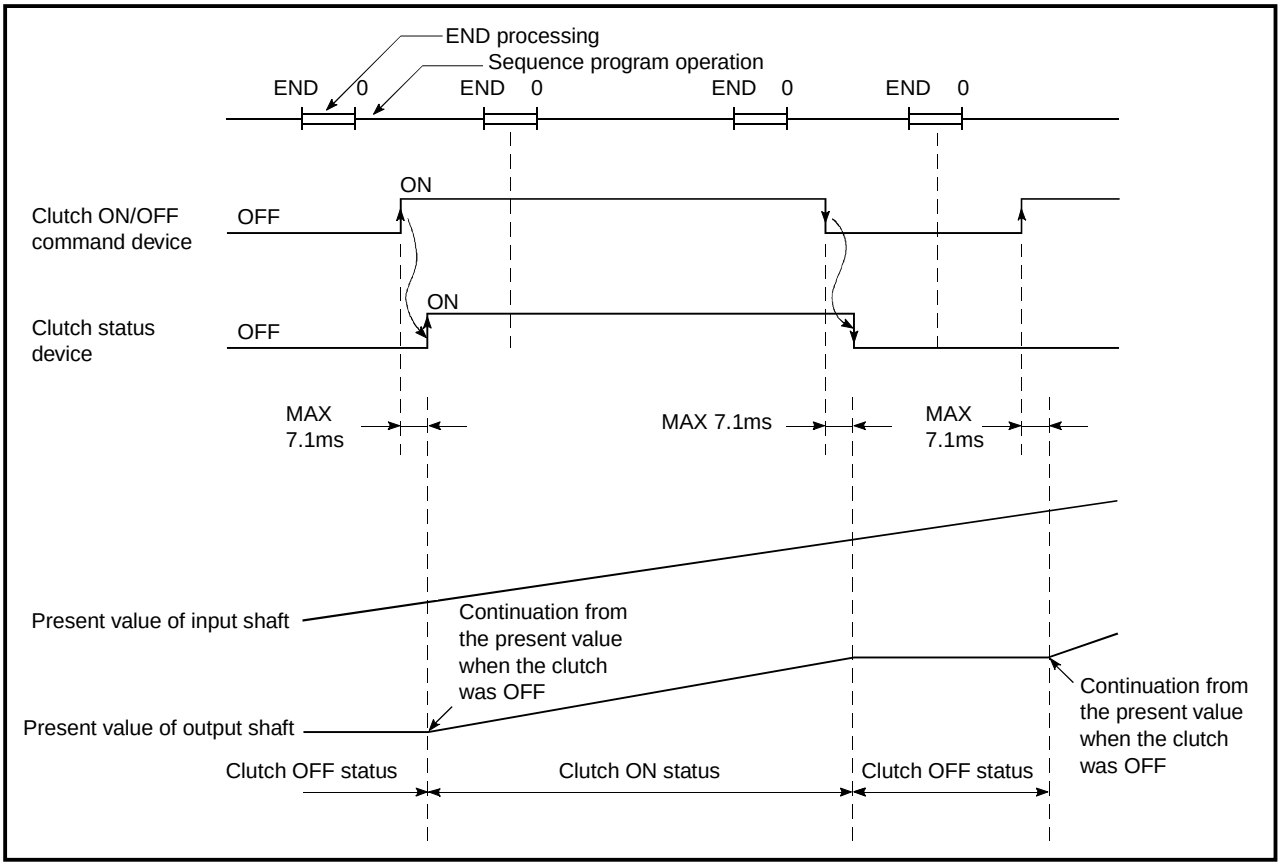


Fig. 7.2 Operation Timing for the ON/OFF Mode

(2) Address mode

(a) In this mode, the clutch is turned ON and OFF in accordance with the clutch ON/OFF command device and the present value of the virtual axis (effective when the mode setting device is set to "1").

1) When the designated clutch ON address is reached while the clutch ON/OFF command is ON, the clutch is set to the ON status.
2) When the designated OFF address is reached while the clutch ON/OFF command is OFF, the clutch is set to the OFF status.

(b) The clutch ON/OFF control differs according to the type of output module connected.

1) If the output module is a ball screw or roller, ON/OFF control is executed in accordance with the present value of the virtual axis.
If a differential gear is connected to the main shaft, ON/OFF control is executed in accordance with the present value after the main shaft's differential gear.
2) If the output module is a rotary table or cam, ON/OFF control is based on the virtual axis present value in one revolution.
(See Rotary Tables and Cams in Section 8 "Output Modules" for details.)

(c) Make sure that the clutch ON/OFF command device is turned ON/OFF, and the status in which the clutch ON/OFF address can be accepted is established, before the present value of the virtual axis reaches the clutch ON/OFF address.
In the address mode, a delay occurs from the time the clutch ON/OFF command device is turned ON/OFF until the clutch ON/OFF address can be accepted.
See Appendix 2 for details about the delay times.
1) When the clutch ON/OFF device is OFF, the clutch will not be set to the ON status even if the clutch ON address is reached.
2) When the clutch ON/OFF device is ON, the clutch will not be set to the OFF status even if the clutch OFF address is reached.

(d) The clutch ON/OFF status can be checked by means of the clutch ON/OFF status device.

Connected Module		Corresponding Device	
		A172SHCPU	A171SHCPU
Output module for axis 1	Drive shaft	M1984	M1984
	Auxiliary input shaft	M1985	M1985
Output module for axis 2	Drive shaft	M1986	M1986
	Auxiliary input shaft	M1987	M1987
Output module for axis 3	Drive shaft	M1988	M1988
	Auxiliary input shaft	M1989	M1989
Output module for axis 4	Drive shaft	M1990	M1990
	Auxiliary input shaft	M1991	M1991
Output module for axis 5	Drive shaft	M1992	——
	Auxiliary input shaft	M1993	——
Output module for axis 6	Drive shaft	M1994	——
	Auxiliary input shaft	M1995	——
Output module for axis 7	Drive shaft	M1996	——
	Auxiliary input shaft	M1997	——
Output module for axis 8	Drive shaft	M1998	——
	Auxiliary input shaft	M1999	——

(e) See Appendix 2 for details about the refresh period of the clutch ON/OFF status device.

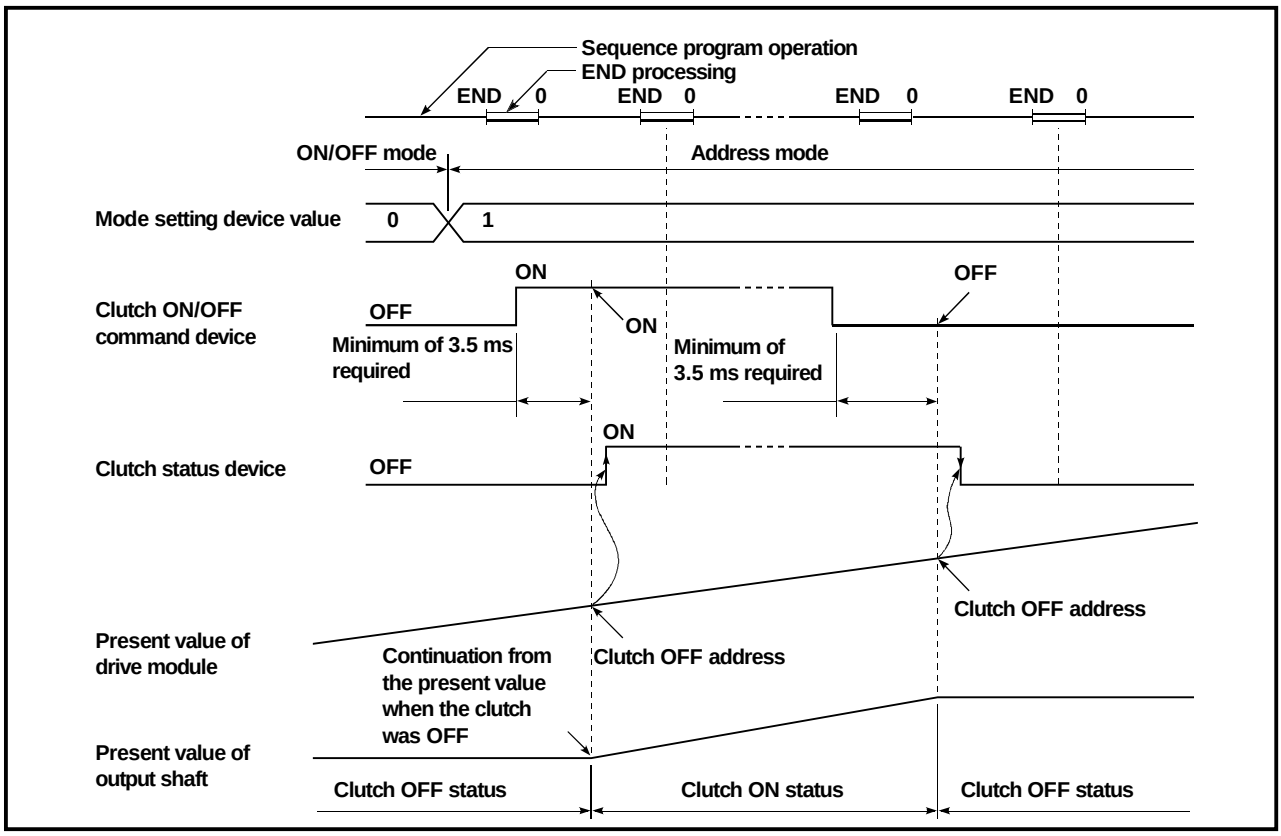


Fig. 7.3 Operation Timing for the Address Mode

POINT

(1) If the mode setting device stores a value other than "0" or "1", this is regarded as an error and control is continued on the basis of the previously set value.
(2) See Appendix 2 for details about reading periods of the clutch ON/OFF address setting device value.
(3) Control mode changes (mode setting device value: 0↔1) are valid at any time.

(3) External input mode

(a) In this mode the clutch is turned ON and OFF in accordance with the clutch ON/OFF command bit device and the external input (TREN signal: synchronous encoder start signal).
Since the input pulses from the synchronous encoder are counted in response to the leading edge of the external input signal, the clutch in this mode gives high-speed response and high accuracy.
1) The clutch is set to the ON status at the leading edge (OFF→ON) of the external input signal after the clutch ON/OFF command bit device has come ON.
2) When the clutch ON/OFF command bit device goes OFF, the clutch is set to the OFF status after a maximum delay of 7.1 ms.

(b) Make sure that the clutch ON/OFF command device is turned ON and the external input acceptance enabled status is established before the external input (TREN signal) comes ON.
In the external input mode, a maximum of 7.1 ms is required after the clutch ON/OFF command device comes ON before the external input acceptance enabled status is established.
1) When the clutch ON/OFF command device is OFF, the clutch is not set to the ON status even if the external input changes from OFF to ON.
2) When the external input is ON, the clutch is not set to the ON status even if the clutch ON/OFF status comes ON.
3) Even if the external input goes OFF after the clutch has been set to the ON status, the clutch will remain ON.

(c) The clutch ON/OFF status can be checked by means of the clutch ON/OFF status device.
The ON/OFF status of the clutch status device is refreshed at 3.5 ms intervals.

Connected Module		Corresponding Device	
		A172SHCPU	A171SHCPU
Output module for axis 1	Drive shaft	M1984	M1984
	Auxiliary input shaft	M1985	M1985
Output module for axis 2	Drive shaft	M1986	M1986
	Auxiliary input shaft	M1987	M1987
Output module for axis 3	Drive shaft	M1988	M1988
	Auxiliary input shaft	M1989	M1989
Output module for axis 4	Drive shaft	M1990	M1990
	Auxiliary input shaft	M1991	M1991
Output module for axis 5	Drive shaft	M1992	——
	Auxiliary input shaft	M1993	——
Output module for axis 6	Drive shaft	M1994	——
	Auxiliary input shaft	M1995	——
Output module for axis 7	Drive shaft	M1996	——
	Auxiliary input shaft	M1997	——
Output module for axis 8	Drive shaft	M1998	——
	Auxiliary input shaft	M1999	——

(d) The present value of the input shaft (virtual axis) only changes when the clutch is in the ON status.

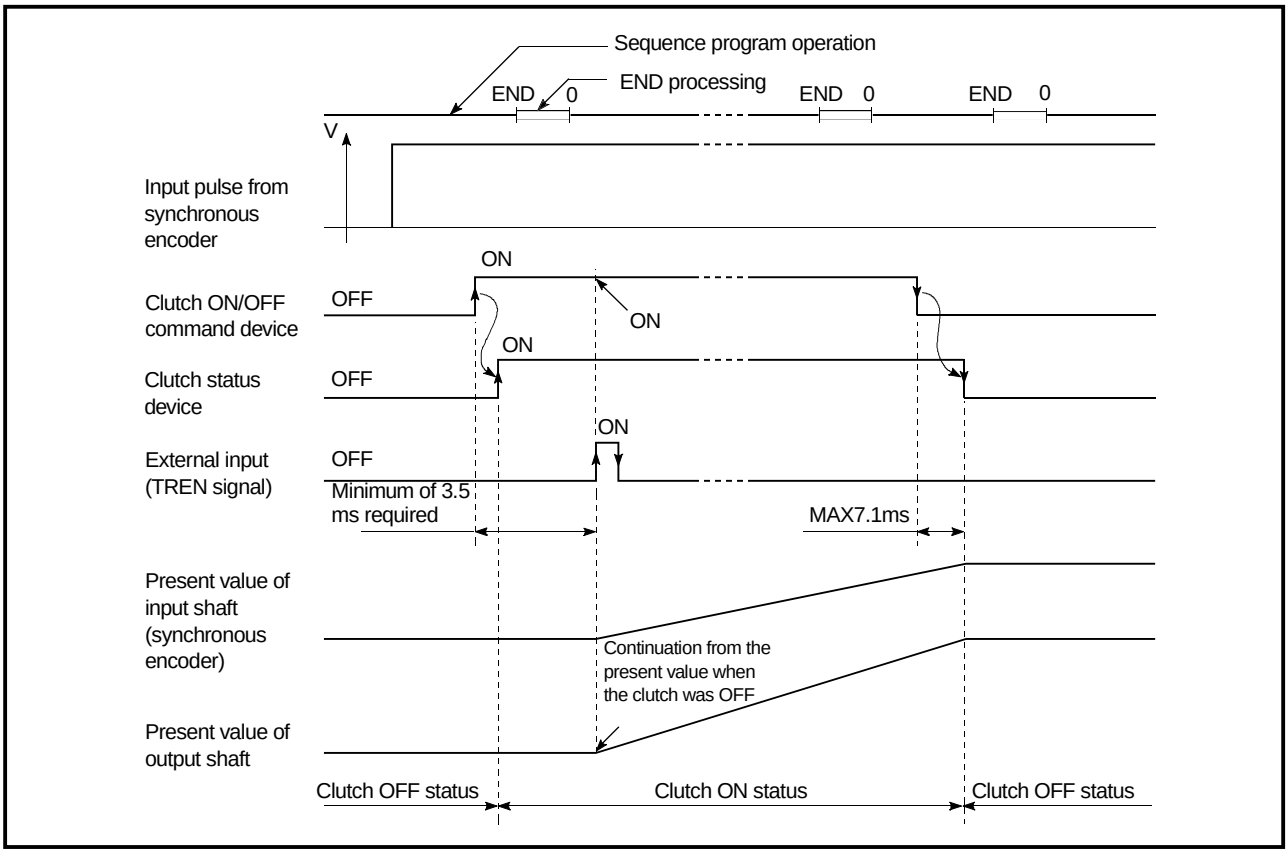


Fig. 7.4 Operation Timing for the External Input Mode

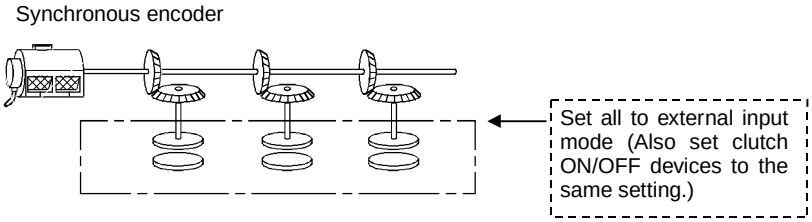
(e) When using the external input mode, only axes for which an incremental synchronous encoder (manual pulse generator) is set as the drive module can be used. Axes for which an absolute synchronous encoder is set as the drive module cannot be used.

(f) A synchronous encoder, external input and external input mode clutch can only be set in a 1:1 ratio.
The relationship between the synchronous encoder and external input is shown in the table below.

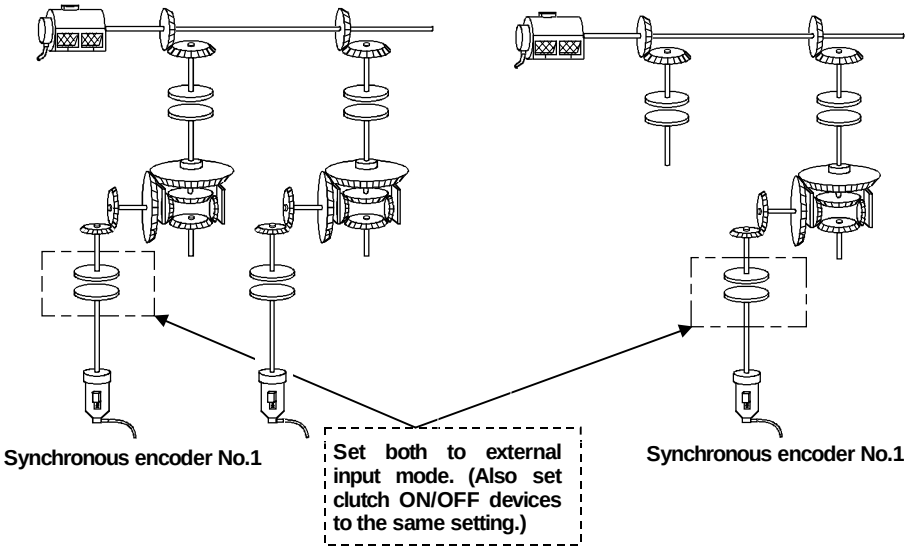
Synchronous Encoder	External Input (TREN Signal)
P1/E1	TREN 1

(g) If the clutch connected to an encoder is used in the external input mode, all other clutches connected to the same encoder number must be set to the external input mode.
However, it is permissible to use a combination of direct clutches and smoothing clutches.

Example 1 **Synchronous encoder connected to a drive shaft**
If an external input mode clutch is used, set all clutches connected to the synchronous encoder to the external input mode. (Also set clutch ON/OFF devices to the same setting.)

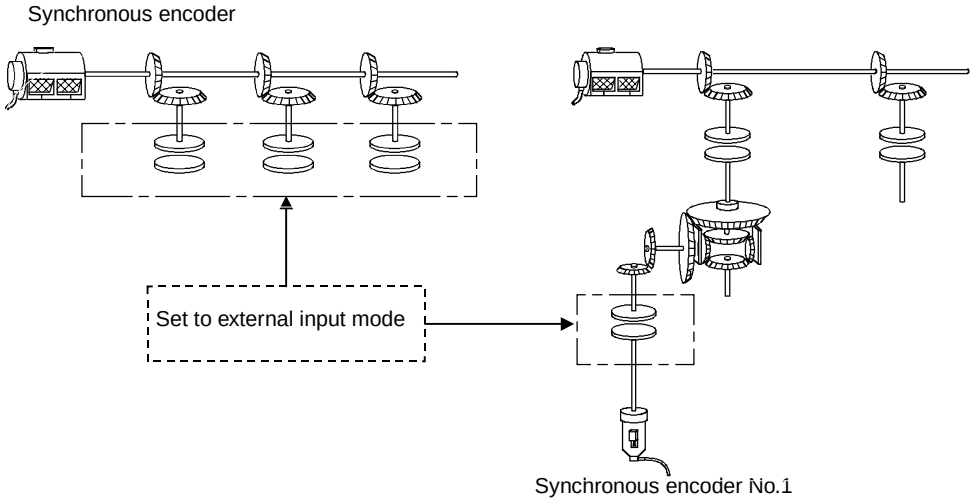


Example 2 **Synchronous encoder connected to auxiliary input shafts**
Set all the clutches connected to the same synchronous encoder set to the external input mode. (Also set clutch ON/OFF devices to the same setting.)



Example 3 **Same synchronous encoder connected to a drive shaft and auxiliary input shaft**

Set all the connected clutches to the external input mode. (See examples 1 and 2)



7.2.2 Parameters

The clutch parameters are presented in Table 7.2 and each item in this table is explained in (1) through (6) below. For the method for setting clutch parameters, refer to the SW2SRX-GSV22PE/SW0IX-CAMPE Operating Manual.

Table 7.2 Parameter List

No.	Setting Item	Default Value	Setting Range			Setting Possible	
1	Control Mode	ON/OFF mode	ON/OFF mode	ON/OFF mode Address mode in conjunction	External input mode	Direct clutch	Smoothing clutch
2	Mode setting device (1 word)	——	——	Word device	——	○	○
3	Clutch ON/OFF command device	——	Bit device			○	○
4	Clutch ON address setting device (2 words)	——	——	Word device	——	○	○
5	Clutch OFF address setting device (2 words)						
6	Clutch status storage device	——	——			——	——
7	Smoothing method	Time constant designation	Time constant designation/ Amount of slip designation			——	○
8	Smoothing time constant	0	0 to 65535ms			——	○
9	Amount of slip setting device (2 words)	——	Word device			——	○

(1) Control mode

(a) This is the setting for the mode used to switch the clutch ON/OFF.
The following three modes can be set:
- ON/OFF mode
- ON/OFF mode and address mode in conjunction
- External input mode

For details on each of the control modes, see Section 7.2.1.

(b) If a synchronous encoder is used as the drive module, the control modes that can be set differ depending on the encoder interface connected to the A172SENC/A171SENC.

A172SENC/A171SENC Encoder Interface	Clutch Control Mode		
	ON/OFF Mode	Address Mode	External Input Mode
Manual pulse generator input (INC)	○	○	○
Serial encoder input (ABS)	○	○	×

○: Can be set ×: Cannot be set

(2) Mode setting device (set only when using ON/OFF mode and address mode in conjunction; 1 word)

(a) This is the device used to switch between the ON/OFF mode and the address mode.
The settings of the mode setting device are as follows:
- 0 : ON/OFF mode
- 1 : Address mode

If a value other than 0 or 1 is set, this is regarded as an error and the previously set mode remains in effect.

(b) The following devices can be used as the mode setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

(3) Clutch ON/OFF command device

(a) This device is used to execute the clutch ON/OFF command.

(b) The following devices can be used as the clutch ON/OFF command device.

Device Type	A172SHCPU/A171SHCPU
Input	X0 to X7FF
Output	Y0 to Y7FF
Internal relay/ latch relay	M/L0 to M/L1959
Timer	TC0 to TC255 (timer coil)
	TT0 to TT255 (timer contact)
Counter	CC0 to CC255 (counter coil)
	CT0 to CT255 (counter contact)
Link relay	B0 to B3FF

*1: The area used for the synchronous encoder shaft cannot be set.

(4) Clutch ON/OFF address setting device (can only be set when the ON/OFF mode and address mode are used in conjunction; 2 words for each mode)
(a) This device serves to set the address at which the clutch is switched ON and address at which the clutch is switched OFF in the address mode.

(b) The following devices can be used as clutch ON/OFF address setting devices:

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1: If a cam is used at the output module, the area used for the cam cannot be set.

*2: If a differential gear is connected to the main shaft, the area it uses cannot be set.

*3: The first device number of the devices must be an even number.

(c) The applicable range for clutch ON/OFF address settings is as follows.
1) When the output module is a ball screw or roller
−2147483648 (-2^{31}) to 2147483647 ($2^{31}-1$) pulse
2) When the output module is a cam or rotary table
0 to number of pulses in one rotation

(5) Smoothing method
(a) Set the method used for smoothing processing at the clutch.
The following two methods can be set:
- Time constant designation
- Amount of slip designation

(b) For details on the operation with each method, see Section 7.2.

(6) Smoothing time constant
This is the time taken to reach 63% of the speed of the output shaft speed.

(7) Amount of slip setting device (2 words)
(a) This is the device used to set the amount of clutch slip.

(b) The following devices can be used as amount of slip setting devices.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1: If a cam is used at the output module, the area used for the cam cannot be set.

*2: If a differential gear is connected to the main shaft, the area it uses cannot be set.

*3: The first device number of the devices must be an even number.

(c) The applicable setting range for amount of slip is 0 to 2147483647 pulse.

7.3 Speed Change Gear

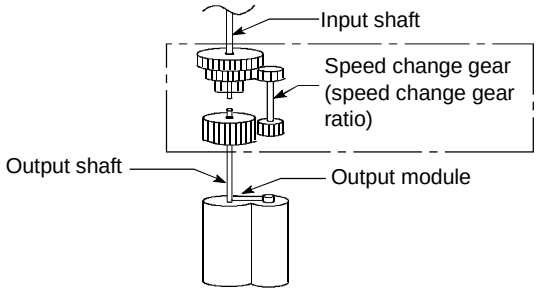
This section describes the operation of the speed change gear and the parameters required to use it.

7.3.1 Operation

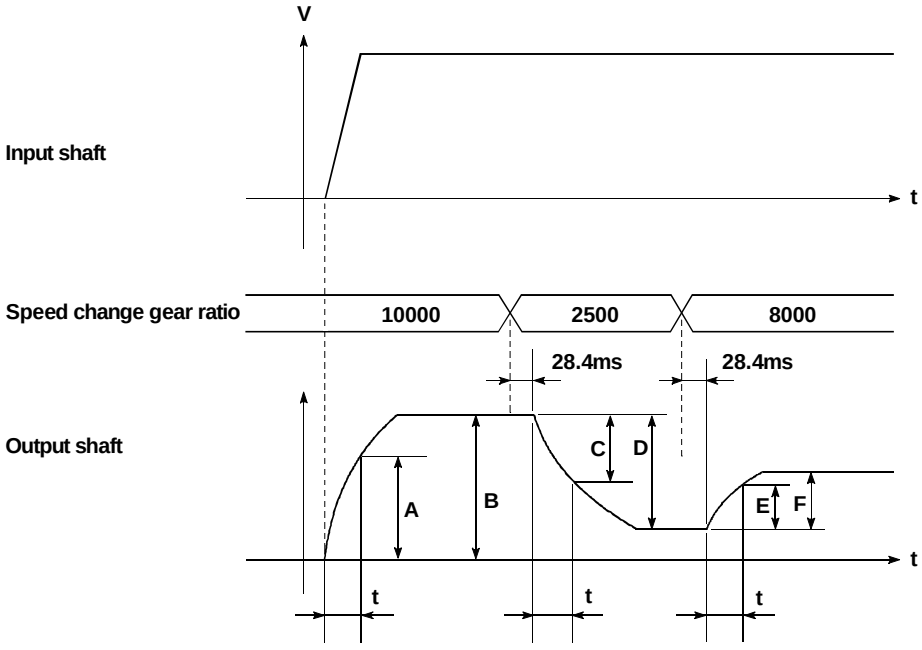
This section describes the operation of the speed-change gear.

(1) The speed change gear transmits a speed which is the input shaft speed multiplied by a speed change gear ratio set in the speed change gear ratio setting device, to the output shaft.

$$[\text{Output shaft speed}] = [\text{input shaft speed}] \times \frac{[\text{speed change gear ratio}]}{10000} \text{ (Units: pulse/s)}$$



(2) If the speed change gear ratio changes, acceleration and deceleration processing is executed in accordance with the smoothing time constant (t) set in the speed change gear parameters.



REMARK

"t" is the time taken to reach the following condition:

$$\frac{A}{B} \times 100 = \frac{C}{D} \times 100 = \frac{E}{F} \times 100 = 63\%$$

7.3.2 Parameter list

The speed change gear parameters are presented in Table 7.3 and each item in this table is explained in (1) through (3) below. For the method for setting speed change gear parameters, refer to the SW2SRX-GSV22PE/SW0IX-CAMPE Operating Manual.

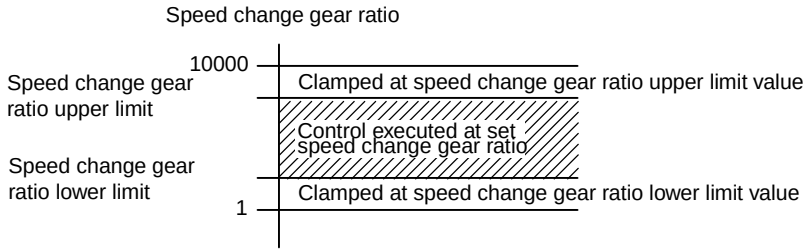
Table 7.3 Speed Change Gear Parameter List

No.	Setting Item	Default Value	Setting Range
1	Speed change gear ratio upper limit	10000	1 to 10000
2	Speed change gear ratio lower limit	1	1 to 10000
3	Speed change gear ratio setting device (1 word)	———	D0 to D799 W0 to W3FF
4	Smoothing time constant	0	0 to 65535(ms)

(1) Speed change gear ratio upper limit value/lower limit value

(a) This is the setting for the effective range (0.01% to 100%) for the speed change gear ratio set in the speed change gear ratio setting device.

(b) If the set value of the speed change gear ratio setting device is greater than the speed change gear ratio upper limit value, control is executed with the speed change gear ratio clamped at the upper limit value.
Conversely, if the set value of the speed change gear ratio setting device is smaller than the speed change gear ratio lower limit value, control is executed with the speed change gear ratio clamped at the lower limit value.



(c) The speed change gear ratio upper limit value/lower limit value is set in the range 1 to 10000, i.e. 100 times the settings actually made: 0.01% to 100%.

(d) Set the speed change gear ratio upper limit value/lower limit value in accordance with the formula below.

$$1 \leq \left\{ \begin{array}{c} \text{Speed change gear ratio} \\ \text{lower limit} \end{array} \right\} \leq \left\{ \begin{array}{c} \text{Speed change gear ratio} \\ \text{upper limit} \end{array} \right\} \leq 10000$$

(2) Speed change gear ratio setting device

(a) This is the setting for the device that sets the speed change gear ratio of the speed change gear.

(b) The following devices can be used as speed change gear ratio setting devices.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

(c) The setting range is from the speed change gear ratio lower limit value to the speed change gear ratio upper limit value.

(3) Smoothing time constant

This is the setting for the time taken to reach 63% of the output shaft speed.

7.4 Differential Gear

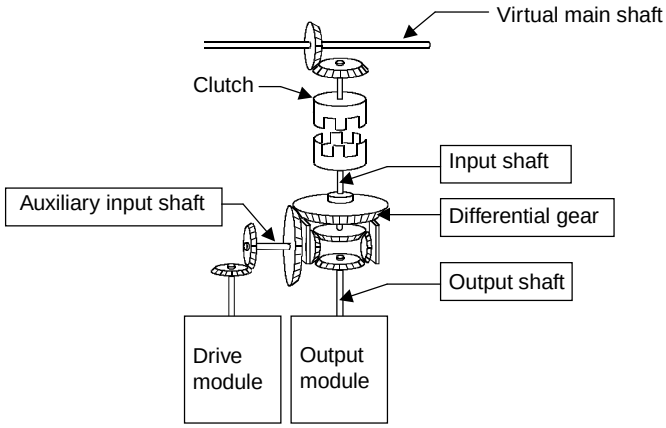
The differential gear is used for the following purposes;

- For shifting the output module phase or carrying out alignment of the operation start position
- For carrying out independent operation separated from the virtual main shaft

7.4.1 Operation

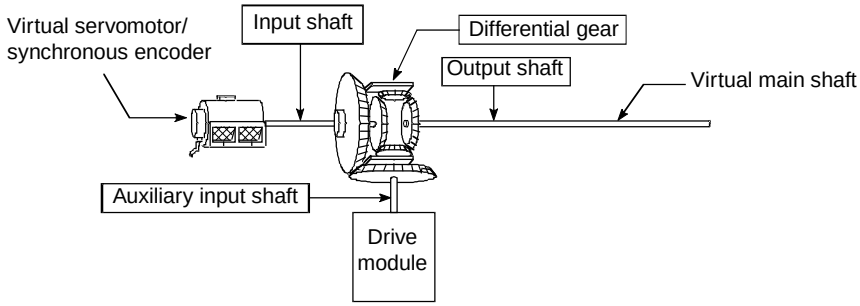
(1) When the input shaft clutch is engaged
The differential gear subtracts the auxiliary input shaft travel distance from the input shaft travel distance and transmits this to the output axis.

[Output shaft travel value]	=	[Input shaft travel value]	–	[Auxiliary input shaft travel value]	(Unit: pulse)



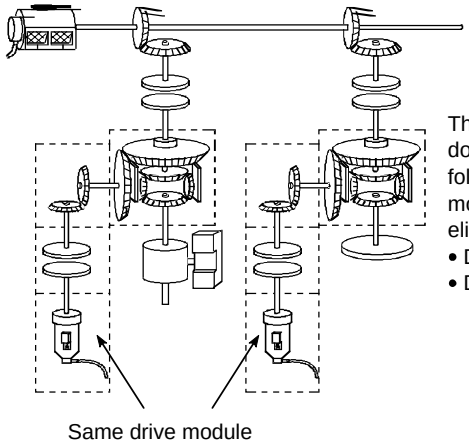
(2) When the input shaft clutch is disengaged
Independent operation is possible using the auxiliary input shaft since the differential gear transmits only the amount of travel from the auxiliary input shaft to the output shaft.

(3) When the differential gear is used to connect to the virtual main shaft
This is used for operation in which the main shaft is switched or when the same drive module is used as auxiliary input to control all blocks.



Set different drive modules for the virtual main shaft side and auxiliary input shaft side.

<Conventional mechanical system program>



The mechanical modules enclosed by the dotted line frames take the place of the following elements, and the mechanical module processing time coefficient can be eliminated:
- Deferential gear 1
- Drive module at auxiliary shaft side .. 1

7.4.2 Parameters (setting not necessary)

No parameters need to be set for the differential gear.

8. OUTPUT MODULES

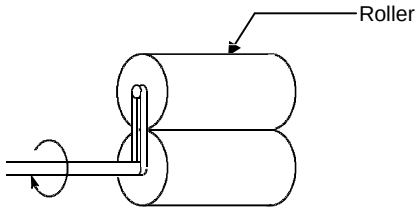
Determine which of the following categories the mechanism actually controlled by the output module falls under and set the parameters in accordance with that mechanism.

- Rollers..... Section 8.1
- Ball screws..... Section 8.2
- Rotary tables..... Section 8.3
- Cams ..... Section 8.4

(1) Output module types

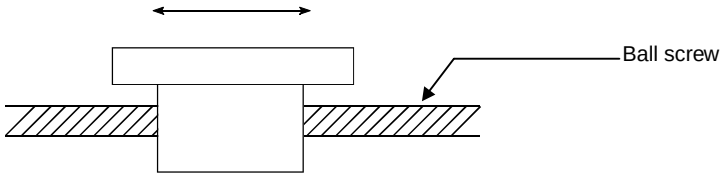
(a) Roller

This is set when the final output (axis) is used to carry out speed control.



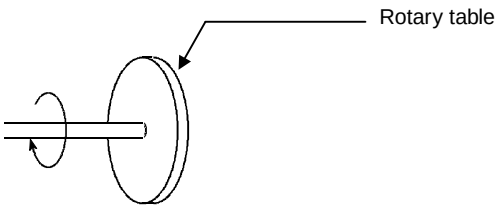
(b) Ball screw

This is set when the final output (axis) is used to carry out linear positioning control.



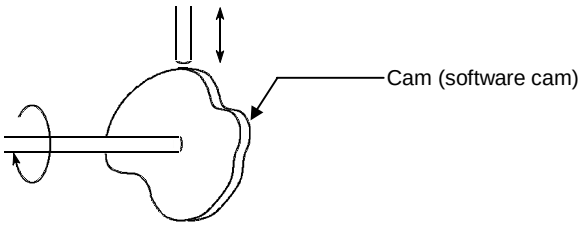
(c) Rotary table

This is set when the final output (axis) is used to carry out angle control.



(d) Cam

The cam settings are made when the last output (axis) is connected to a software cam and controlled.



(2) Device range and device data fetch of the output module parameters
Such things as the device range and setting method are indicated below for the output module parameters and items that are set indirectly using devices.

(a) Device range
The number of device words and device range utilized when an item is set indirectly are indicated below.

Module	Item	Number of Device Words	Device Setting Range		Remarks
			A172SHCPU	A171SHCPU	
Roller	Torque limit value setting device	1			
Ball screw	Torque limit value setting device	1			
Rotary table	Torque limit value setting device	1			
	Virtual axis present value within one revolution storage device (main shaft side)	2			
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	2			
Cam	Cam No. setting device	1			
	Stroke setting device	2			
	Torque limit value setting device	1			
	Stroke lower limit value storage device	2			
	Virtual axis present value within one revolution storage device (main shaft side)	2			
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	2			

Device	Range
D	0 to 799
W	0 to 3FF

POINTS

- For items set using two words, always set an even numbered device. In addition, when setting data in the sequence program for that device, always use the DMOV (P) command.
- When a two word monitor device leads the sequence program, always acquire it in the user device using the DMOV(P) command. Use the fetched device for carrying out such things as upper/lower comparison and calculations.

(b) Device data fetch

When the data of a device that has been set indirectly is switched from the REAL to VIRTUAL mode, first acquire everything as default values and thereafter carry out fetch control during virtual mode operation for the corresponding module.

Shown in the table below are the fetch timing of each device and the refresh cycle of the set device. The device fetch timing and device refresh cycle are the same for both A172SHCPU and A171SHCPU.

Module	Item	Fetch Device	Refresh Device	Device Fetch Timing		Device Refresh Cycle
				REAL→ VIRTUAL Mode Switching	During VIRTUAL Mode Operation	
Roller	Torque limit value setting device	○	——	○	Fetched every 3.5 ms (calculation cycle)	——
Ball screw	Torque limit value setting device	○	——	○		
Rotary table	Torque limit value setting device	○	——	○		
	Virtual axis present value within one revolution storage device (main shaft side)	——	○	——	——	3.5ms
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	——	○	——		
Cam	Cam No. setting device	○	——	○	Fetched every 3.5 ms (calculation cycle). However, the cam No. and stroke switching position pass point are enabled.	——
	Stroke setting device	○	——	○		
	Torque limit value setting device	○	——	○	Fetched every 3.5 ms (calculation cycle)	
	Stroke lower limit value storage device	——	○	——	——	3.5ms
	Virtual axis present value within one revolution storage device (main shaft side)	——	○	——		
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	——	○	——		

8. OUTPUT MODULES

8.1 Rollers

The operation of rollers and the parameter settings required to use rollers are explained here.

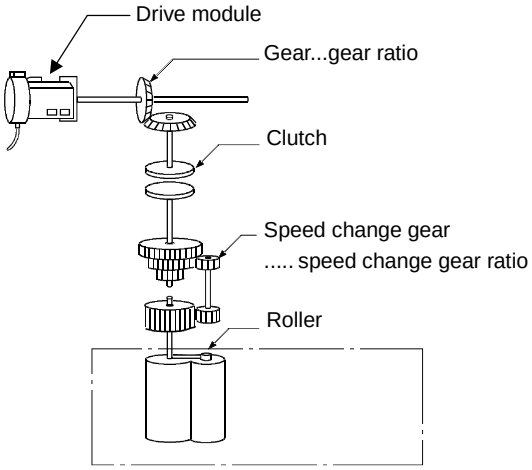
8.1.1 Roller operation

This section describes the operation of the roller.

(1) Operation

(a) The roller speed is controlled to a speed which is the speed of the drive module multiplied by the gear ratio/speed change gear ratio of the transmission module.

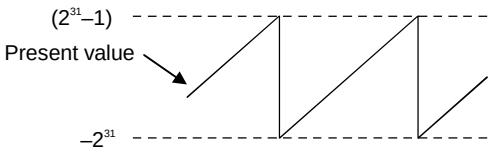
$$[\text{Roller speed}] = \left[\begin{array}{c}\text{Drive module speed}\\(\text{pulse/s})\end{array}\right] \times [\text{gear ratio}] \times \left[\begin{array}{c}\text{speed change}\\\text{gear ratio}\end{array}\right] \quad (\text{Units: pulses/s})$$



(b) If a clutch is used, the roller is controlled from the point when the clutch is turned ON.

(2) Control details

(a) The roller has no present value.
However, when a switch is made from the virtual mode to the real mode, the present value corresponding to the position reached by travel in the virtual mode is established.
[The present value is a ring address in the range –2147483648 (-2^{31}) pulses to 2147483647 ($2^{31}-1$) pulses.]



(b) Backlash compensation processing is continued in accordance with the settings made in the fixed parameters regardless of switches between the real mode and virtual mode.

(c) The peripheral velocity of the roller is monitored by means of a peripheral device and the roller peripheral velocity register.
For the calculation formula for the roller peripheral velocity, see Section 8.1.2, and for details on the roller peripheral velocity register, see Section 8.5.2.

8.1.2 Parameter list

The parameters for rollers are presented in Table 8.1, and each of the items in the table is explained in (1) to (6) below.
For details on setting roller parameters, refer to the SW2SRX/SW2NX-GSV22P/ SW0SRX/SW0NX-CAMP Operating Manual.

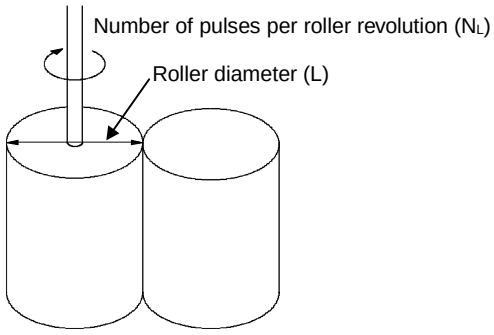
Table 8.1 Parameter List

No.	Setting		Default Value	Setting Range	
1	Output shaft number	When using an A172SHCPU	0	1 to 8	
		When using an A171SHCPU	0	1 to 4	
2	Unit setting		mm	mm	inch
3	Roller diameter (L)		0	0.1 to 214748364.7 μm	0.00001 to 21474.83647
4	Number of pulses per roller revolution (N_L)		0	1 to 2147483647 pulse	
5	Permissible droop pulse value		65535	1 to 65535 pulse	
6	Speed limit value (V_L)		0	0.01 to 6000000.00 mm/inch	0.01 to 600000.000 inch/min
7	Torque limit value setting device (1 word)		——	–(300%) / word device	
8	Comment		None	16 one-byte characters	

(1) Unit setting
(a) This is the setting for the units (mm/inch) for the roller.

(b) When an axis for which a roller setting has been made is in the real mode, the units (unit setting in the fixed parameters) can be any of the following: mm/inch/degree/pulse.

(2) Roller diameter (L)/Number of pulses per roller revolution (N_L)
(a) These are the settings for the roller diameter, and number of pulses per roller revolution, for the roller connected to the servomotor.



(b) The roller peripheral velocity is calculated from the roller diameter and number of pulses per roller revolution in accordance with the formula below.
1) When the units are millimeters
[Roller periheral velocity] = [number of input per minute] $\times \frac{\pi \times L}{N_L}$
(mm/min)
L: mm

2) When the units are inches
[Roller periheral velocity]= [number of input per minute] $\times \frac{\pi \times L}{N_L}$
(mm/min)
L: mm

An integral value obtained by raising 10^n to power of the result of calculations 1) and 2) is stored in the roller peripheral velocity register.

(3) Permissible droop pulse value
(a) This is the setting for the permissible number of droop pulses at the deviation counter.

(b) The deviation counter value is continually monitored, and if it becomes larger than the permissible droop pulse value, the error detection signal (M1607+ 20n) comes ON.
However, since operation of the roller shaft continues, the user must execute the appropriate error processing.

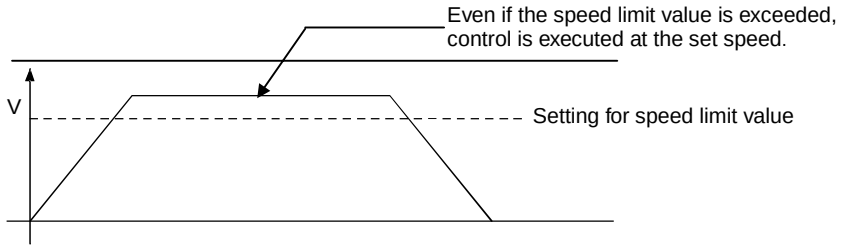
(4) Speed control limit (V_L)
(a) This is the setting for the maximum speed of the roller shaft.

(b) Set the speed limit value within the following range.

$$1 \leq \frac{V_L \times N_L}{60 \times \pi \times L} \leq 1000000 \text{ [pulse/s]}$$

V_L:[mm/min] or [inch/min]
L :[mm] or [inch]

(c) If the speed of the roller shaft exceeds the speed limit value, the error detection signal (M1607+ 20n) comes ON.
However, the roller shaft speed is not clamped.



(5) Torque limit value setting device (1 word)
(a) This sets the device which stores the setting for the torque limit value for the roller shaft.
Once the device has been set, torque control is executed in accordance with the setting stored in this device.
In the virtual mode, the torque limit setting is always valid.
If no device setting is made, the torque limit is set at 300%.

(b) The following devices can be set as the torque limit setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1: If a cam is used at the output module, the area used for the cam cannot be set.

*2: If a differential gear is connected to the main shaft, the area it uses cannot be set.

(c) The setting range for the torque limit value is 1 to 500%.

(6) Comment
(a) A comment is created for purposes such as describing the application of the roller shaft.
If a comment is created, it can be displayed when monitoring at a peripheral device.

(b) Comments up to 16 one-byte characters long can be created.

8.2 Ball Screws

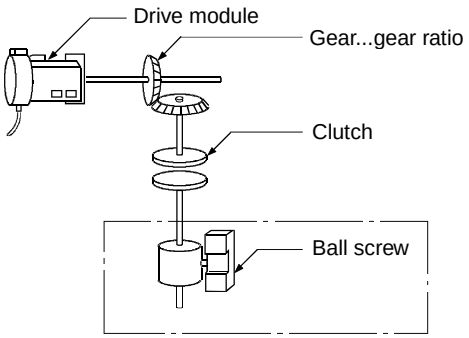
The operation of ball screws and the parameter settings required to use ball screws are explained here.

8.2.1 Ball screw operation

This section describes the operation of the ball screw.

(1) Operation
A ball screw outputs a travel value which is the product of the drive module travel value and the gear ratio of the transmission module.

[Ball screw travel value] =	[transmission module travel value (pulses)]	× [gear ratio]	(Units: pulses)



If a clutch is used, the ball screw is controlled from the point at which the clutch is turned ON.

(2) Control details
(a) The feed present value is maintained on switching from the real mode to the virtual mode or from the virtual mode to the real mode.

(b) Backlash compensation processing is continued in accordance with the settings made in the fixed parameters regardless of switches between the real mode and virtual mode.

(c) The travel value per pulse is controlled by the ball screw parameters (ball screw pitch, number of pulses per ball screw revolution).
Make it the same value as the travel value per pulse in the fixed parameters.

8.2.2 Parameter list

The parameters for ball screws are presented in Table 8.2, and each of the items in the table is explained in (1) to (8) below.
For details on setting ball screw parameters, refer to the SW2SRX/SW2NX-GSV22P/SW0SRX/SW0NX-CAMP Operating Manual.

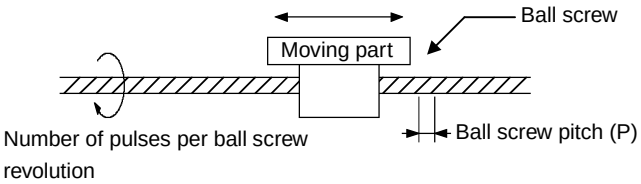
Table 8.2 Parameter List

No.	Setting		Default Value	Setting Range	
1	Output shaft number	When using an A172SHCPU	0	1 to 8	
		When using an A171SHCPU	0	1 to 4	
2	Unit setting		mm	mm	inch
3	Ball screw pith (P)		0	0.1 to 214748364.7 μm	0.00001 to 21474.83647inch
4	Number of pulses per ball screw revolution (N_P)		0	1 to 2147483647pulse	
5	Permissible droop pulse value		65535	1 to 635535pulse	
6	Stroke limit upper limit value		$2^{31}-1$	–214748364.8 to 214748364.7 μm	–21474.83648 to 21474.83647 inch
7	Stroke limit lower limit value		0		
8	Speed limit value (V_L)		——	0.01 to 6000000.00 mm/inch	0.01 to 600000.000 inch/min
9	Limit switch output		Not used	Used / Not used	
10	Torque control limit setting device (1 word)		——	–(300%) / word device	
11	Comment		None	16 one-byte characters	

(1) Unit setting
  (a) This is the setting for the units (mm/inch) for the ball screw.

  (b) Set the same units as used in the real mode (unit setting in the fixed parameters) for the ball screw units.
  If the ball screw units and units in the real mode are different, a mode switching error will occur on switching from the real mode to the virtual mode.

(2) Ball screw pitch (P)/Number of pulses per ball screw revolution (N_P)
  (a) These are the settings for the pitch of the ball screw connected to the servomotor and the number of pulses when the ball screw rotates one revolution.



  (b) The travel value per pulse is calculated from the ball screw pitch and number of pulses per ball screw revolution.

$$[\text{Travel per pulse}] = \frac{P}{N_P}$$

(3) Permissible droop pulse value
(a) This is the setting for the permissible number of droop pulses at the deviation counter.

(b) The deviation counter value is continually monitored, and if it becomes larger than the permissible droop pulse value, the error detection signal (M1607+ 20n) comes ON.

(4) Stroke limit upper limit value/lower limit value
(a) This is the setting for the stroke range in the virtual mode.

(b) If the stroke range is exceeded during operation, the error detection signal (M1607+ 20n) comes ON.
However, ball screw shaft stop processing is not executed.

(5) Speed limit value (V_L)
(a) This is the setting for the maximum speed of the ball screw.

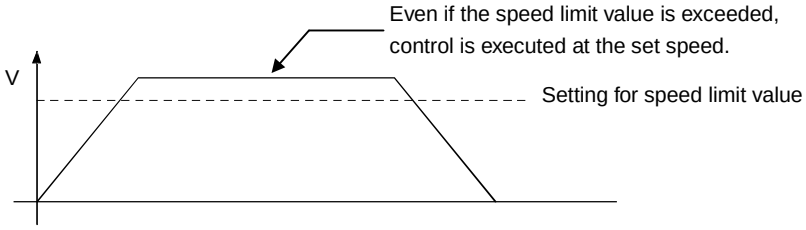
(b) Set the speed limit value within the following range.
1) When the units are millimeters

$$1 \leq \frac{V_L \times 10^4 \times N_P}{60 \times P} \leq 1000000 \text{ [pulse/s]}$$

2) When the units are inches

$$1 \leq \frac{V_L \times 10^5 \times N_P}{60 \times P} \leq 1000000 \text{ [pulse/s]}$$

(c) If the speed of the ball screw shaft exceeds the speed limit value, the error detection signal (M1607+ 20n) comes ON.
However, <u>the ball screw speed is not clamped.</u>



(6) Limit switch output
(a) This setting determines whether or not a limit switch signal is output for the ball screw shaft.
- Limit switch output used ..... Limit switch signal is output based on the ball screw's actual present value.
- Limit switch output not used ..... Limit switch signal is not output.

(7) Torque limit value setting device (1 word)

(a) This sets the device which stores the setting for the torque limit value for the ball screw shaft.
Once the device has been set, torque control is executed in accordance with the setting stored in this device.
In the virtual mode, the torque limit setting is always valid.
If no device setting is made, the torque limit is set at 300%.

(b) The following devices can be set as the torque limit setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1: If a cam is used at the output module, the area used for the cam cannot be set.

*2: If a differential gear is connected to the main shaft, the area it uses cannot be set.

(c) The setting range for the torque limit value is 1 to 500%.

(8) Comment

(a) A comment is created for purposes such as describing the application of the ball screw shaft.
If a comment is created, it can be displayed when monitoring at a peripheral device.

(b) Comments up to 16 one-byte characters long can be created.

8.3 Rotary Tables

The operation of rotary tables and the parameter settings required to use rotary tables are explained here.

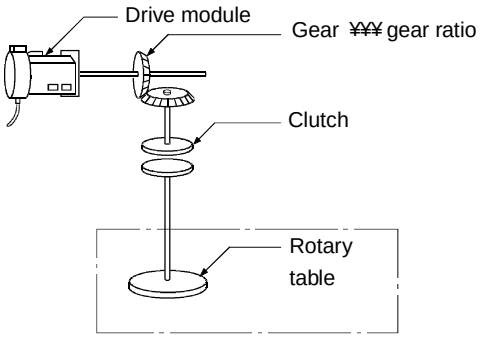
8.3.1 Rotary table operation

This section describes the operation of the rotary table.

(1) Operation

(a) A rotary table outputs a travel value which is the product of the drive module travel value and the gear ratio of the transmission module.

$$[\text{Rotary table travel value}] = \left[\begin{array}{c}\text{transmission module}\\ \text{travel value (pulses)}\end{array}\right] \times [\text{gear ratio}] \ (\text{Units: pulses})$$



(b) If a clutch is used, the rotary table is controlled from the point at which the clutch is turned ON.

(2) Control details

(a) The feed present value is maintained on switching from the real mode to the virtual mode or from the virtual mode to the real mode.

(b) Backlash compensation processing is continued in accordance with the settings made in the fixed parameters regardless of switches between the real mode and virtual mode.

(c) The travel value per pulse is controlled by the rotary table parameters (number of pulses per rotary table revolution).
Make it the same value as the travel value per pulse in the fixed parameters.

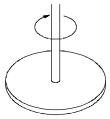
8.3.2 Parameter list

The parameters for rotary tables are presented in Table 8.3, and each of the items in the table is explained in (1) to (9) below.
For details on setting rotary table parameters, refer to the SW2SRX/SW2NX-GSV22P/SW0SRX/SW0NX-CAMP Operating Manual.

Table 8.3 Parameter List

No.	Setting		Default Value	Setting Range
1	Output shaft number	When using an A172SHCPU	0	1 to 8
		When using an A171SHCPU	0	1 to 4
2	Number of pulses per rotary table revolution (N_D)		——	1 to 1073741824 (pulse)
3	Permissible droop pulse value		65535	1 to 65535 (pulse)
4	Stroke limit upper limit value		0	0 to 359.99999 (degree)
5	Stroke limit lower limit value		0	0 to 359.99999 (degree)
6	Speed limit value (V_L)		0	0.01 to 2147483.647 (degree/min)
7	Limit switch output		Not used	Used / Not used
8	Torque control limit setting device (1 word)		——	–(300%) / word device
9	Comment		None	16 one-byte characters
10	Virtual axis present value in one revolution storage device (main shaft side) (2 word)		——	– / word device
11	Virtual axis present value in one revolution storage device (auxiliary input shaft side) (2 word)		——	– / word device

(1) Number of pulses per rotary table revolution (N_D)
(a) This is the setting for the number of pulses equivalent to one revolution of the rotary table connected to the servomotor.



Number of pulses per rotary table revolution (N_D)

(b) The travel value per revolution is calculated from the number of pulses per rotary table revolution in accordance with the following formula:

$$[\text{Travel per pulse}] = \frac{360}{N_D} \text{(degree)}$$

(2) Permissible droop pulse value
(a) This is the setting for the permissible number of droop pulses at the deviation counter.

(b) The deviation counter value is continually monitored, and if it becomes larger than the permissible droop pulse value, the error detection signal (M1607+ 20n) comes ON.

(3) Stroke limit upper limit value/lower limit value
(a) This is the setting for the stroke range in the virtual mode.
The settings for the stroke limit upper limit value and lower limit value can determine whether the stroke range is valid or not: if the stroke limit upper limit value is equal to the stroke limit lower limit value, the stroke limits are invalid.

(b) If the stroke range is exceeded during operation, the error detection signal (M1607+ 20n) comes ON.
However, rotary table shaft stop processing is not executed.

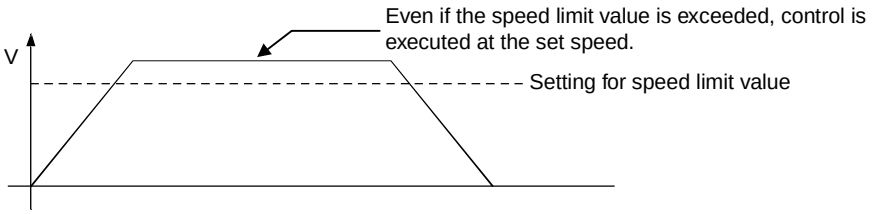
(4) Speed limit value (V_L)

(a) This is the setting for the maximum speed of the rotary table shaft.

(b) Set the speed limit value within the range prescribed by the following formula:

$$1 \leq \frac{V_L \times 10^5 \times N_D}{60 \times 360 \times 10^5} \leq 1000000 \text{ [pulse/s]}$$

(c) If the speed of the rotary table shaft exceeds the speed limit value, the error detection signal (M1607+ 20n) comes ON.
However, the rotary table shaft speed is not clamped.



(5) Limit switch output

(a) This setting determines whether or not a limit switch is output for the rotary table shaft.
- Limit switch output used ..... Limit switch signal is output based on the rotary table's actual present value.
- Limit switch output not used ..... Limit switch signal is not output.

(6) Torque limit value setting device (1 word)

(a) This is the setting for the device which stores the setting for the torque limit value for the rotary table shaft.
Once the device has been set, torque control is executed in accordance with the setting stored in this device.
In the virtual mode, the torque limit setting is always valid.
If no device setting is made, the torque limit is set at 300%.

(b) The following devices can be set as the torque limit setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1: If a cam is used at the output module, the area used for the cam cannot be set.

*2: If a differential gear is connected to the main shaft, the area it uses cannot be set.

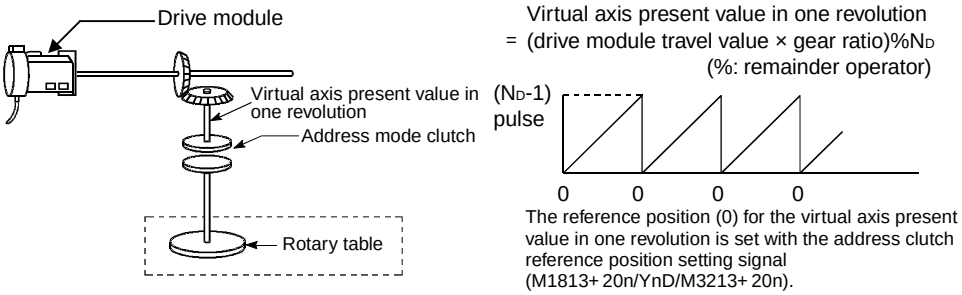
(c) The setting range for the torque limit value is 1 to 500%.

(7) Comment

(a) A comment is created for purposes such as describing the application of the rotary table shaft.
If a comment is created, it can be displayed when monitoring at a peripheral device.

(b) Comments up to 16 one-byte characters long can be created.

(8) Virtual axis present value in one revolution storage device (main shaft side) (2 words)
This parameter is set if an address mode clutch has been set at the rotary table main shaft side.



(a) The virtual axis present value in one revolution for the main shaft side of the rotary table is stored in the set device.

(b) The following devices can be set as the virtual axis present value in one revolution storage device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

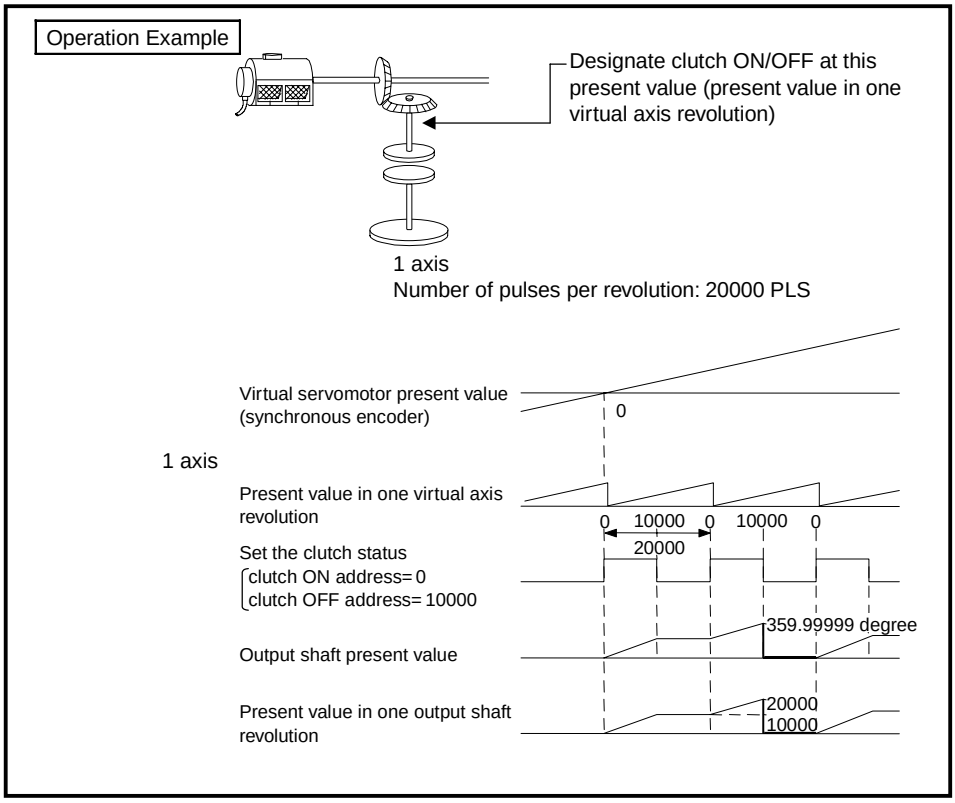
*3 : The first device number of the devices must be an even number.

(c) The applicable range for the virtual axis present value in one revolution is 0 to (ND-1) pulses. (ND: number of pulses per rotary table revolution)

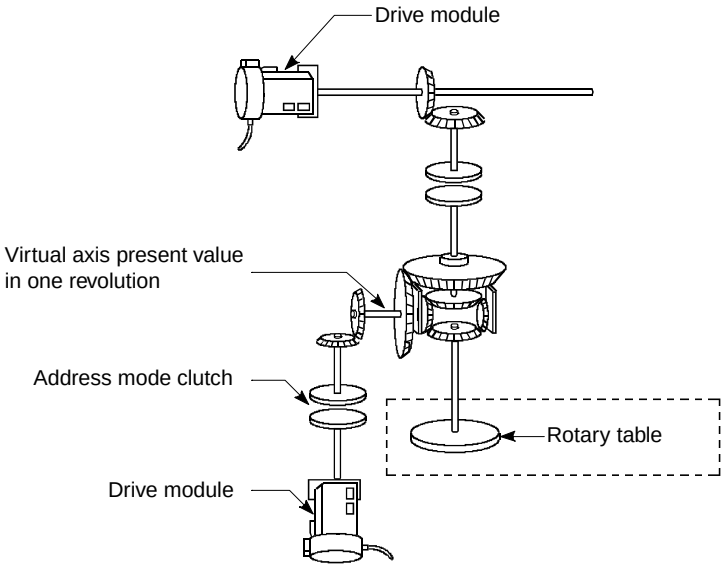
(d) The address mode clutch is turned ON and OFF at designated addresses in the virtual axis present value in one revolution range: 0 to (ND-1) pulses.
Therefore, set the value in the clutch ON/OFF address setting device within the range 0 to (ND-1) pulses.

(e) The virtual axis present value in one revolution reference position "0" is set by turning M1813+20n (address clutch reference setting signal) ON and switching to the virtual mode.
This sets the virtual axis present values in one revolution for both the main shaft and the auxiliary input shaft to "0".
If the switch to the virtual mode is made with M1813+20n turned OFF, control continues from the virtual axis present value in one revolution that was effective last time the virtual mode was in effect.

(f) An example of the operation of an address mode clutch is shown below.



(9) Virtual axis present value in one revolution storage device (auxiliary input shaft side) (2 words)
This parameter is set if an address mode clutch has been set at the rotary table auxiliary input shaft side.



(a) By setting the virtual axis present value in one revolution for the auxiliary input shaft of the rotary table in the set device, the current present value in one revolution of the virtual axis is stored.

(b) The following devices can be set as the virtual axis present value in one revolution storage device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

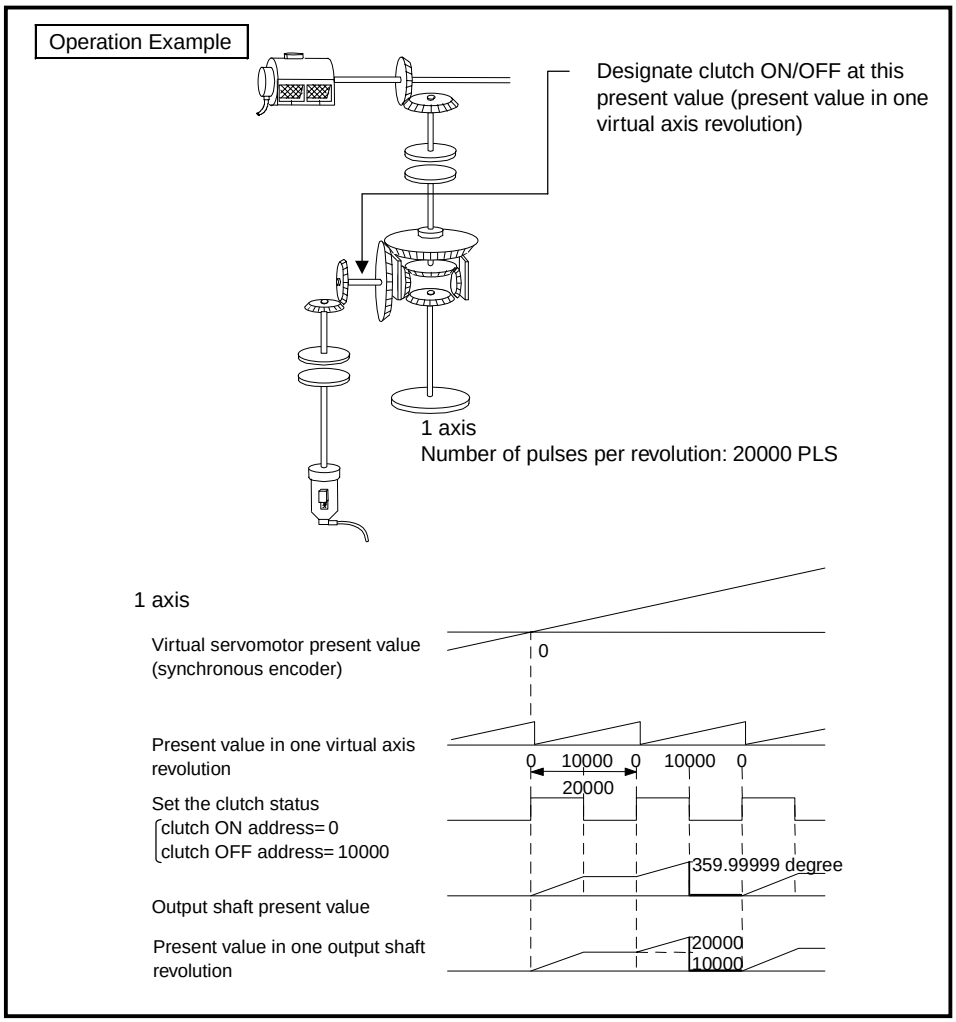
*3 : The first device number of the devices must be an even number.

(c) The applicable range for the virtual axis present value in one revolution is 0 to (ND-1) pulses. (ND: number of pulses per rotary table revolution)

(d) The address mode clutch is turned ON and OFF at designated addresses in the virtual axis present value in one revolution range: 0 to (ND-1) pulses.
Therefore, set the value in the clutch ON/OFF address setting device within the range 0 to (ND-1) pulses.

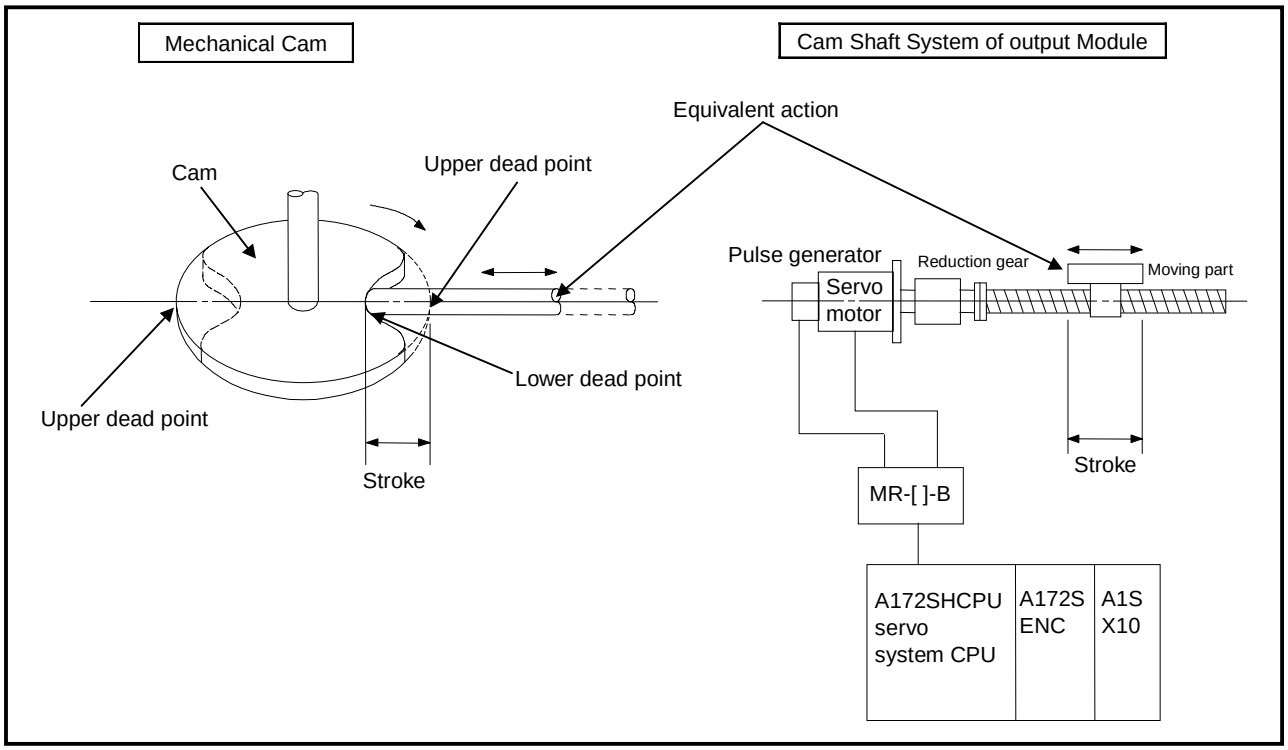
(e) The setting for the virtual axis present value in one revolution reference position "0" is made by turning M1813+20n (address clutch reference setting signal) ON and switching to the virtual mode.
This sets the virtual axis present values in one revolution for both the main shaft and the auxiliary input shaft to "0".
If the switch to the virtual mode is made with M1813+20n turned OFF, control continues from the virtual axis present value in one revolution that was effective last time the virtual mode was in effect.

(f) An example of the operation of an address mode clutch is shown below.



8.4 Cams

(1) For axes at which the output module is set as a cam, the same action as a cam is achieved by using a ball screw model as shown in the example below.



(2) The following two types of data have to be set in order to use a cam.

- Settings made when the cam data is created
  These are the settings made at a personal computer running the SW0SRX/SW0NX-CAMP software when creating the cam data (cam curve).
  (See Section 8.4.2)
- Cam parameters
  These are the parameters used to set a cam as the output module when creating the mechanical device program.
  (See Section 8.4.3)

8.4.1 Cam operation

The operation of cams is described below.

(1) Procedure for switching from the REAL mode to the VIRTUAL mode
On switching from the REAL mode to the VIRTUAL mode, perform device setting in accordance with the following procedure using the sequence program.

(a) Set a cam number and stroke in the "cam No. setting device" and "stroke setting device" set for each axis in the cam shaft parameters.
Switch the cam reference position setting signal (M1814+ 20n) ON/OFF as required.
(See Section 8.5.1(2) to (p))

↓

(b) Issue a REAL mode→VIRTUAL mode switching request
(M2043: OFF→ON)

↓

(c) Start operation based on the cam pattern, stroke, cam reference setting signal, and address clutch reference setting signal set for each cam shaft.

(2) Processing on switching from the REAL mode to the VIRTUAL mode
When a switch is made from the REAL mode to the VIRTUAL mode, the cam shaft present value in one revolution is indexed based on the cam reference position setting signal (M1814+ 20n), the feed present value, the stroke lower limit value, the stroke and cam No. (cam pattern), at that time.

(3) Operation
A value based on the cam shaft present value in one revolution and calculated using the stroke ratio in the cam data table is output.
[(Feed present value) = (stroke lower limit value) + (stroke)× (stroke ratio)]
The cam shaft present value in one revolution is determined by the travel value calculated by multiplying the drive module travel value by the transmission module gear ratio or other applicable value.
The number of pulses per stroke is controlled based on the travel value per pulse set in the fixed parameters in the REAL mode.

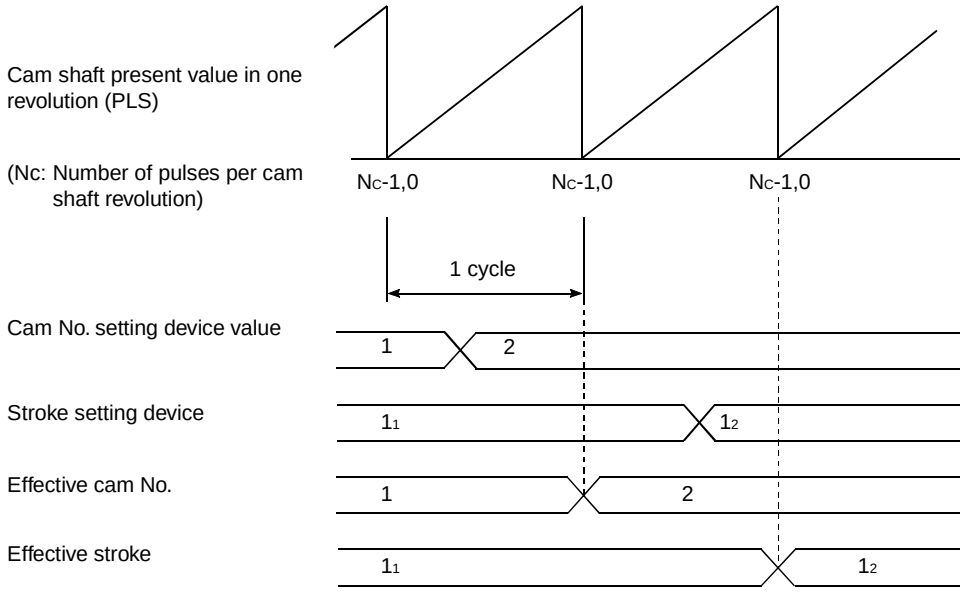
(4) Switching the stroke and cam No. during operation

(a) It is possible to change the cam stroke and effective cam number during cam operation by using the sequence program.

(b) The stroke and cam No. are changed by means of the address set in the "stroke, cam No. change point" setting made when creating the cam data. When the "stroke, cam No. change point" is passed, the stroke/cam No. is changed on the basis of the value in the stroke setting device and cam No. setting device set in the cam parameters.

Example

The figure below shows the timing for switching between cam No.1 and cam No.2, and switching between stroke I1 and stroke I2 when the stroke/cam No. change point is set as "0".



(c) Causes of errors when changing the stroke/cam No. during operation

1) The set cam No. and stroke are always input to the PCPU on switching from the REAL mode to the VIRTUAL mode, and in the VIRTUAL mode. On input to the PCPU, a relative check is executed. An error occurs, the error detection signal (M1607+20n) comes ON, and the error code is stored in the minor error code register in the following cases:

- When the stroke is outside the range 1 to 2147483647 (2^{31}–1).

When, in the two-way cam mode, the following condition is not met:
stroke lower limit value + stroke≤ 2147483647 (2^{31}–1)

- When the control modes of the set cam Nos. are not the same.

2) Processing in the event of a cam No./stroke error
- If the error occurs on attempting to switch from the REAL mode to the VIRTUAL mode, the VIRTUAL mode is not established.
- If the error occurs on reaching the set "stroke, cam No. change point" (during cam operation), operation continues without switching to the set stroke/cam No.
  Reset the error detection signal and the minor error code register with the error reset command (M1807+ 20n).

3) Processing in the event of an error
i) If an error occurs on switching from the REAL mode to the VIRTUAL mode, correct it by following the procedure below.
- Turn the REAL/VIRTUAL mode switching request flag (M2043) OFF.
- Set the cam No. and stroke correctly.
- Turn the REAL/VIRTUAL mode switching request flag ON and switch to the VIRTUAL mode.

ii) If an error occurs during cam operation, set the cam No. and stroke correctly.

(5) Control details

(a) On switching from the REAL mode to the VIRTUAL mode, or on switching from the VIRTUAL mode to the REAL mode, the currently effective feed present value of the cam remains effective.

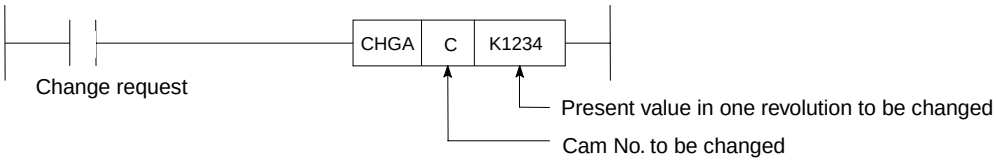
(b) Backlash compensation processing is not executed in the case of cam shafts only. (If necessary, take this into account when creating the cam pattern.)

(c) No stroke limit upper limit value/lower limit value check or speed limit check is executed.

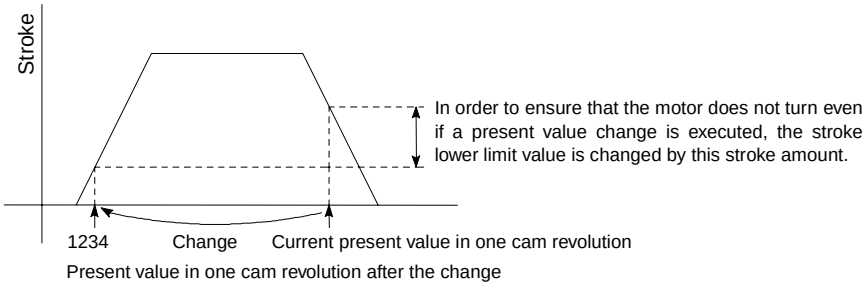
(6) Changing control

The cam shaft present value in one revolution can be changed to any required value to change cam control during operation in the VIRTUAL mode.
The present value change is executed using the CHGA instruction.
See Section 10.1.

[Example sequence program]

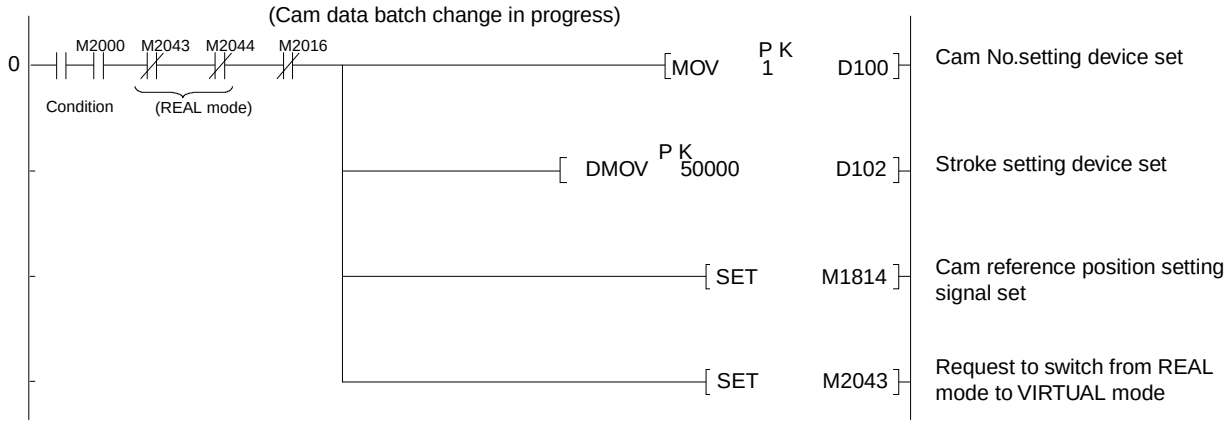


[Operation]

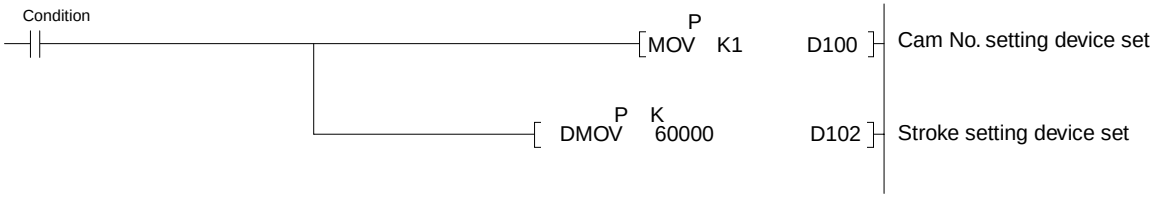


(7) Example sequence program

[Switching from REAL mode to VIRTUAL mode]



[Changing cam No./stroke during operation]



8.4.2 Settings when creating cam data

The settings made when creating cam data at a peripheral device are described below.

Table 8.4 Table of Settings when Creating Cam Data

No.	Setting	Default Value	Setting Range
1	Cam No.	——	1 to 64
2	Resolution	256	256,512,1024,2048
3	Stroke, cam No. change point	0	0 to (resolution –1)
4	Control mode	Two-way cam mode	•Two-way cam mode •Feed cam mode
5	Cam data table	0	0 to 32767

(1) Cam No.
This is the setting for the number of the created cam data.
Set this number in the sequence program.

(2) Resolution
(a) This setting determines the number of index divisions in one cam cycle.

(b) The time required to complete one cycle in which data for the maximum number of points possible under the set resolution are reliably output is calculated as follows:

3.5 ms × (set resolution)

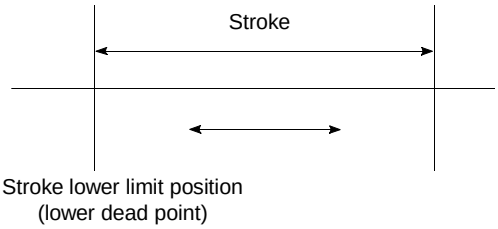
(3) Stroke/cam No. change point
(a) This is the setting for the position at which the stroke/cam No. is switched during operation.

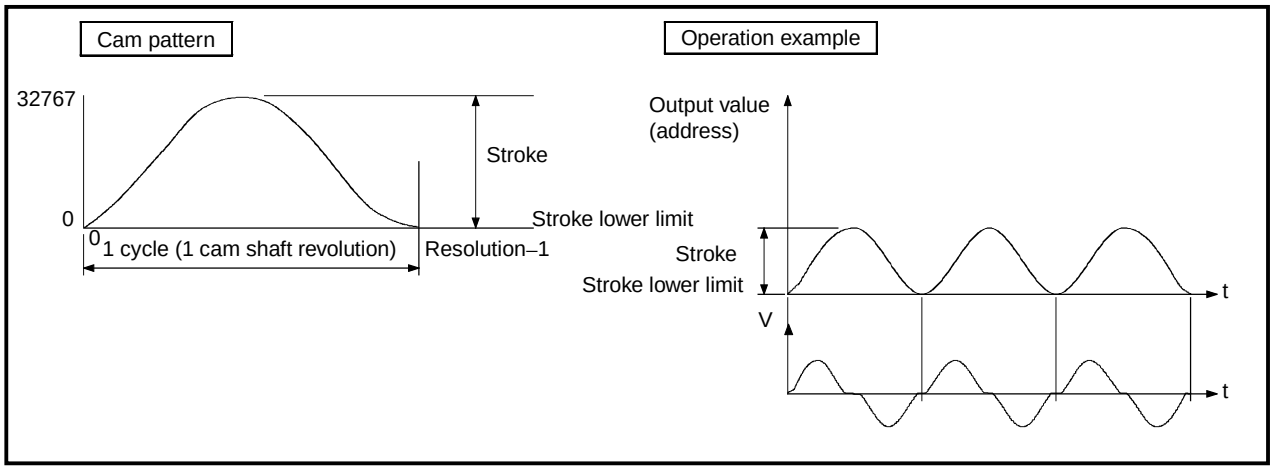
(b) When the set switching position [range: 0 to (resolution –1)] is reached, a switch is made to the set stroke and cam No., provided the stroke and cam No. are normal.

(4) Control mode

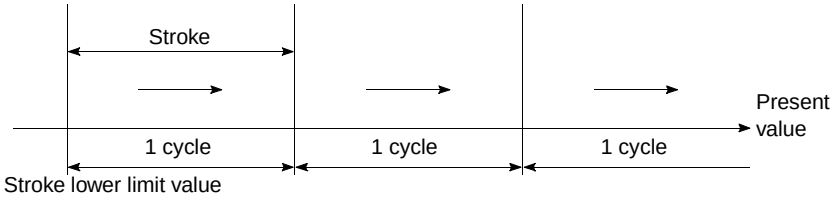
(a) This is the setting for the two-way cam mode or feed cam mode.

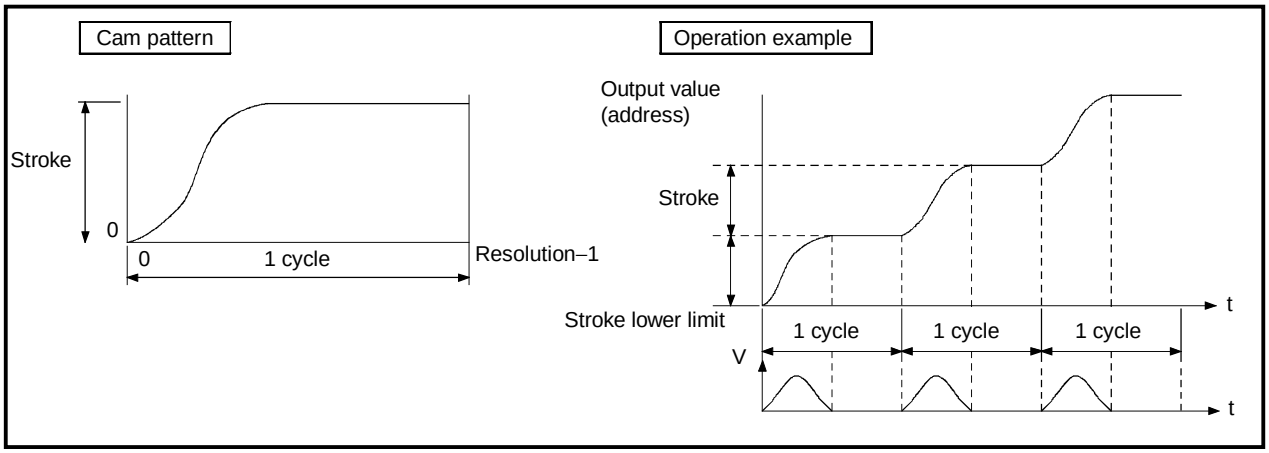
1) Two-way cam mode .....A two-way operation is repeated between the stroke lower limit position (lower dead point) and the range set for the stroke.





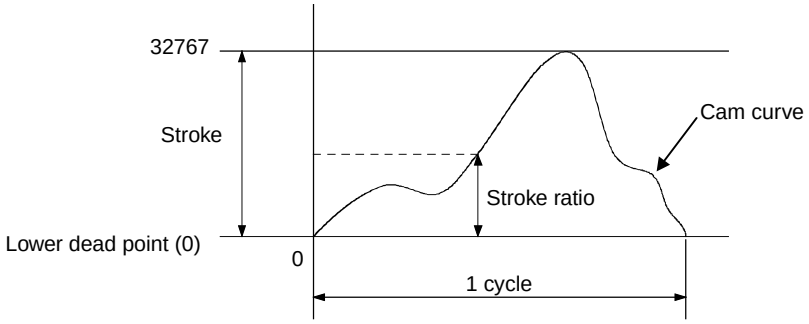
2) Feed cam mode .....With the stroke lower limit value (lower dead point) as the operation start position, positioning is executed by feeding one stroke length per cycle in a fixed direction.





(5) Cam data table

(a) The cam data table is generated by setting the stroke ratio (when the stroke is divided into 32767 divisions) at every point in the set resolution.



(b) The cam data table is automatically generated at the peripheral device when the cam curve is created.

The cam curves that can be used with the servo system CPU are indicated in Section 8.4.4.

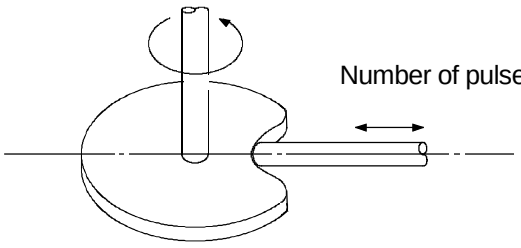
8.4.3 Parameter list

The cam parameters are presented in Table 8.5 and item numbers 2 to 13 in the table are described in (1) through (12) below.
For details on how to set the cam parameters refer to the Operating Manual for the relevant motion controller.

Table 8.5 Parameter List

No.	Setting		Default Value	Setting Range		
1	Output shaft number	When using an A171SHCPU	0	1 to 4		
		When using an A172SHCPU	0	1 to 8		
2	Number of pulses per cam shaft revolution		0	1073741824(pulse)		
3	Used cam No.		——	——		
4	Cam No. setting device (1 word) (Nc)		——	Word device		
5	Permissible droop pulse value		65535(pulse)	1 to 65535 (pulse)		
6	Unit setting		mm	mm	inch	pulse
7	Stroke setting device (2 words)		——	Word device		
8	Limit switch output		Not used	Used/Not used		
9	Torque control limit setting device (1 word)		——	–(300%)/word device		
10	Comment		None	16 one-byte characters		
11	Stroke lower limit value storage device		——	–/ word device		
12	Present value in one virtual axis revolution storage device (main shaft side, 2 words)		——	–/ word device		
13	Present value in one virtual axis revolution storage device (auxiliary input shaft side, 2 words)		——	–/ word device		

(1) Number of pulses per cam shaft revolution (Nc)
(a) This is the setting for the number of pulses required to rotate the cam through one cycle.



(b) The setting for the number of pulses per cam shaft revolution is independent of the travel value per pulse (setting in the fixed parameters).

(2) Used cam No.
This parameter does not need to be set.
Operation will be possible as long as a registered cam No. is set.

(3) Cam No. setting device (1 word)

(a) This is the setting for the device that sets, in the sequence program, the cam No. that is to be used for control.

(b) The following devices can be used as the cam No. setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

(c) If the value stored in the cam No. setting device is changed during operation, the switch to the changed cam No. will occur at the "stroke/cam No. switching position" set when the cam data was created.

(4) Permissible droop pulse value

(a) This is the setting for the permissible number of droop pulses at the deviation counter.

(b) The deviation counter value is continually monitored, and if it becomes larger than the permissible droop pulse value, the error detection signal (M1607+ 20n) comes ON.

(5) Unit setting

(a) This is the setting for the units (mm/inch/pulse) for the cam.

(b) The units for an axis for which a cam setting has been made are the units in the REAL mode (unit setting in the fixed parameters).

(6) Stroke setting device (2 words)

(a) This is the setting for the cam stroke.

(b) The following devices can be set as the stroke setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

*3 : The first device number of the devices must be an even number.

(c) Set the stroke within the range indicated below.

- Setting range in the two-way cam mode
  mm : Stroke lower limit value + stroke ≤ $2147483647 \times 10^{-1}$ μm
  inch : Stroke lower limit value + stroke ≤ $2147483647 \times 10^{-5}$ inch
  Pulse : Stroke lower limit value + stroke ≤ 2147483647 pulse
- Setting range in the feed cam mode
  mm : 0 < stroke ≤ $2147483647 \times 10^{-1}$ μm
  inch : 0 < stroke ≤ $2147483647 \times 10^{-5}$ inch
  Pulse : 0 < stroke ≤ 2147483647 pulse

(7) Limit switch output

(a) This setting determines whether or not a limit switch signal is output.

1) Limit switch output not used .....Limit switch signal is not output.
2) Limit switch output used
   A limit switch signal is output in the present value mode/1 cam shaft revolution present value mode.
   The selection of the present value mode or 1 cam shaft revolution present value mode is made in the limit switch ON/OFF point setting window.
   If the [F5] key is pressed while the limit switch ON/OFF point setting window is displayed, the limit switch output mode selection screen is displayed.

Limit switch output mode
1 : Present value
2 : 1 cam shaft revolution present value

The default is 1: present value

Using the numeric keys, enter the limit switch output mode to be selected (1 or 2).
For details on the present value mode and the 1 cam shaft revolution present value mode, see Section 8.4.6.

(8) Torque limit value setting device (1 word)

(a) This is the setting for the device which stores the setting for the torque limit value for the cam shaft.
Once the device has been set, torque control is executed in accordance with the setting stored in this device.
In the virtual mode, the torque limit setting is always valid.
If no device setting is made, the torque limit is set at the default of 300%.

(b) The following devices can be set as the torque limit setting device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

(c) The setting range for the torque limit value is 1 to 500%.

(9) Comment

(a) A comment is created for purposes such as describing the application of the ball screw shaft.
If a comment is created, it can be displayed when monitoring at a peripheral device.

(b) Comments up to 16 one-byte characters long can be created.

(10) Stroke lower limit value storage device

(a) This is the setting for the device that stores the cam stroke lower limit value. The device stores the present stroke lower limit value.

(b) The following devices can be used as the stroke lower limit value storage device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

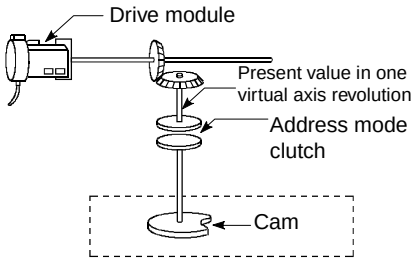
*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

*3 : The first device number of the devices must be an even number.

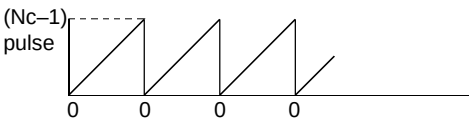
(c) The setting range for the stroke lower limit value is –2147483648 (-2^{31}) to 2147483647 ($2^{31}-1$).

1) The stroke lower limit value is determined as follows for each unit setting:
mm : Stroke lower limit value $\times 10^{-1}\mu$m
inch : Stroke lower limit value $\times 10^{-5}$inch
Pulse : Stroke lower limit value $\times$ 1 pulse

(11) Virtual axis present value in one revolution storage device (main shaft side)(2 words)
This parameter is set if an address mode clutch is set at the main shaft side of the cam.



Present value in one virtual axis revolution
= (drive module travel value gear) % Nc
(%: remainder operator)



(a) The present value in one virtual axis revolution for the main shaft side of the cam is stored in this device.

(b) The following devices can be used as the present value in one virtual axis revolution storage device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

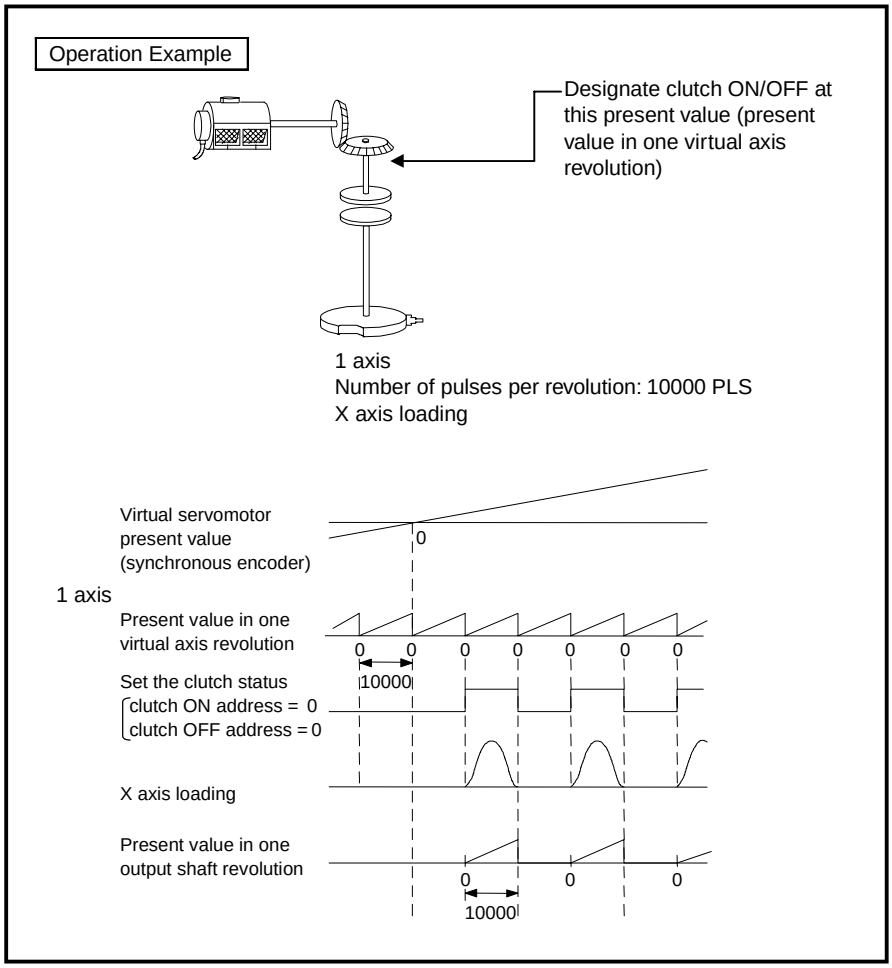
*3 : The first device number of the devices must be an even number.

(c) The setting range for the present value in one virtual axis revolution is 0 to (Nc –1) pulses.
(Nc: number of pulses in one cam shaft revolution)

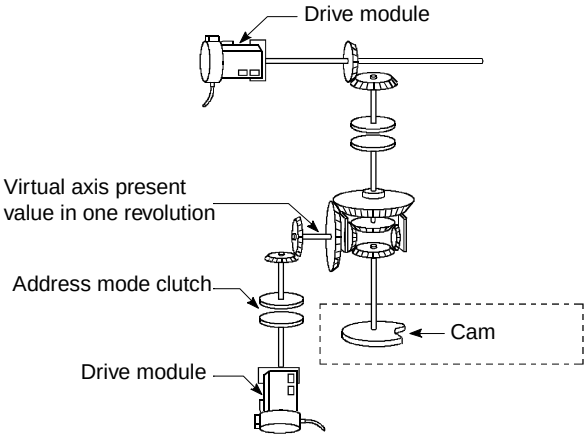
(d) The address mode clutch is turned ON and OFF at designated addresses in the virtual axis present value in one revolution range: 0 to (Nc–1) pulses. Therefore, set a value in the range 0 to (Nc–1) pulses in the clutch ON/OFF address setting device.

(e) The virtual axis present value in one revolution reference position "0" is set by turning M1813+ 20n (address clutch reference setting signal) ON and switching to the virtual mode.
This sets the virtual axis present values in one revolution for both the main shaft and the auxiliary input shaft to "0".
If the switch to the virtual mode is made with M 1813+ 20n turned OFF, control continues from the virtual axis present value in one revolution that was effective last time the virtual mode was in effect.

(f) An example of the operation of an address mode clutch is shown below.



(12) Virtual axis present value in one revolution storage device (auxiliary input shaft side) (2 words)
This parameter is set if an address mode clutch has been set at the cam auxiliary input shaft side.



(a) By setting the device to store the virtual axis present value in one revolution for the auxiliary input shaft of the cam, the current present value in one revolution of the virtual axis is stored.

(b) The following devices can be set as the virtual axis present value in one revolution storage device.

Device Type	A172SHCPU/A171SHCPU
Data register	*1 *2 D0 to D799 *3
Link register	W0 to W3FF

*1 : If a cam is used at the output module, the area used for the cam cannot be set.

*2 : If a differential gear is connected to the main shaft, the area it uses cannot be set.

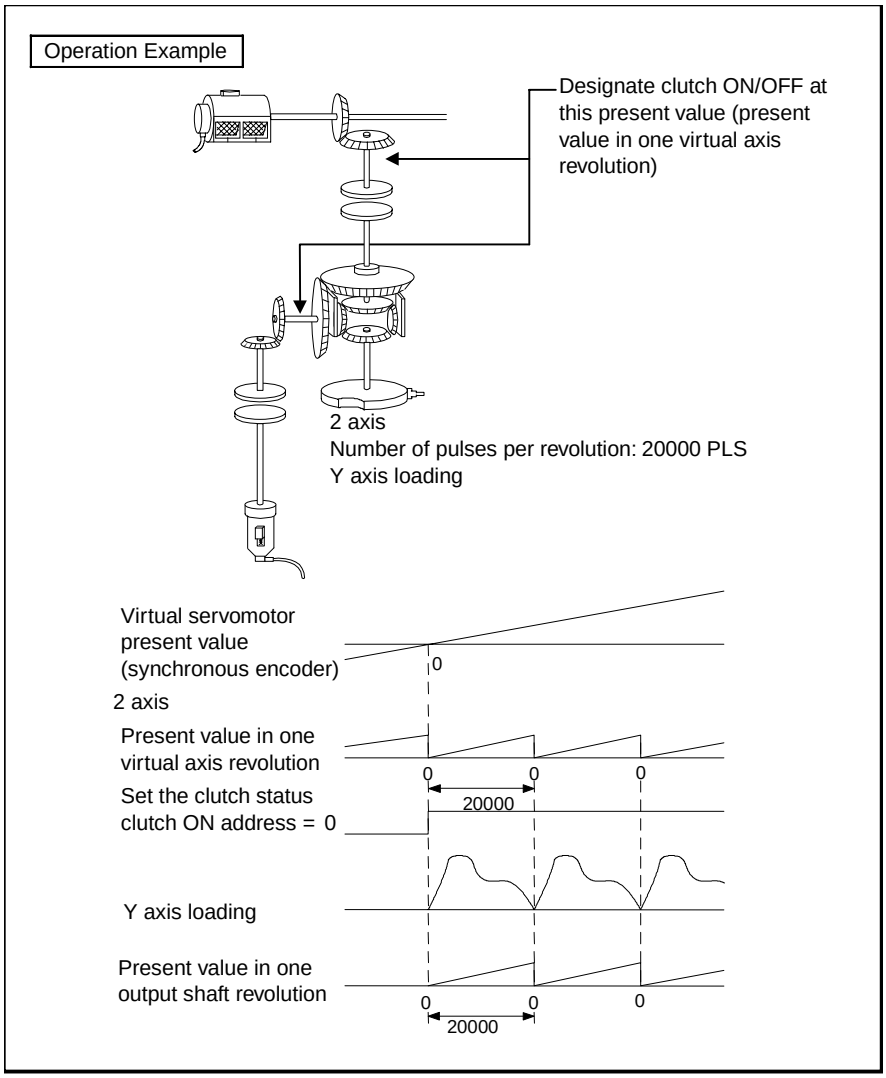
*3 : The first device number of the devices must be an even number.

(c) The applicable range for the virtual axis present value in one revolution is 0 to (Nc−1) pulses.

(d) The address mode clutch is turned ON and OFF at designated addresses in the virtual axis present value in one revolution range: 0 to (Nc−1) pulses. Therefore, set the value in the clutch ON/OFF address setting device within the range 0 to (Nc−1) pulses.

(e) The setting for the virtual axis present value in one revolution reference position "0" is made by turning M1813+20n (address clutch reference setting signal) ON and switching to the virtual mode.
This sets the virtual axis present values in one revolution for both the main shaft and the auxiliary input shaft to "0".
If the switch to the virtual mode is made with M1813+20n turned OFF, control continues from the virtual axis present value in one revolution that was effective last time the virtual mode was in effect.

(f) An example of the operation of an address mode clutch is shown below.



8.4.4 Cam curve list

Cam curves which can be used in the VIRTUAL mode are discussed below.

(1) Cam curve characteristics
The cam curve characteristics are compared in Table 8.6 below.

Table 8.6 Cam Curve Characteristics Comparison Table

Class		Cam Curve Name	Acceleration Curve Shape	Vm	Am	(A•V)m	(V•V)m	(S•V)m	Remarks
Discontinuous curves		Constant speed		1.00			1.00	1.00	
		Uniform acceleration		2.00	±4.00	±8.00	4.00	1.09	
Both-side stationary curve	Symmetrical curves	5th		1.88	±5.77	±6.69	3.52	1.19	
		Cycloid		2.00	±6.28	±8.16	4.00	1.26	
		Distorted trapezoid		2.00	±4.89	±8.09	4.00	1.20	Ta= 1/8
		Distorted sine		1.76	±5.53	±5.46	3.10	1.13	Ta= 1/8
		Distorted constant speed		1.28	±8.01	±5.73	1.63	1.07	Ta= 1/16 Ta= 1/4
	Asymmetrical curves	Trapecloid		2.18	±6.17	±10.84	4.76	1.28	m= 1
One–side stationary curve		Multiple hypotenuse		2.04	+5.55 –9.87	+7.75 –9.89	4.16	1.39	
Non–stationary curve		Single hypotenuse		1.57	±4.93	±3.88	2.47	1.02	

(2) Free-form curve
The spline interpolation function can be used to create free-form cam curves.

8.4.5 Creation of cam data by user

(1) Creating cam data at IBM PC started up with SW0SRX/SW0NX-CAMP.
Cam data is created by creating a cam curve for 1 cam rotation using at the free- form curve or one of the cam curves shown in section 8.4.4.
For details regarding the creation of cam curves at IBM PC computers which have been started up with the SW0SRX/SW0NX-CAMP software, refer to the SW2SRX/SW2NX-GSV22P/SW0SRX/SW0NX-CAMP Operation Manual.

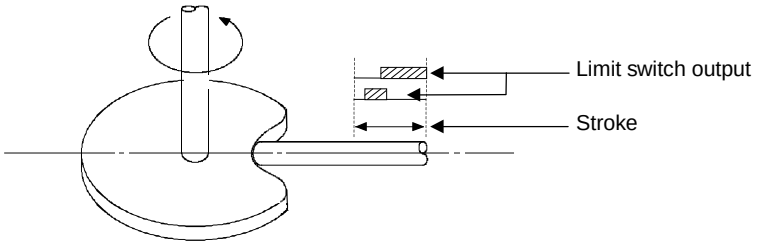
8.4.6 Limit switch outputs in present value mode & present value in 1 cam revolution mode

There are 2 types of limit switch outputs:

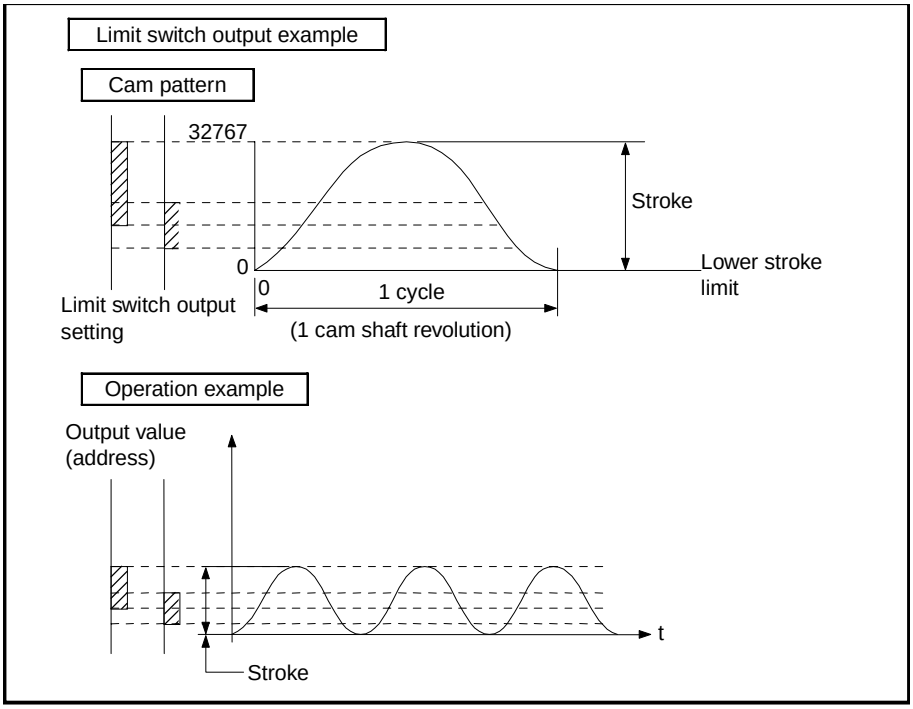
- Limit switch outputs in present value mode.
- Limit switch outputs in present value in 1 cam revolution mode.

(1) Limit switch outputs in present value mode.
Limit switch outputs occur in accordance with the cam's actual present value (stroke).

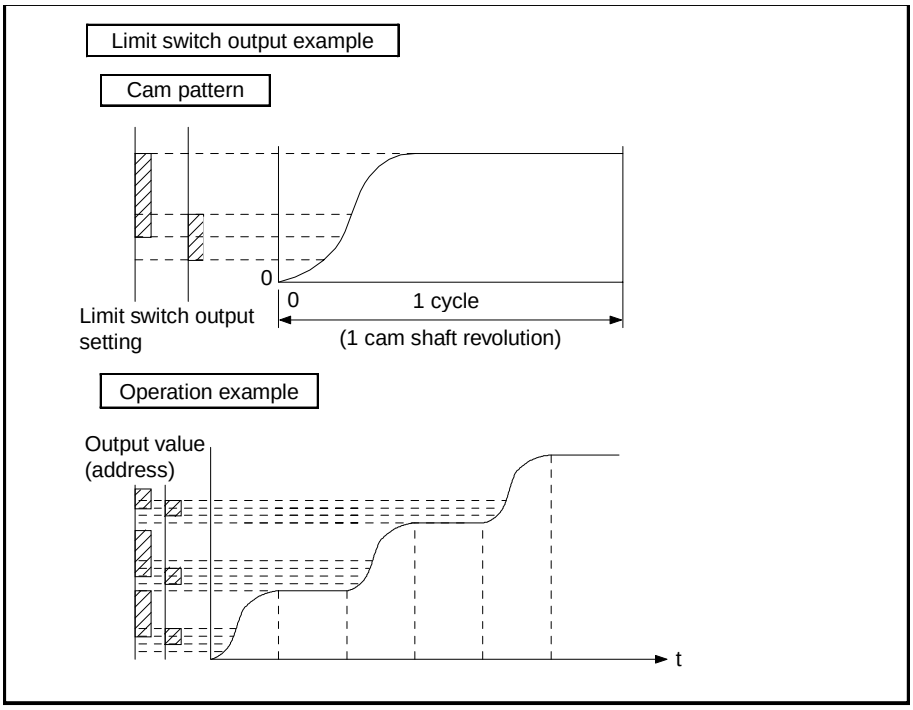
[Cam]



(a) For two-way cam
The limit switch output pattern is identical for both directions.

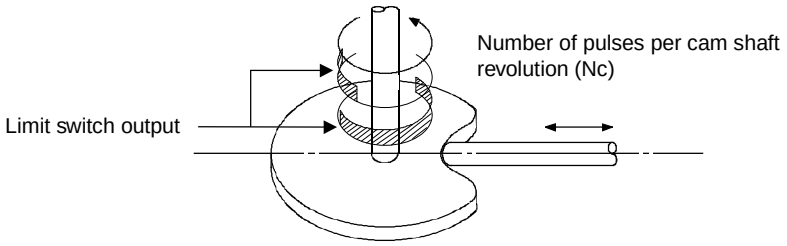


(b) For feed cam

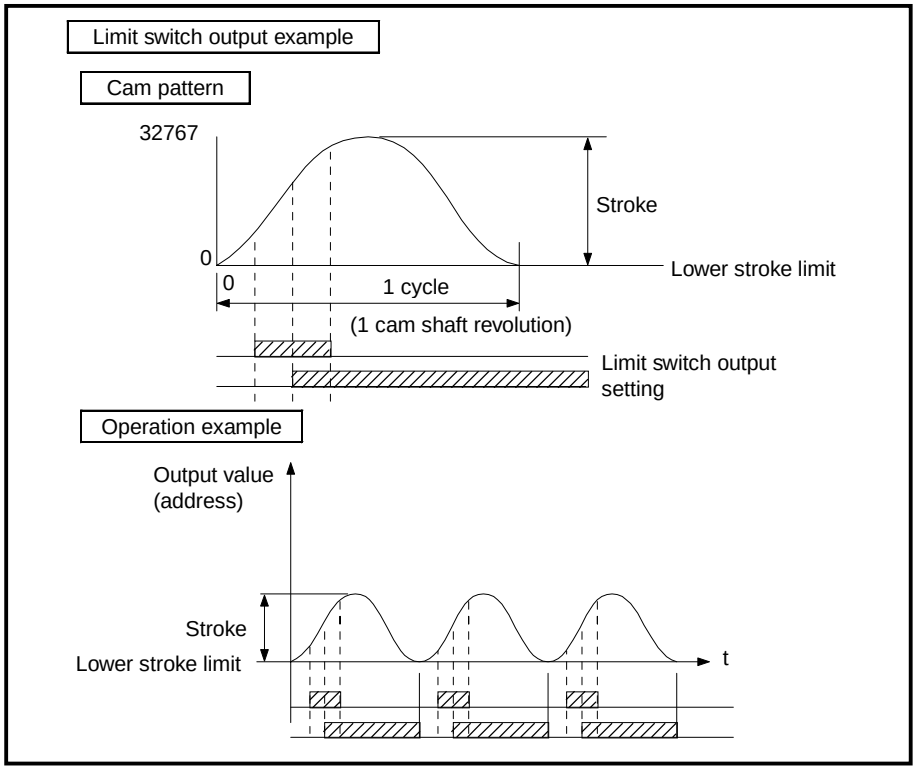


(2) Limit switch outputs in 1 cam shaft revolution present value
Limit switch outputs occur in accordance with the present value within 1 cam shaft revolution (0 to Nc−1).

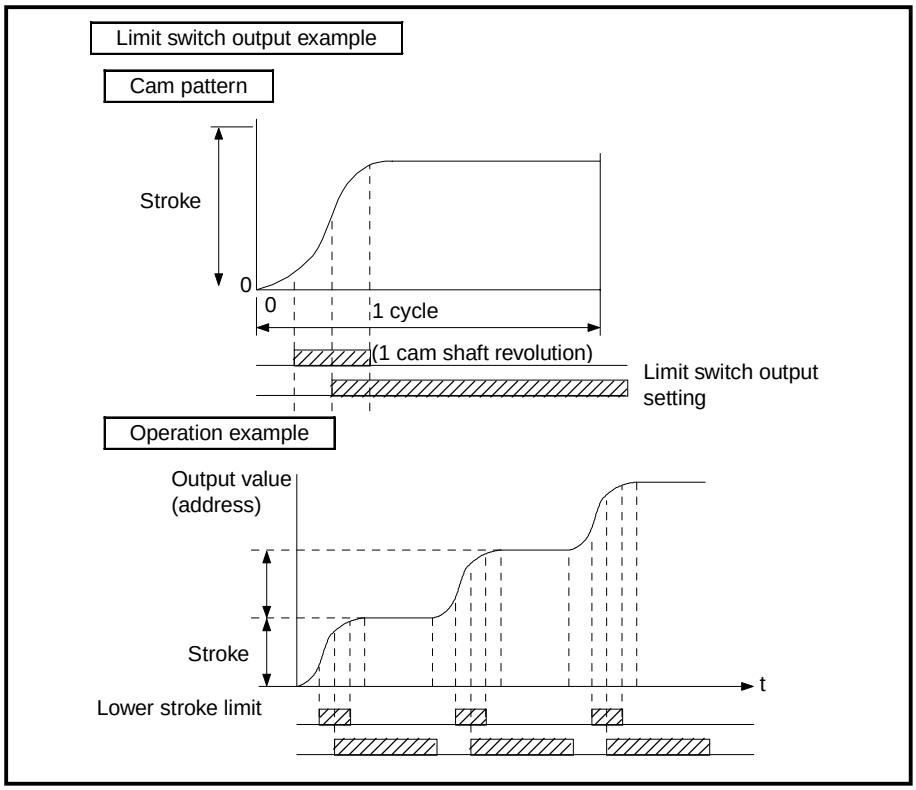
[Cam]



(a) For two-way cam
Different limit switch output patterns can be used for the feed and return strokes.



(b) For feed cam



8.4.7 Limit switch output data in present value within 1 cam revolution mode

Limit switch output data can be created by the user at IBM PC computers which have been started up with the SW2SRX/SW2NX-GSV22P software.
For details regarding the limit switch output data creation procedure, refer to the SW2SRX/SW2NX-GSV22P/SW0SRX/SW0NX-CAMP Operating Manual.

(1) Limit switch output data storage area
The limit switch output data set in the cam axis present value in one revolution mode {see section 8.4.3 (11), (12)} is stored in internal memory.

8.5 Common Devices (Input/Output, Internal Relays, Data Registers)

The I/Os, internal relays and data registers used in the output modules are explained here.

8.5.1 Internal relays (M)

(1) Internal relay (M) list

(a) Status of each axis

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	M1600 to M1619	M1600 to M1619	(○ Valid)
2	M1620 to M1639	M1620 to M1639	
3	M1640 to M1659	M1640 to M1659	
4	M1660 to M1679	M1660 to M1679	
5	M1680 to M1699		
6	M1700 to M1719		
7	M1720 to M1739		
8	M1740 to M1759		

	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball Screw	Rotary Table	Cam			
0	Positioning start completed	○	OFF	OFF	OFF	OFF	SCPU← PCPU	—	
1	Positioning completed	○	OFF	OFF	OFF	OFF			
2	In-position	○	○	○	○	○		3.5ms	
3	Command in-position	○	OFF	OFF	OFF	OFF		—	
4	Speed control in progress	○	OFF	OFF	OFF	OFF			
5	Speed/position switching latch	○	OFF	OFF	OFF	OFF			
6	Zero pass	○	○	○	○	○		3.5ms	
7	Error detection	○	○	○	○	○		Imme-diately	
8	Servo error detection	○	○	○	○	○		3.5ms	
9	Home position return request	○	○	○	○	○		10ms	
10	Home position return completed	○	○	○	○	○		3.5ms	
11	External signal FLS	○	○	○	○	○		10ms	
12	External signal RLS	○	○	○	○	○			
13	External signal STOP	○	○	○	○	○			
14	External signal DOG/CHANGE	○	○	○	○	○			
15	Servo ON/OFF	○	○	○	○	○		3.5ms	
16	Torque control in progress	○	○	○	○	○			
17	(External signal DOG/CHANGE)	○	○	○	○	○		10ms	
18	Virtual mode intermittent actuation disabled warning	○	○	○	○	○			
19	M code output in progress	○	OFF	OFF	OFF	OFF		—	

(b) Command signals for each axis

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name

(○ Valid)

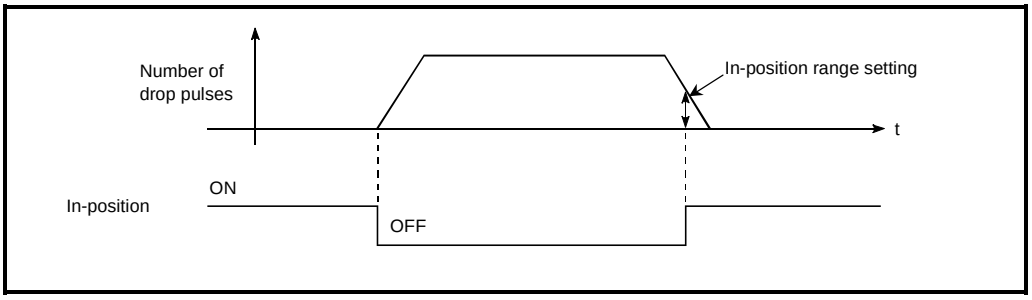
	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball Screw	Rotary Table	Cam			
0	Stop command	○	×	×	×	×	SCPU→ PCPU		—
1	Rapid stop command	○	×	×	×	×			
2	Forward JOG start	○	×	×	×	×			
3	Reverse JOG start	○	×	×	×	×			
4	End signal OFF command	○	×	×	×	×			
5	Speed/position switching enabled	○	×	×	×	×			
6	Limit switch output enabled	○	×	○	○	○			3.5ms
7	Error reset	○	○	○	○	○			10ms
8	Servo error reset	○	×	×	×	×			—
9	External STOP input valid/invalid when starting	○	×	×	×	×			
10	Unusable	—	—	—	—	—			
11	Unusable	—	—	—	—	—			
12	Feed present value update request command	○	×	×	×	×			
13	Address clutch reference setting	×	×	×	○	○			REAL → VIRTUAL switching
14	Cam reference position setting	×	×	×	×	○			
15	Servo OFF	○	○	○	○	○			3.5ms
16	Unusable	—	—	—	—	—			—
17	Unusable	—	—	—	—	—			
18	Control loop setting	○	○	○	○	○			10ms
19	FIN signal	○	×	×	×	×			—

Axis No.	SV22C Device No.	SV22F Device No.
1	M1800 to M1819	M1800 to M1819
2	M1820 to M1839	M1820 to M1839
3	M1840 to M1859	M1840 to M1859
4	M1860 to M1879	M1860 to M1879
5	M1880 to M1899	
6	M1900 to M1919	
7	M1920 to M1939	
8	M1940 to M1959	

(2) Internal relay (M) details

(a) In-position signal (M1602+ 20n)

1) The in-position signal is a signal that comes ON when the number of droop pulses at the deviation counter falls below the in-position range set in the servo parameters.



2) An in-position check is performed at the following times.

- When the servo system power is switched ON
- After automatic deceleration is started in positioning control
- After automatic deceleration is started due to the JOG start signal going OFF
- During manual pulse generator operation
- After the near zero point dog comes ON during home position return
- After deceleration is started by a stop command
- Speed change to zero speed

During REAL mode operation

- Constant check ..... During VIRTUAL mode operation

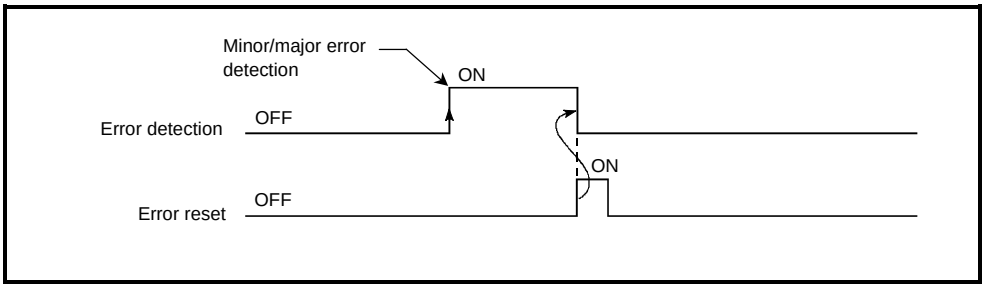
(b) Zero pass signal (M1606+ 20n)

This signal switches ON when the zero point is passed following a servo amplifier power ON.
Once the zero point has been passed, this signal remains ON until a CPU reset occurs.

(c) Error detection signal (M1607+ 20n)

1) This signal switches ON when a minor or major error is detected, and it is used to determine if an error has occurred.
When a minor error is detected, the corresponding error code is stored at the minor error code storage area.
When a major error is detected, the corresponding error code is stored at the major error code storage area.

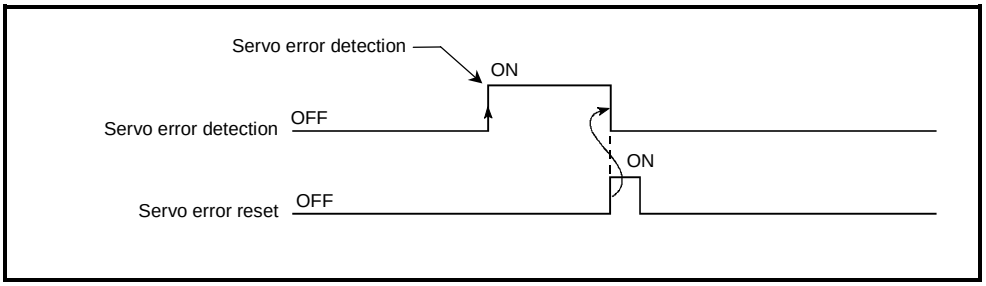
2) The error detection signal goes OFF when the error reset signal (M1807+ 20n) is switched ON.



(d) Servo error detection signal (M1608+ 20n)

1) This signal switches ON when an error (excluding causes of warning errors and emergency stops) is detected at the servo amplifier, and it is used to determine if a servo error has occurred.
When an error is detected at the servo amplifier, the corresponding error code is be stored at the servo error code storage area.

2) The servo error detection signal switches OFF when the servo error reset signal (M1808+ 20n) is switched ON, or when the servo power is switched OFF and back ON again. (Servo error reset is only effective in the REAL mode.)



(e) Home position return request signal (M1609+ 20n)

This signal switches ON when a home position address check is required at power ON or during positioning control.

1) Other than absolute position system
   i) The home position return request signal switches ON at the following times.
      - At power ON, and on resetting the servo system CPU
      - During home position return
   ii) The home position return request signal switches OFF when the home position return is completed.
2) Absolute position system
   i) The home position return request signal switches ON at the following times.
      - During home position return
      - When a sum check error occurs (at power ON) for the backup data (reference values).
   ii) The home position return request signal switches OFF when the home position return is completed.

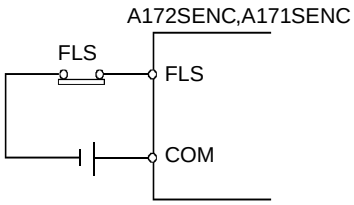
(f) Home Position Return Completed Signal (M1610+ 20n)

1) This signal switches ON when a home position return designated by the servo program or in the TEST mode is completed.
2) This signal switches OFF when a positioning start, JOG start, or manual pulse generator start occurs.
3) If a home position return is attempted (by the servo program) while this home position return completed signal is ON, the "consecutive home position return start" error will be activated, and the home position return operation will not be started. (Near-zero point dog type home position returns only.)

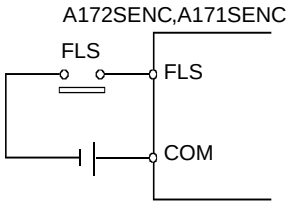
(g) FLS signal (M1611+ 20n)

1) The FLS signal is controlled according to the ON/OFF status of upper limit switch inputs (FLS) to the A172SENC or A171SENC from an external source.
   - Upper limit switch input OFF ..... FLS signal ON
   - Upper limit switch input ON ..... FLS signal OFF
2) The upper limit switch (FLS) status at FLS signal ON/OFF is shown below.

When FLS signal is ON



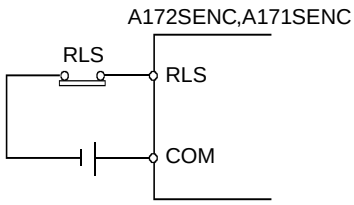
When FLS signal is OFF



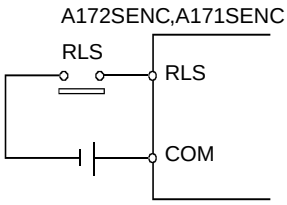
(h) RLS Signal (M1612+ 20n)

1) The RLS signal is controlled according to the ON/OFF status of lower limit switch inputs (RLS) to the A172SENC or A171SENC from an external source.
   - Lower limit switch input OFF ..... RLS signal ON
   - Lower limit switch input ON ..... RLS signal OFF
2) The lower limit switch (RLS) status at RLS signal ON/OFF is shown below.

When RLS signal is ON



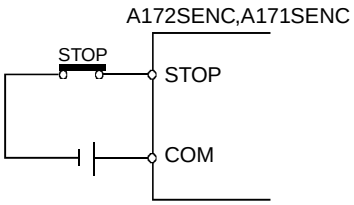
When RLS signal is OFF



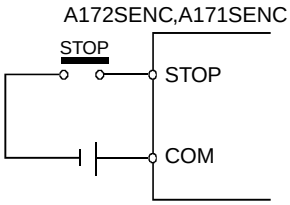
(i) STOP signal (M1613+ 20n)

1) The STOP signal is controlled according to the ON/OFF status of STOP signal inputs to the A172SENC or A171SENC from an external source.
   - STOP signal OFF ..... STOP signal OFF
   - STOP signal ON ..... STOP signal ON
2) The STOP signal status at STOP signal ON/OFF is shown below.

When STOP signal is ON



When STOP signal is OFF



(j) DOG/CHANGE signal (M1614+ 20n)

1) The DOG/CHANGE signal is controlled according to the ON/OFF status of near-zero point dog inputs to the A172SENC, A171SENC from an external source.
2) Regardless whether "N/O input" or "N/C input" is designated in the system settings, the DOG/CHANGE signal turns ON when the near-zero point dog or CHANGE signal is ON, and the near-zero point dog or CHANGE signal turns OFF.
3) If "N/O input" is designated in the system settings, the near-zero point dog or CHANGE input turns ON when the near-zero point dog or CHANGE signal turns ON. If "N/C input" is designated in the system settings, the near-zero point dog or CHANGE input turns ON when the near-zero point dog or CHANGE signal turns OFF.

(k) Servo READY signal (M1615+ 20n)

1) The servo READY signal switches ON when a READY status exists at the servo amplifiers connected to each axis.
2) The servo READY signal switches OFF at the following times:
   - When no servo amplifier is installed
   - When the servo parameters have not been set
   - When an emergency stop signal is input to the power supply module from an external source
   - When the servo OFF status is established by switching ON M1815+ 20n
   - When a servo error occurs

   See Section 11.4 "Servo Errors" for details.

(l) Torque control in progress signal (M1616+ 20n)

This signal switches ON at axes where torque control is being executed.

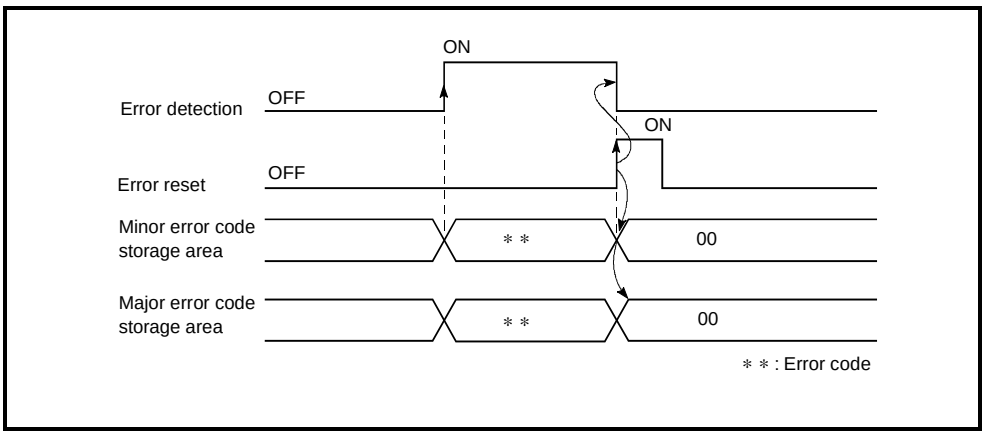
(m) Limit switch output enabled command (M1806+ 20n)

The limit switch output enable command is used to enable limit switch output.

- ON ..... The limit switch output's ON/OFF pattern is output from AY42.
- OFF .... The limit switch output is switched OFF from AY42.

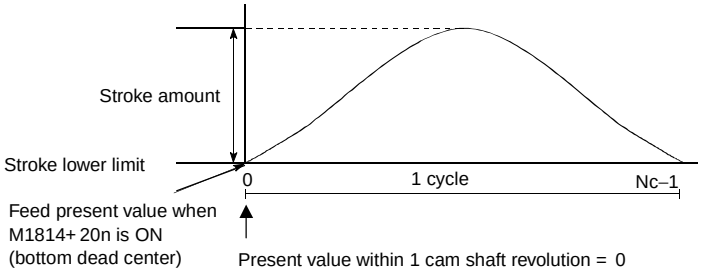
(n) Error reset command (M1807+ 20n)

The error reset command is used to clear the minor error codes and major error codes of axes for which errors have been detected (M1607+ 20n: ON) and to reset the error detected signal (M1607+ 20n).



(o) Address clutch reference setting signal (M1813+ 20n)
This command signal is only operative when the output module is a rotary table or a cam connected to an address mode clutch, and it is used to designate the "0" reference position for the present value in 1 virtual axis revolution.
When a REAL to VIRTUAL mode switching request occurs, processing will be as shown below, depending on the ON/OFF status of the address clutch reference setting signal.
1) When the address clutch reference setting signal (M1813+ 20n) is ON
VIRTUAL mode operation will begin with the present value in 1 virtual axis revolution designated as "0" for the main shaft and auxiliary input shaft.
2) When the address clutch reference setting signal (M1813+ 20n) is OFF
- If the drive module is a virtual servo motor or an incremental type synchronous encoder, main shaft and auxiliary input shaft operation will be continued from the present value in 1 virtual axis revolution value from the previous VIRTUAL mode operation.
- If the drive module is an absolute type synchronous encoder, main shaft and auxiliary input shaft operation will be continued from the present value in 1 virtual axis revolution value calculated from the encoder's present value.

(p) Cam reference position setting signal (M1814+ 20n)
This command signal is only operative when the output module is a cam, and it is used to designate the cam's reference position.
When a REAL to VIRTUAL mode switching request occurs, processing will be as shown below, depending on the ON/OFF status of the cam reference position setting signal.
1) When the cam reference position setting signal (M1814+ 20n) is ON
- The present value becomes the cam's reference position.
- The current feed present value becomes the stroke lower limit value (bottom dead center). Moreover, a cam table search is conducted from the beginning of a cycle, and the bottom dead center (0) point is designated as the present value in 1 cam shaft revolution.

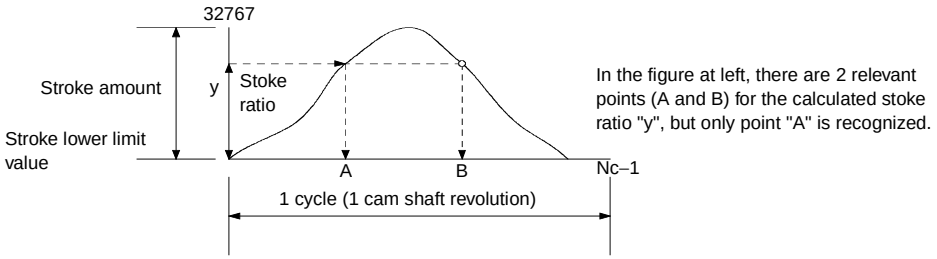


- After the system is started and cam's bottom dead center alignment is completed, YnE must be switched ON the first time REAL to VIRTUAL mode switching occurs.
Once the bottom dead center setting has been designated, it is not necessary to switch M1814+20n ON when subsequent REAL to VIRTUAL mode switching occurs.
(The bottom dead center position is stored in the backup memory.)

2) When the cam reference position setting signal (M1814+ 20n) is OFF
   - When the following condition exists, operation is continued with the stroke lower limit value and present value in 1 cam shaft revolution from the previous VIRTUAL mode operation adopted.

   (Final servo command value in previous VIRTUAL mode operation) – (current servo present value) ≤ (in-position)
   - When the following condition exists, operation is continued with the stroke lower limit value from the previous VIRTUAL mode operation being adopted, and the present value in 1 cam shaft revolution calculated based on the current feed present value.

[Present value in 1 cam shaft revolution calculation]
The stroke ratio (y) is first calculated as follows:
(Feed present value) = (stroke) × (stroke ratio) × (stroke lower limit value)
The cam table for the designated cam No. is then searched (from the beginning of a cycle), and the present value in 1 cam shaft revolution which corresponds to the relevant point is calculated.
Because the search for the present value in 1 cam shaft revolution is always conducted from the beginning of a cycle, beware of cases where the same stroke ratio appears more than once in the cycle.
(Make the necessary position adjustment when switching from the REAL to VIRTUAL mode occurs.)



(q) Servo OFF command (M1815+ 20n)
The servo OFF command is used to switch the servo OFF (free run status).
- YnF OFF ..... Servo ON
- YnF ON ..... Servo OFF (free run status)

This command is inoperative during positioning, and should therefore be executed after positioning is completed.
When the servo OFF command occurs in the VIRTUAL mode, the clutch will be disengaged before the servo OFF command is executed.
If the servo OFF command occurs while a "clutch ON" status exists, a minor error will occur, and the servo OFF command will become inoperative.

(r) VIRTUAL mode continuation disabled warning(M1618+ 20n)
If, for an ABS axis, the difference between the final servo command value in the last operation in the VIRTUAL mode and the servo present value the next time a switch is made to the VIRTUAL mode exceeds the "POWER OF ALLOWED TRAVELING POINTS (number of X feedback pulses)" in the system settings, a warning that VIRTUAL mode operation cannot be continued is issued, and the "VIRTUAL mode continuation disabled warning device" comes ON.
This is checked at the following times:

No.	Check Time	Remarks
1	When the ABS axis servo amplifier power is turned on	At this time, the minor error 901 (when the power is turned on in the REAL mode) or 9010 (when the power is turned on in the VIRTUAL mode) is also set.
2	Continuously during REAL mode operation	The device also comes ON in the following cases. (1) When a home position return is executed. (2) When a present value change is executed. (3) When jog operation, speed control I or II, or speed/position switching control is executed.

To reset the "VIRTUAL mode continuation disabled warning device", reset it in the sequence program.

8.5.2 Data registers (D)

(1) Data register (D) list

(a) Monitor devices of each axis

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	D800 to D819	D800 to D819	
2	D820 to D839	D820 to D839	
3	D840 to D859	D840 to D859	
4	D860 to D879	D860 to D879	
5	D880 to D899		
6	D900 to D919		
7	D920 to D939		
8	D940 to D959		

	Signal Name	(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value/roller cycle	○	○	SCPU←PCPU	3.5ms	
2 3	Actual present value					
4 5	Deviation counter value					
6	Minor error code				Immediately	
7	Major error code					
8	Servo error code				10ms	
9 10	Travel value when the near-zero point DOG/CHANGE is ON	○	Backup		END	
11	Home position return second travel value				3.5ms	
12	Execution program Number	○	○			
13	M code					
14	Torque limit value	○	○			
15 16	Travel value change register	○	×	SCPU→PCPU		3.5ms
17 18	Actual present value when STOP is input	○	×	SCPU←PCPU	END	
19	Data set pointer for constant speed control	○	○		At driving or during driving	

(b) Control change registers

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	D960 to D965	D960 to D965	
2	D966 to D971	D966 to D971	
3	D972 to D977	D972 to D977	
4	D978 to D983	D978 to D983	
5	D984 to D989		
6	D990 to D995		
7	D996 to D1001		
8	D1002 to D1007		

	Signal Name	(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Present value change register	○	○	SCPU→PCPU		CHGA execution
2 3	Speed change register					CHGV execution
4 5	JOG speed setting register (*1)					At driving

(*1) ▭ represents a backup register.

*The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

(c) Cam shaft monitor device

Axis No.	SV22C Device No.	SV22F Device No.	Signal Name
1	D760 to D764	D760 to D764	
2	D765 to D769	D765 to D769	
3	D770 to D774	D770 to D774	
4	D775 to D779	D775 to D779	
5	D780 to D784		
6	D785 to D789		
7	D790 to D794		
8	D795 to D799		

	Signal Name	(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Effective cam No.	Backup	○	SCPU←PCPU	Every END	
1 2	Effective stroke amount					
3 4	Present value in 1 cam shaft revolution					

* "Every END" of the refresh cycle is referred to as the sequence program scan time.

(2) Data register (D) details

(a) Effective cam No. register (D760 + 5n) ..... Data sent from PCPU to SCPU

1) The No. of the cam currently being controlled is stored in binary code at the effective cam No. register.
Cam No. updates occur at the sequence program's END processing.

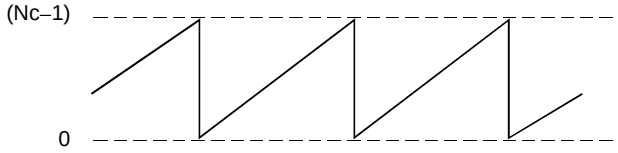
2) The cam No. stored at the effective cam No. register is saved until operation at another cam is executed. (A stored cam No. is not cleared when control at that cam is ended.)

(b) Effective stroke register (D760 + 5n)..... Data sent from PCPU to SCPU

1) The current control stroke is stored in binary code at this register.
Stroke updates occur in the sequence program's END processing.

(c) Present value in 1 cam shaft revolution register (D760 + 5n)
..... Data sent from PCPU to SCPU

1) The present value in 1 cam shaft revolution designated by the parameter setting is stored at this register.
The present value is a ring address in the range "0 to [number of pulses per cam shaft revolution (Nc)–1]".



Present value updates occur in the sequence program's END processing.

(d) Feed present value/Roller peripheral velocity register (D760+5n)
..... Data sent from PCPU to SCPU
1) The target address which is output to the servo amplifier is stored at this register. The target address is based on the command address calculated from the mechanical system program settings.
2) A stroke range check occurs at this feed present value data.
3) Roller peripheral velocity is stored.
The storage range for the peripheral velocity at this register is as shown below.

Setting System-of-Units	Storage Range	Actual Roller Peripheral Velocity
mm	1 to 600000000	0.01 to 6000000.00 mm/min
inch		0.001 to 600000.000 inch/min

(e) Actual Present Value register (D802 + 20n)
..... Data sent from PCPU to SCPU
1) The present value obtained from actual travel (feed present value minus the deviation counter's droop pulse count) is stored at this register.
2) When a STOP status is in effect, the present feed value is equal to the actual present value.

(f) Deviation counter value register(D804 + 20n)
..... Data sent from PCPU to SCPU
The difference between the feed present value and the actual present value is stored at this register.

(g) Minor error code register(D806 + 20n) ..... Data sent from PCPU to SCPU
1) When a minor error occurs, the corresponding error code is stored at this register.
Each time a subsequent error occurs, the stored error code is replaced by the new error code.
2) Minor error codes are cleared by executing an error reset (M1807+ 20n).

(h) Major error code register(D807 + 20n) ..... Data sent from PCPU to SCPU
1) When a major error occurs, the corresponding error code is stored at this register.
Each time a subsequent error occurs, the stored error code is replaced by the new error code.
2) Major error codes are cleared by executing an error reset (M1807+ 20n).

(i) Servo error code register(D808 + 20n)..... Data sent from PCPU to SCPU
1) When a servo error occurs, the corresponding error code is stored at this register.
Each time a subsequent error occurs, the stored error code is replaced by the new error code.
2) When a servo error occurs, the system returns to the REAL mode.

(j) Torque limit value register(D814 + 20n) ..... Data sent from PCPU to SCPU
The designated servo torque limit value is stored at this register.
A torque limit value of "300%" is stored here when the servo power is switched ON, and at the leading edge of the programmable controller READY (M2000) signal.

9. REAL & VIRTUAL MODE SWITCHING AND STOP/RESTART

This section discusses the procedure for switching between the REAL and VIRTUAL modes, and the data items which are checked when such switching occurs.

(1) Switching between the REAL & VIRTUAL modes
Switching between the REAL & VIRTUAL modes is executed by switching the M2043 signal (REAL/VIRTUAL mode switch request flag) ON and OFF.
- For REAL mode ..... A REAL mode switching request occurs when M2043 is switched from ON to OFF.
- For VIRTUAL mode .... A VIRTUAL mode switching request occurs when M2043 is switched from OFF to ON.

(2) REAL & VIRTUAL mode confirmation
The present control mode status (REAL or VIRTUAL) is confirmed by the ON/OFF status of the M2044 signal (REAL/VIRTUAL mode status).
- M2044 OFF..... REAL mode status.
- M2044 ON..... VIRTUAL mode status.

9.1 Switching from the REAL to VIRTUAL Mode

When a REAL to VIRTUAL mode switching request (M2043 OFF→ ON) occurs, the following processing occurs.
- Check to determine if switching to the VIRTUAL mode is possible ..... See Table 9.1
- Output module check..... See Table 9.2
- Synchronous encoder axis check..... See Table 9.3

Switching from the REAL to VIRTUAL mode is possible if the check items shown in Tables 9.1 to 9.3 are all normal.

(1) Check to determine if switching to the VIRTUAL mode is possible
(a) The items shown in Table 9.1 are checked to determine if switching to the VIRTUAL mode is possible.
All the check items must be normal in order for switching to occur.

(b) If an error exists at any of the Table 9.1 check items, M2045 will switch ON, and the error code will be stored at the D9195 register.
Refer to section 11.6 for details regarding the error codes which are stored at D9195.

9. REAL & VIRTUAL MODE SWITCHING AND STOP/RESTART

Table 9.1 Checklist for REAL to VIRTUAL Mode Switching

Check Sequence	Check Item	Output Module Checked				Normal Condition	Abnormal Condition
		Roller	Ball Screw	Rotary Table	Cam		
1	• Are PC READY (M2000) and PCPU READY (M9074) flags ON?	○	○	○	○	ON	OFF
2	• Are all axes stopped? (M2001–M2004/ M2001–M2008 are OFF)	○	○	○	○	YES	NO
3	• Has cam data been changed by the sequence program?	○	○	○	○	NO	YES
4	• Has the mechanical system program been registered?	○	○	○	○	YES	NO
	• Does the axis No. designated in the system settings match the output shaft designated in the mechanical system program?	○	○	○	○	YES	NO
5	• Is the all–axes servo ON command (M2042) ON?	○	○	○	○	ON	OFF
6	• Is servo START processing in progress due to a servo error reset at the amplifier module axis?	○	○	○	○	Servo START completed	Servo START processing in progress
7	• Is external encoder normal?	○	○	○	○	YES	NO
8	• Is an external emergency stop (EMG) input in effect?	○	○	○	○	NO	YES
9	• Is the servo error detection (M1608+20n) signal OFF at all the axes?	○	○	○	○	YES	NO
10	• Is the home position return request (M1609+20n) signal OFF for all the axes? (excluding roller axis)	—	○	○	○	YES	NO
11	• Does the system-of-units designated in the fixed parameters match that designated at the output module?	—	○	○	○	YES	NO
12	• Has the cam data been registered?	—	—	—	○	YES	NO
13	• Has the cam No. been designated at the "cam No. setting device" (cam parameters)?	—	—	—	○	YES	NO
14	• Has the stroke (1 to 2^{31}–1) been designated at the "stroke setting device" (cam parameters)?	—	—	—	○	YES	NO
15	• Is the cam's "stroke setting device" No. an even number?	—	—	—	○	YES	NO

(2) Output module check

(a) The items shown in Table 9.2 below are checked to determine the output module status.
If an error is found, switching to the VIRTUAL mode will not occur, and the corresponding system cannot be started. When an error exists, switch back to the REAL mode and correct the error cause, then switch to the VIRTUAL mode again.

(b) When an error is found, the corresponding output module's error detection signal (M1607+ 20n) will switch ON, and the error code will be stored in the minor/major error code register.

Table 9.2 Output Module Checklist

Check Sequence	Check Item	Output Module Checked				Normal Condition	Abnormal Condition
		Roller	Ball Screw	Rotary Table	Cam		
1	• Is the feed present value within the stroke range?	—	○	○	—	YES	NO
	• Is the feed present value within the range "[lower stroke limit value] to [stroke]"?	—	—	—	○		
2	• When in the two-way cam mode, does "[lower stroke limit value] + [stroke]" exceed 2^{31}–1?	—	—	—	○	NO	YES
3	[Drive module] • When the clutch connected to the synchronous encoder is in an "external input mode", are the clutch's ON/OFF bit devices the same device?	○	○	○	○	YES	NO
	[Drive module] • When the clutch connected to the synchronous encoder is in an "external input mode", is the encoder interface input a manual pulse generator input?	○	○	○	○	YES	NO (serial encoder (ABS) input)
4	• Does a servo ON status (M1615+ 20n is ON) exist at an output module where either a "no clutch" or "clutch ON command" is in effect for the virtual main shaft or the virtual auxiliary input shaft?	○	○	○	○	YES	NO
	• Is the external input "STOP" signal OFF at an output module where either a "no clutch" status or "clutch ON command" is in effect for the virtual main shaft or the virtual auxiliary input axis?	○	○	○	○	YES	NO
5	• When in the two-way cam mode, can the present value be calculated within 1 cam revolution?	—	—	—	○	YES	NO
6	• Is the No. of the clutch ON/ OFF address setting device (for address mode clutch) an even number?	○	○	○	○	YES	NO

(3) Synchronous encoder axis check

(a) The items shown in Table 9.3 below are checked to determine the synchronous encoder status.
If an error is found, switching to the VIRTUAL mode will not occur. Error causes can only be corrected by switching back to the REAL mode.

(b) When an error is found, the corresponding output module's error detection signal (M1607+ 20n) will switch ON, and the error code will be stored in the minor/major error code register.

Table 9.3 Synchronous Encoder Axis Checklist

Check Sequence	Check Item	Output Module Checked		Normal Condition	Abnormal Condition
		External Synchronous Encoder	Output Module		
1	• Is the synchronous encoder connected to an A172SENC/A171SENC unit?	○	—	Connected	Not connected
					Cable break

9.2 Switching from the VIRTUAL to REAL Mode

VIRTUAL to REAL mode switching can be conducted by the user or by the OS.
- By user ..... Switch M2043 OFF
- By OS ..... Switching occurs automatically when a servo error is detected.

9.2.1 VIRTUAL to REAL mode switching by user

(1) When a VIRTUAL to REAL mode switching request (M2043 ON→OFF) occurs, the item shown in Table 9.4 is checked.
If normal, switching to the REAL mode will occur. Before switching M2043 OFF, make sure that this item's status is normal.

(2) If an error is detected, M2045 will switch ON, and the error code will be stored at the D9195 register. (See section 11.6)

Table 9.4 Checklist for VIRTUAL to REAL Mode Switching

Check Sequence	Check Item	Normal Condition	Abnormal Condition
1	• Are all axes stopped?(M2001–M2008/M2001–M2004 are OFF)	YES	NO

9.2.2 VIRTUAL to REAL mode switching by OS

(1) If any of the following conditions are detected during VIRTUAL mode operation, the OS will automatically switch back to the REAL mode.
- When an external emergency stop (EMG) input occurs.
- When the servo error detection signal (M1608+ 20n) switches ON at any axis.
- When the PC READY (M2000) signal switches OFF.
- If an alarm occurs in the 24V DC power supply to the A172SENC/A171SENC (major error 15010 occurs) while the servos are ON at all axes and the A172SENC/A171SENC brake has been set for use.

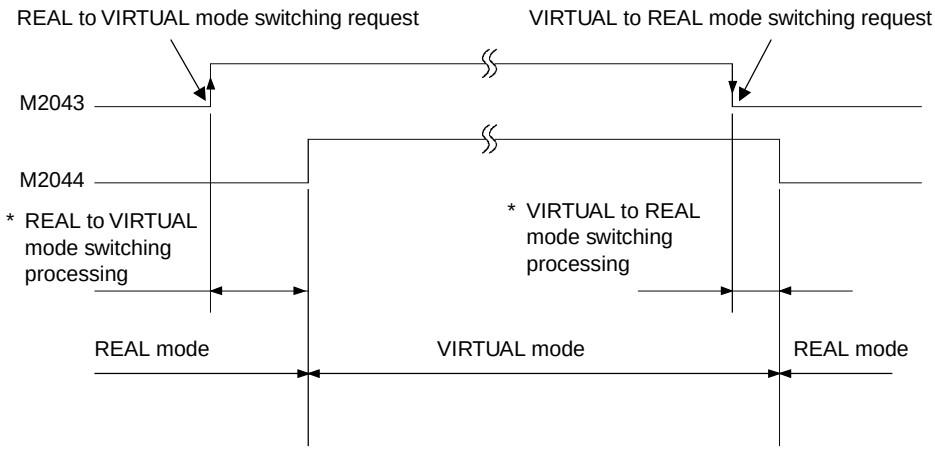
(2) If any of the above conditions occur, the OS will switch back to the REAL mode, and the resulting error code will be stored in the D9195 register.
M2045 will not switch ON at this time.

9.3 Precautions When Switching between REAL and VIRTUAL Modes

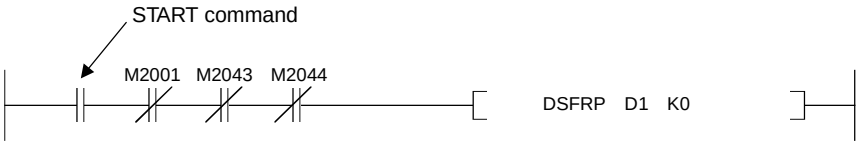
The precautions when switching between the REAL and VIRTUAL modes are described below.

(1) The DSFRP/SVST, DSFLP/CHGA/CHGV instructions are inoperative during REAL/VIRTUAL mode switching processing (indicated by asterisks * in the timing chart below). If one of these instructions is attempted at such a time, an error will occur at the START point.
In order to execute the DSFRP/SVST and DSFLP/CHGA/CHGV instructions, M2043 and M2044 should be used as an interlock function.

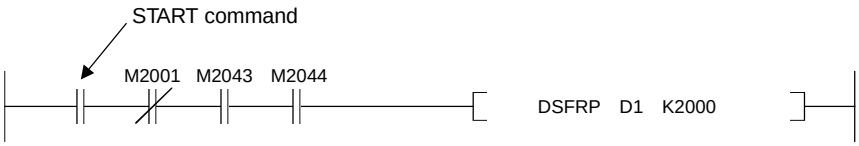
[Timing Chart]



[Program Example]
(a) Servo program START request at REAL mode



(b) Servo program START request at VIRTUAL mode



REMARKS

1) For details regarding the DSFRP/SVST and DSFLP/CHGA/CHGV instructions, refer to the Motion Controller (SV13/22) Programming Manual (REAL Mode) IB-67265.
2) The M2043 and M2044 names are as follows.
   - M2043 ..... REAL/VIRTUAL mode switching request flag
   - M2044 ..... REAL/VIRTUAL mode status flag

   (See Section 4.1)

(2) During TEST mode operation, M2043 ON/OFF (REAL/VIRTUAL mode switching request) switching from a peripheral device is ignored.
During TEST mode operation, REAL/VIRTUAL mode switching can be executed from a peripheral device.
M2044 will switch ON/OFF in accordance with the REAL/VIRTUAL mode status.

REMARK

When REAL/VIRTUAL mode switching is executed from a peripheral device, the data which is checked is identical to that checked at M2043 OFF→ON and ON→OFF. (See Sections 9.1 and 9.2)

9.4 STOP & RESTART

The basic method for stopping the system (output module) during VIRTUAL mode operation is to stop the main shaft. If an auxiliary input shaft is being used, that shaft should also be stopped.

(1) Virtual Axis STOP

The procedures for stopping and restarting the virtual shaft, and the stop processing details are discussed below. A virtual servo motor axis can be stopped by the 3 types of stop processing shown below. This processing is also valid for interpolation axes during interpolation operations.

1. Deceleration to stop.....A deceleration to stop occurs in accordance with the parameter block's "stop deceleration time" setting.
2. Rapid stop .....A deceleration to stop occurs in accordance with the parameter block's "rapid stop deceleration time" setting.
3. Immediate stop.....An immediate stop occurs without deceleration.

Because an immediate input stop occurs for synchronous encoder axes, operation should be executed only after the synchronous encoder axis has been stopped by an external input, except for abnormal stops such as an emergency stop or a servo error occurrence, etc.
([Ex]: Switch M2000 OFF, or execute an all-axes servo OFF command, etc.)
(An immediate stop at output modules connected to the synchronous encoder will result in a servo error, and possibly, a synchronization discrepancy.)
When the stop cause is such that a synchronization discrepancy occurs, a synchronization discrepancy warning (M2046) will switch ON. In this case, re-align the axes in the REAL mode, switch M2046 OFF, then continue with the VIRTUAL mode operation.
The stop procedure/stop causes, and restarting procedure are shown in the following Table.

9. REAL & VIRTUAL MODE SWITCHING AND STOP/RESTART

No.	Stop Procedure or Stop Causes during Operation	Affected Virtual Axis			Stop Processing		Return to REAL Mode by OS after All Virtual Axes Stop Completed	Synchroni-zation Discrepancy Warning (M2046) set	
		Virtual Servo Motor Axis	Synchronous Encoder Axis	All Axes Batch	Virtual Servo Motor Axis	Synchronous Encoder Axis			
1	Stop command ON	○ (Relevant axis)	—	—	Deceleration to stop	—	—	—	
2	Rapid stop command ON	○ (Relevant axis)	—	—	Rapid stop	—	—	—	
3	All-axes servo OFF command (M2042 OFF Command from peripheral device when in TEST mode)	—	—	○	Deceleration to stop	Immediate input stop	—	—	
4	PC READY (M2000) OFF	—	—	○	Deceleration to stop	Immediate input stop	○	—	
5	Servo system CPU stop	—	—	○	Deceleration to stop	Immediate input stop	○	—	
6	All-axes rapid stop by key input from peripheral device	—	—	○	Rapid stop	Immediate input stop	—	—	
7	Stop by key input from peripheral device during TEST mode	○ (All axes)	—	—	Deceleration to stop	—	—	—	
8	External emergency stop (EMG) input (emergency stop from teaching module)	—	—	○	Rapid stop	Immediate input stop	○	○	
9	Servo error at any output module	—	—	○	Rapid stop	Immediate input stop	○	○	
10	SCPU WDT error	—	—	○	Deceleration to stop	Immediate input stop	—	—	
11	PCPU WDT error	—	—	○	Immediate stop	Immediate input stop	—	—	
12	Servo system CPU reset	—	—	○	Immediate stop	Immediate input stop	—	—	
13	Servo system CPU power OFF	—	—	○	Immediate stop	Immediate input stop	—	—	
14	Other errors during virtual axis operation	○	—	—	Deceleration to stop	—	—	—	
15	Error at absolute synchronous encoder axis	—	○	—	—	Immediate input stop	—	—	

	Error Set	Output Module Operation	Operation Continuation ENABLED (○)/ DISABLED (×)	Restarting after a Stop
	—	• Deceleration to stop based on smoothing time constant.	○	• Resume operation by switching the stop command OFF (not necessary when ON) and executing a START.
	—	• Deceleration to stop based on smoothing time constant.	○	• Resume operation by switching the stop command OFF (not necessary when ON) and executing a START.
	—	• After a deceleration to stop based on the smoothing time constant, the servo OFF status is established.	○	• Resume operation by turning all clutches OFF→all axes servo ON→clutch ON. (However, there must be no motor movement during the servo OFF status. Moreover, clutch OFF/ON switching occurs only as required by the user.) • For synchronous encoder axes, switch to the REAL mode, then back to the VIRTUAL mode to resume inputs.
	Minor error (200) set (virtual axis)	• Deceleration to stop based on smoothing time constant.	○	• After PC READY (M2000) switches ON, execute a REAL to VIRTUAL mode switching request (M2047 ON) to enable operation.
	Minor error (200) set (virtual axis)	• Deceleration to stop based on smoothing time constant.	○	• After a servo system CPU "RUN" status is established, execute a REAL to VIRTUAL mode switching request (M2047 ON) to enable operation.
	—	• Deceleration to stop based on smoothing time constant.	○	• After a stop occurs, execute a START to resume operation. • For synchronous encoder axes, switch to the REAL mode, then back to the VIRTUAL mode to resume inputs.
	—	• Deceleration to stop based on smoothing time constant.	○	• After a stop occurs, execute a START to resume operation.
	—	• Servo switches OFF after immediate stop.	×	• Operation cannot be resumed due to a synchronization discrepancy between the virtual axis and output module which occurs at the stop. • After canceling the emergency stop, re-align the output module in the REAL mode, switch the synchronization discrepancy warning (M2046) OFF, then switch back to the VIRTUAL mode to resume operation.
	Relevant output module (Servo error, Servo error code set)	• Servo error at MR-[ ]-B axis. An immediate stop occurs only at the axis where the error occurred, and a servo OFF status is established. All other axes are synchronized with the virtual axis and are then stopped.	×	• After executing a servo error reset in the REAL mode, re-align the axes, switch the synchronization discrepancy warning (M2046) OFF, then switch back to the VIRTUAL mode to resume operation.
	—	• Deceleration to stop based on smoothing time constant.	×	• After the stop, reset the servo system CPU in the REAL mode to resume operation.
	M9073(PCPU WDT error)ON	• Servo switches OFF after immediate stop.	×	• Operation cannot be resumed due to a synchronization discrepancy between the virtual axis and output module which occurs at the stop. • After resetting the servo system CPU, re-align the output module,then switch to the VIRTUAL mode to resume operation.
	—	• Servo switches OFF after immediate stop.	×	• Operation cannot be resumed due to a synchronization discrepancy between the virtual axis and output module which occurs at the stop. • After resetting the servo system CPU, re-align the output module,then switch to the VIRTUAL mode to resume operation.
	—	• Servo switches OFF after immediate stop.	×	• Operation cannot be resumed due to a synchronization discrepancy between the virtual axis and output module which occurs at the stop. • After resetting the servo system CPU, re-align the output module,then switch to the VIRTUAL mode to resume operation.
	Relevant error set	• Deceleration to stop based on smoothing time constant.	○	• Eliminate the error cause to enable a START.
	Relevant error set	• Deceleration to stop based on smoothing time constant.	×	• Return to the REAL mode, re-align the axes, then switch to the VIRTUAL mode to resume operation.

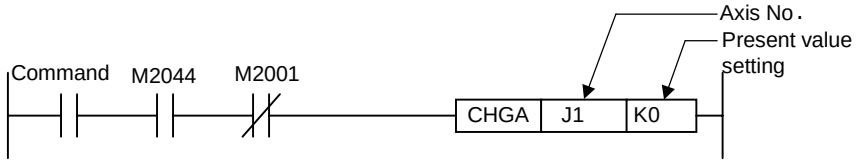
10. AUXILIARY / APPLIED FUNCTIONS

10.1 Present Value Change / Speed Change

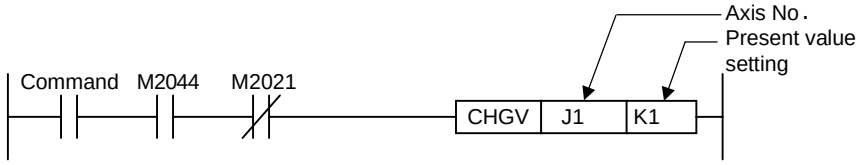
Virtual servo motor present value changes, speed changes, and synchronous encoder present value changes are explained here.
Present value changes are carried out using the CHGA instruction while speed changes are performed using the CHGV instruction.
In addition, when A172SHCPU or A171SHCPU is used it is also possible to carry out present value change/speed change using the DSFLP instruction.
For details regarding the CHGA, CHGV, and DSFLP instructions, refer to the Motion Controller (SV13/22 REAL Mode) Programming Manual.

10.1.1 Present value change by CHGA instruction and speed change by CHGV instruction

Program examples are illustrated below.
(1) Virtual servo motor present value change program



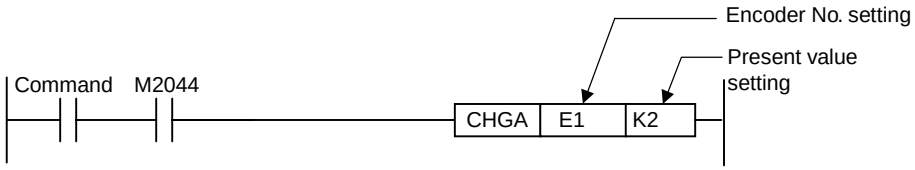
(2) Virtual servo motor speed change program



REMARKS

(1) M2001: Start accept flag {see section 4.1.8 (2)}
(2) M2044: REAL mode/VIRTUAL mode status flag {see section 4.1.8 (13)}
(3) M2021: Speed change in progress flag {see section 4.1.8 (7)}

(3) Synchronous encoder present value change program



(a) The change in the present value and speed are set using the devices described below.

- Indirect setting.....Data register (D)
  Link register (W) } Double word
  File register (R)
- Direct setting.....Decimal constant (K)

(b) The encoder No. setting range is described below.

- When A172SHCPU is used.....E1
- When A171SHCPU is used.....E1

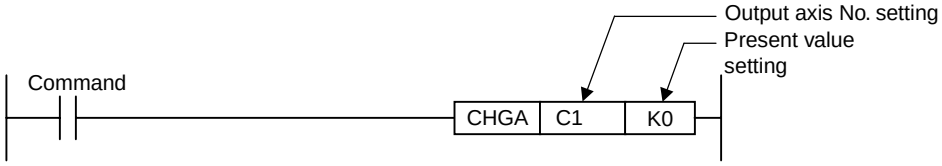
(c) Precautions

- When a synchronous encoder present value change is carried out in the REAL mode, an error will occur and the present value change will not be carried out.
- A synchronous encoder present value change can be executed in the VIRTUAL mode even while operation is in progress (during pulse input from the synchronous encoder).
  When the present value is changed the synchronous encoder feed present value will be continued from the changed value.
- Even if a synchronous encoder present value change is carried out, it will have no effect on the output module present value.

REMARK

(1) M2044: REAL mode/VIRTUAL mode status flag {see section 4.1.8 (13)}

(4) Cam axis present value change in one revolution program (when cam axis 1 is used)



(a) The change in the present value and speed are set using the devices described below.

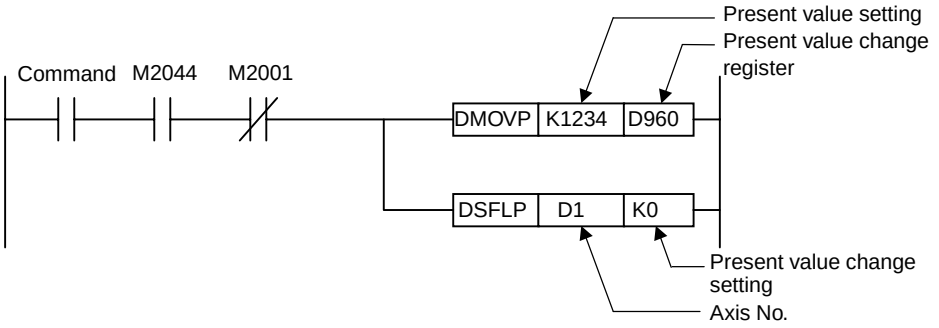
- Indirect setting.....Data register (D)
  Link register (W) } Double word
  File register (R)
- Direct setting.....Decimal constant (K)

(b) The cam axis No. setting range is described below.
- When A172SHCPU is used..... 1 to 8
- When A171SHCPU is used..... 1 to 4

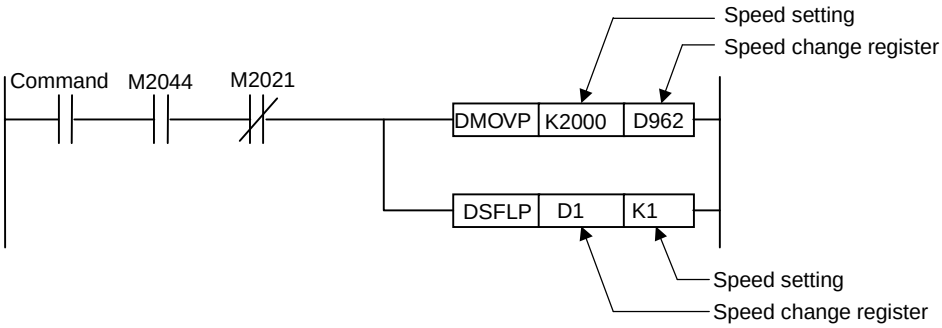
(c) Precautions
- If the present value that has been changed is out of the one revolution range {0 – (number of pulses per revolution –1)}, an error will result (error code: 6120) and the present value change will not be carried out.

10.1.2 Present value & speed changes by DSFLP instruction

Program examples are illustrated below.
(1) Virtual servo motor present value change program



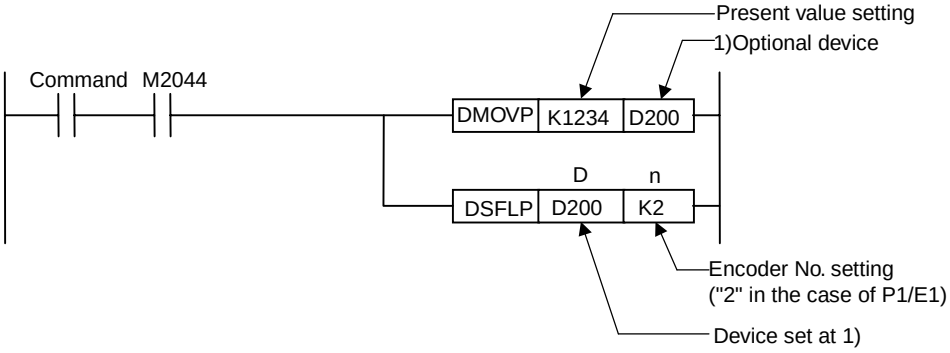
(2) Virtual servo motor speed change program



REMARKS

(1) M2001: Start accept flag {see section 4.1.8 (2)}
(2) M2044: REAL mode/VIRTUAL mode status flag {see section 4.1.8 (13)}
(3) M2021: Speed change in progress flag {see section 4.1.8 (7)}

(3) Synchronous encoder present value change program



(a) The devices that can be used in "D" and "n" described in the above program are given below.

- D ..... Data register (D)
  Link register (W)
  File register (R)
  Timer (T)
  Counter (C)
- n ..... Decimal constant (K)
  Hexadecimal constant (H)

(b) The encoder No. setting method is given below.

- Encoder No.1 ..... K2/H2
- Encoder No.2 ..... K3/H3
- Encoder No.3 ..... K4/H4

(c) Precautions

- When a synchronous encoder present value change is carried out in the REAL mode an error will occur and the present value change will not be carried out.
- A synchronous encoder present value change can be executed in the VIRTUAL mode even while operation is in progress (during pulse input from the synchronous encoder).
  When the present value is changed the synchronous encoder feed present value will be continued from the changed value.
- Even if a synchronous encoder present value change is carried out, it will have no effect on the output module present value.

REMARK

(1) M2044: REAL mode/VIRTUAL mode status flag {see section 4.1.8 (13)}

10.2 Improved Present Value Management

By adding the functions described below, present value management when using an absolute encoder has been improved.

(1) Added functions

(a) An encoder data validity check is now possible during operation.

- It is checked whether the amount of change at the encoder in 3.5 ms intervals corresponds to rotation within 180° at the motor shaft. (If abnormal, an error is displayed.)
- Consistency between the encoder data and the feedback position controlled at the servo amplifier is checked. (If abnormal, an error is displayed.)

(b) Addition of the present value history monitor has enabled monitoring of the following data at a peripheral device.

- Encoder present value/servo command value/monitor present value when the power is switched ON.
- Encoder present value/servo command value/monitor present value when the power is switched OFF.
- Encoder present value/servo command value/monitor present value when a home position return is performed.

(c) By setting the allowable travel while the power is OFF, a change in the encoder data to a value outside the setting range while the power is OFF can now be checked when the servo amplifier power is turned ON. (If abnormal, an error is displayed.)

(2) Restrictions due to the combination of positioning OS and positioning software package

The following restrictions apply, depending on whether an allowable travel while the power is OFF is set or not.

<table>
<tr><th>Positioning OS Version</th><th>Positioning Software Package Version</th><th>Restrictions</th></tr>
<tr><td rowspan="2">V or later</td><td>R or later *1</td><td>There are no restrictions.
(When a new version positioning OS is installed in place of an old version, it is essential to execute a home position return.)</td></tr>
<tr><td>Q or earlier *2</td><td>• Present value history monitor cannot be used.
• Since the allowable travel while the power is OFF cannot be set, a minor error (error code: 901 or 9010) occurs when the servo amplifier power is turned on. (When a new version positioning OS is installed in place of an old version, it is essential to execute a home position return.)*3</td></tr>
<tr><td rowspan="2">U or earlier</td><td>R or later *1</td><td rowspan="2">None of the function upgrades can be used</td></tr>
<tr><td>Q or earlier *2</td></tr>
</table>

*1: Allowable travel while the power is OFF can be set.

*2: Allowable travel while the power is OFF cannot be set.

*3: Since the allowable travel while the power is OFF cannot be set when using an old version positioning software package a minor error is displayed, but this poses no problem to operation.

(3) Restrictions due to servo amplifier

The following restrictions apply depending on the combination of servo amplifier and positioning software package used when using positioning OS version V or later.

Servo Amplifier	Positioning Software Package Version	Restrictions
MR-H-B: BCD-B13W000-B2 or later MR-J2-B: BCD-B20W200-A1 or later	R or later	There are no restrictions.
	Q or earlier	Only the function upgrade described in item (a) applies.
MR-H-B: BCD-B13W000-B1 or earlier MR-J2-B: BCD-B20W200-A0 or earlier MR-J-B: All models ADU: All models	R or later	Only the function upgrade described in item (c) applies. (However, with respect to item (b), monitoring is possible with the exception of the encoder present value.)
	Q or earlier	None of the function upgrades can be used.

11. ERROR CODES STORED AT THE PCPU

Errors detected at the PCPU include servo program setting errors, positioning errors, and control mode switching errors.

(1) Servo program setting errors
Servo program setting errors consist of errors in the positioning data designated at the servo program. A check occurs for these errors each time a servo program is started. When positioning data is designated indirectly, an error will occur if the designated data violates the prescribed range.
When an error is activated, the following occur:
- The servo program setting error flag (M9079) switches ON.
- The program No. where the error occurred is recorded in the error program No. register (D9189).
- The error code is recorded in the error information storage register (D9190).

(2) Positioning errors
(a) Positioning errors occur at positioning START, or during the positioning operation. There are three types of positioning error: minor errors, major errors, and servo errors.
1) Minor error..... These errors are caused by the sequence program or servo program. The error code range for these errors is 1 to 999 for drive modules, and 4000 to 9990 for output modules. The cause of these errors can be eliminated by correcting the sequence program or servo program in accordance with the error code.

2) Major errors ..... These errors are caused by external input signals or by control commands from the SCPU. The error code range for these errors is 1000 to 1999 for drive modules, and 10000 to 11990 for output modules. Eliminate the cause of these errors in accordance with the error code.

3) Servo errors..... These are errors detected by the servo amplifier or servo power supply module. The error code range for these errors is 2000 to 2999. Eliminate the cause of these errors in accordance with the error code.

Error Class	Error Occurrence Point	Applicable Modules	
		Drive Module	Output Module
Minor error	Setting data	1 to 99	4000 to 4990
	At START	100 to 199	5000 to 5990
	During operation	200 to 299	6000 to 6990
	At control change	300 to 399	—
Major error	At START	1000 to 1099	10000 to 10990
	During operation	1100 to 1199	11000 to 11990
	System	—	—
		—	15000 to 15990
Servo error	Servo amplifier	—	2000 to 2799 (2100 to 2499 are warnings)
	Servo power supply module		2800 to 2999 (2900 to are warnings)

(b) When an error occurs, the error detection signal for the axis in question will switch ON, and the corresponding error code will be recorded in the minor error code, major error code, or servo error code register.

		Error Code Registers	Error Detection Signal	Error Reset Flag	Note
Virtual servo motor	Minor error code	D702 + 6n	D1207 + 20n	D1407 + 20n	When A172SHCPU is used n = 0 to 7 When A171SHCPU is used n = 0 to 3 (n = Axis No.–1)
	Major error code	D703 + 6n			
Synchronous encoder	Minor error code	D750	M1360	M1560	
	Major error code	D751			
Output module	Minor error code	D806 + 20n	D1607 + 20n	D1807 + 20n	
	Major error code	D807 + 20n			
	Servo error code	D808 + 20n	D1608 + 20n	D1808 + 20n (Reset is also valid for REAL mode errors)	

(c) Each time an error occurs, the previously stored error code will be replaced (deleted) by the new error code. However, a log of errors can be recorded for reference purposes at a peripheral device (IBM PC running the SW2SRX-GSV22PE software).

(d) The error detection flag and error code are saved until the error reset signal or the servo error reset signal is switched ON.

POINTS

(1) When a servo error occurs, there are cases where the same servo error code will be stored again even after a servo error reset (M1808+ 20n: ON) is executed.
(2) When a servo error occurs, eliminate the error cause, then execute a servo error reset.

(3) REAL/VIRTUAL mode switching errors
A check for REAL/VIRTUAL mode switching errors occurs when the REAL/VIRTUAL mode switching request flag (M2043) switches from OFF to ON, and from ON to OFF. (See Sections 9.1 and 9.2 for the check content.) If an error is found, the following occur:

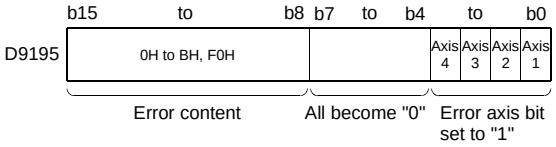
- REAL/VIRTUAL mode switching will not occur, and the present mode will be maintained.
- The REAL/VIRTUAL mode switching request flag (M2045) switches ON.
- The corresponding error code will be stored in the REAL/VIRTUAL mode switching error information register (D9195).

POINT

(1) The error codes stored in the D9195 storage registers which apply to axis errors are shown below.

(a) When A172SHCPU is used

(b) When A171SHCPU is used



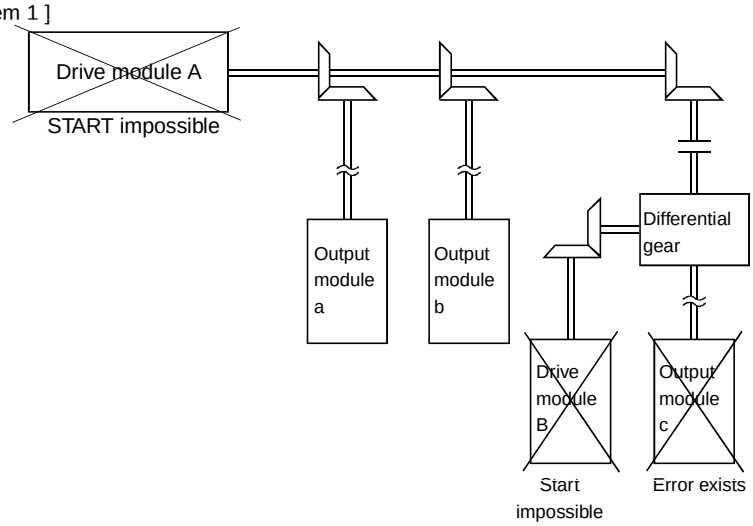
11. ERROR CODES STORED AT THE PCPU

11.1 Related Systems & Error Processing

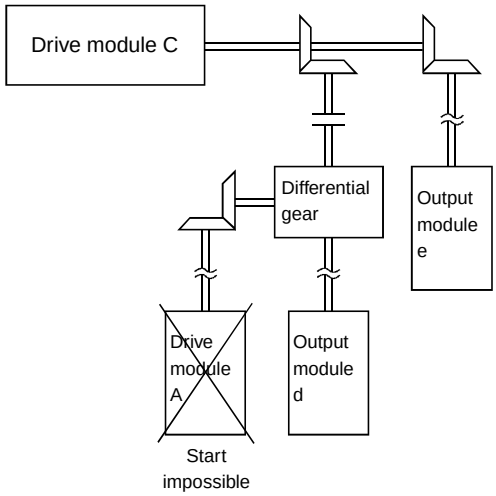
The following 2 types of related systems exist in the VIRTUAL mode.
(1) System consisting of a drive module and output module.
(2) Multiple systems using the same drive module.

The following occurs when an error is detected at an output module.
(1) If an error is detected at any output module, a drive module START will be impossible, and that system will be disabled.
The auxiliary input shaft operation for that output module will also be disabled.
(2) Other systems which use the drive module which was disabled by the output module error will also be disabled.

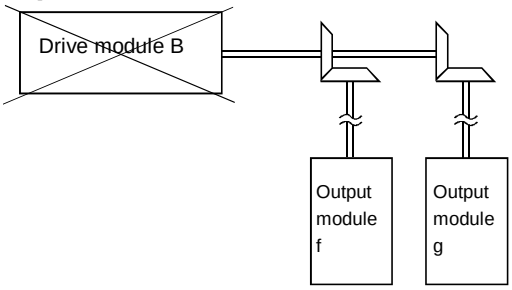
[System 1]



[System 2]



[System 3]



(1) If an error occurs at any of the "a", "b", "c" system 1 output modules, a drive module "A" START will become impossible, and system 1 will be disabled. A drive module "A" START at system 2 will also become impossible.

(2) If an error occurs at system 1 output module "C", a drive module "B" START will become impossible. A drive module "B" START at system 3 will also become impossible, thereby disabling system 3 as well.

(3) The system 2 drive module "C" can be started.

11.2 Servo Program Setting Errors

The error codes, error descriptions, and corrective actions for servo program setting errors are shown in Table 11.1 below. The "n" in the asterisked error codes in Table 11.1 indicates the axis number (1 to 8/1 to 4).

Table 11.1 Servo Program Setting Error List

Error Codes Stored at D9190	Error Name	Description	Error Processing	Corrective Action
1	Parameter block No. setting error	The parameter block No. setting is outside the 1 to16 range.	The default parameter block No. of "1" will be adopted for servo program operation.	Designate a parameter block No. within the 1 to 16 range.
N03*	Address/travel value setting error (excluding speed control)	At incremental method positioning control, the travel value setting is as follows: -2147483648 (H80000000)	(1) START is disabled. (at all interpolation axes during interpolation control.) (2) If an error is detected during speed switching control or constant speed control, a deceleration to stop will occur. (3) When a simultaneous START is in effect, an error at any servo program will disable all servo programs.	The travel value setting should be designated with a 0 to ±2147483647 range.
4	Commanded speed error	(1) The commanded speed violated the "1 to speed limit" range. (2) The commanded speed violated the setting range. System-of-units: pulse; Address setting range: 1 to 1000000 PLS/sec	(1) START will be disabled if a setting of 0 or less is designated. (2) When the setting exceeds the speed limit, the speed limit value will be adopted.	(1) Designate the commanded speed with the "1 to speed limit" range.
5	Dwell time setting error	The dwell time setting violated the 0 to 5000 range.	The default value of "0" will be adopted.	Designate the dwell time setting within the 0 to 5000 range.
6	M code setting error	The M code setting violated the 0 to 255 range.	The default value of "0" will be adopted.	Designate the M code setting within the 0 to 255 range.
n08*	Auxiliary point setting error (at auxiliary point designation at circular interpolation)	(1) In incremental method positioning control, the travel value setting is as follows: -2147483648 (H80000000) (2) [START point] = [auxiliary point], or [auxiliary point] = [END point] (3) The auxiliary point is located on the straight line which connects the START and END points.	START is disabled.	(1) The travel value setting should be designated within the range 0 to ±2147483647. (2) Set as follows: [START point] ≠ [auxiliary point] ≠ [END point]. (3) Designate an auxiliary point value which is not located on the straight line connecting the START and END points.
n09*	Radius setting error (radius setting for circular interpolation)	(1) In incremental method positioning control, the travel value setting is as follows: -2147483648 (H80000000) (2) [START point] = [END point] (3) The distance between the START and END points is larger than the diameter.	START is disabled.	(1) The travel value setting should be designated within the range 0 to ±2147483647. (2) Set as follows: [START point] ≠ [END point]. (3) Set so that the relationship between the START point to END point distance (L) and the radius (R) is as follows: $\frac{L}{2R} \leq 1$

Table 11.1 Servo Program Setting Error List (Continued)

Error Codes Stored at D9190	Error Name	Description	Error Processing	Corrective Action
n10*	Center point setting error (center point setting for circular interpolation)	At incremental method positioning control, the travel value setting is as follows: −2147483648 (H80000000)	START is disabled.	The travel value setting should be designated within the range 0 to ± 2147483647.
12	Speed limit setting error	The speed limit setting violates the setting range.	The default value of "200000 pulse/s" is adopted.	Designate a speed limit value within the setting range.
13	Acceleration time setting error	The acceleration time is "0".	The default value of "1000" is adopted.	Designate an acceleration time within the range 1 to 65535.
14	Deceleration time setting error	The deceleration time is "0".		Designate a deceleration time within the range 1 to 65535.
15	Rapid stop deceleration time setting error	The rapid stop deceleration time is "0".		Designate a rapid stop deceleration time setting within the range 1 to 65535.
17	"Allowable error range for circular interpolation" setting error	The "allowable error range for circular interpolation" setting violates the prescribed setting range. System-of-units: pulse; Address setting range: 0 to 10000000 PLS	The default value of "100 PLS" is adopted.	Designate the "allowable error range for circular interpolation" setting within the prescribed setting range.
18	"Number of repeats" setting error	The "number of repeats" setting violates the prescribed setting range 1 to 32767.	A "number of repeats" setting of "1" is adopted.	Designate the "number of repeats" setting within the range 1 to 32767.
19	START instruction setting error	(1) The servo program designated by the START instruction does not exist.	START is disabled.	(1) Create the servo program No. designated by the START command.
		(2) A START instruction exists in the designated servo program.		(2) Delete the servo program which contains a START command.
		(3) Duplicate START axes exist in the designated servo program.		(3) Designate the START axes without duplications.
20	Point setting error	During constant speed control, there is no point designation in the instruction.	START is disabled.	Designate a point between the CPSTART and CPEND instructions.
21	Reference axis speed setting error	During a reference axis speed designation in linear interpolation, a non-interpolation axis was designated as the reference axis.	START is disabled.	Designate one of the interpolation axes as the reference axis.
22	S-curve ratio setting error	When designating the S-curve acceleration/deceleration speed, the S-curve ratio violated the 0 to 100% range.	An S-curve ratio of "100%" is adopted.	Designate an S-curve ratio within the 0 to 100% range.
23	VSTART setting error	No speed switching points were designated between the VSTART and VEND instructions, or between the FOR and NEXT instructions.	START is disabled.	Designate a speed switching point between the VSTART and VEND instructions, or between the FOR and NEXT instructions.
24	Cancel function start program number error	Cancel function start program number is not in the range 0 to 4095.	START is disabled.	Set the cancel function start program number in the range 0 to 4095, and start again.
900	START instruction setting error	The servo program designated by the SVST/DSFRP instruction does not exist.	START is disabled.	Designate the correct servo program.
901	START instruction setting error	(1) The axis No. designated by the SVST/ DSFRP instruction is different from that designated by servo program.	START is disabled.	(1) Designate the correct axis No.
		(2) The DSFRP instruction is being used for 4-axis linear interpolation.		(2) Use the SVST instruction for 4-axis linear interpolation.

Table 11.1 Servo Program Setting Error List (Continued)

Error Codes Stored at D9190	Error Name	Description	Error Processing	Corrective Action
902	Servo program instruction code error	The instruction code at the designated servo program cannot be decoded due to an instruction code error.	START is disabled.	Read out the servo program, check it, and make the necessary corrections.
903	START error	A VIRTUAL mode program was started when in the REAL mode.	START is disabled.	Check the program's mode allocation.
904	START error	A REAL mode program was started when in the VIRTUAL mode.	START is disabled.	Check the program's mode allocation.
905	START error	An instruction that cannot be executed in the VIRTUAL mode (VPF, VPR, VPSTART, ZERO, VVF, VVR, OSC) was designated.	START is disabled.	Correct the servo program.
906	START error	An axis listed as "not used" was designated while in the VIRTUAL mode.	START is disabled.	Designate the correct axis No. at the system settings.
907	START error	A START occurred while switching from the REAL to VIRTUAL mode.	START is disabled.	Use the M2034 (REAL/ VIRTUAL mode switching request) and M2044 (REAL/ VIRTUAL mode status) signals to create a START interlock condition.
908	START error	A START occurred while switching from the VIRTUAL to REAL mode.	START is disabled.	
9000*[1]	System setting motor type error	The settings differ from the actual type and size of the connected motor.	Operations are performed normally at the connected motor.	Change the settings according to the actual type and size of the connected motor.

*: These errors occur only when using MR-J2-B servo amplifier.

11.3 Drive Module Errors

Table 11.2 Drive Module Error List (100 to 1199)

Error Class	Error Code	Virtual Servo Axis Control Item										Error Cause	Processing	Corrective Action
		Positioning	Fixed pitch Feed	Speed	Speed Switching	Constant Speed	JOG	Manual Pulse Generator	Synchronous Encoder	Position Follow-Up				
Minor Errors	100	○	○	○	○	○	○	○		○		• The PC READY (M2000) or PCPU READY (M9074) signal is OFF.	START is disabled.	• Set the servo system CPU to RUN. • Switch the PC READY (M2000) signal ON.
	101	○	○	○	○	○	○	○		○		• The relevant axis' "START accept" signal (M2001 to M2008/M2001 to M2004) is ON.		• Set an interlock condition at the program to prevent a START from being designated at an axis which is in motion (Designate the relevant axis and a "START accept OFF" in the START conditions.)
	103	○	○	○	○	○	○	○		○		• The relevant axis' stop command (M1400+20n) is ON.		• Switch the stop command (M1400+20n) OFF, then execute a START.
	104	○	○	○	○	○	○	○		○		• The relevant axis' rapid stop command (M1401+20n) is ON.		• Switch the stop command (M1401+20n) OFF, then execute a START.
	105	○				○				○		• On starting, the feed present value is outside the stroke limit range.		• Return to within the stroke limit range using jog operation. • Move inside the stroke limit range by performing a present value change.
	106*	○	○			○				○		• Positioning violates the stroke limit range.		• Execute positioning back to within the stroke limit range
	107	○				○						• At the auxiliary point designation for circular interpolation, an address was designated which will not produce a circle. (Problem with START point, auxiliary point, and END point addresses)		• Correct the address at the servo program.
	108*	○				○						• At the radius designation for circular interpolation, an address was designated which will not produce a circle. (Problem with START point, radius, and END point addresses.)		
	109	○				○						• At the center point designation for circular interpolation, an address was designated which will not produces circle. (Problem with START point, center point, and END point addresses)		
	110*	○				○						• During circular interpolation, the difference between the END point address and the ideal END point exceeds the "allowable error range for circular interpolation"		
	116						○					• The designated JOG speed is "0".		• Designate a speed setting within the prescribed setting range.
												• The designated JOG speed exceeds the JOG speed limit	The JOG speed limit value is adopted.	
	117						○					• At a JOG simultaneous START, a forward and reverse setting are designated for the same axis.	A forward START will occur at the relevant axis only.	• Designate the setting correctly.

* : During interpolation operations, this error code is stored at all relevant interpolation axis storage areas.

Table 11.2 Drive Module Error List (100 to 1199) (Continued)

Error Class	Error Code	Virtual Servo Axis Control Item										Error Cause	Processing	Corrective Action
		Positioning	Fixed pitch Feed	Speed	Speed Switching	Constant Speed	JOG	Manual Pulse Generator	Synchronous Encoder	Position Follow-Up				
Minor Errors	140	○										• At the reference axis designation for linear interpolation, the reference axis travel value is "0".	START is disabled.	• Do not select an axis where the travel value is "0" as the reference axis.
	141									○		• The position command device No. at position follow-up control is an odd No.		• Designate an even number as the position command device No.
	151	○	○	○	○	○	○	○				• In the VIRTUAL mode, START was designated at an inoperative axis. (Error occurred at REAL to VIRTUAL mode switching, and system START was disabled.)	START is disabled.	• After correcting the error cause in the REAL mode, switch back to the VIRTUAL mode and start operation.
	152	○	○	○	○	○	○	○				• A START was designated during a deceleration to stop which was occurring in response to an all-axes servo OFF (M2042: OFF)		• After correcting the error cause in the REAL mode, switch back to the VIRTUAL mode and start operation.
	153	○	○	○	○	○	○	○				• A START was designated during a deceleration to stop which was occurring in response to a servo error at the output module.		
	200	○	○	○	○	○	○	○	○	○		• The PC READY (M2000) signal was switched OFF during a START which was occurring in response to a START request from the sequence program.	Deceleration to stop	• After all axes have stopped, switch the programmable controller READY (M2000) signal ON.
	204	○	○	○	○	○	○	○	○	○		• The PC READY (M2000) signal was switched ON again during a deceleration to stop which was occurring in response to the PC READY (M2000) signal being switched OFF.	Ignored	• After all axes have stopped, switch the PC READY (M2000) signal ON. (PC READY (M2000) OFF→ON switching during a deceleration to stop is ignored.)
	207	○				○				○		• The feed present value violated the stroke limit range during operation. In circular interpolation operations, the error code will be stored only at the axis where the stroke limit range was violated. In linear interpolation operations, the error code will be stored at all interpolation axes.	Deceleration to stop	• Correct the stroke limit range or the travel value setting to ensure that positioning control remains within the stroke limit range.
	208	○				○		○				• During circular interpolation or manual pulse generator simultaneous operation, the feed present value of another axis violated the stroke limit range. (For other axis error detection.)		
	211					○						• When the final positioning address was identified during a positioning operation, an overrun occurred due to a deceleration distance which was insufficient for the output speed.		(1) Designate a speed which will not cause an overrun. (2) Designate a travel value which will not cause an overrun.
	214							○				• The manual pulse generator status was switched to "enabled" during axis motion, and manual pulse generator operation was attempted.	Manual pulse generator in puts are ignored until a stop occurs.	• Execute manual pulse generator operation after the axis motion has stopped.

Table 11.2 Drive Module Error List (100 to 1199) (Continued)

Error Class	Error Code	Virtual Servo Axis Control Item										Error Cause	Processing	Corrective Action
		Positioning	Fixed pitch Feed	Speed	Speed Switching	Constant Speed	JOG	Manual Pulse Generator	Synchronous Encoder	Position Follow-Up				
Minor Errors	215				○							• The address of the speed switching point exceeds the END point address. • An address was designated which causes opposite direction positioning during speed switching control. • The same servo program operation was designated again	Rapid stop occurs.	• Designate the speed switching point somewhere between the previous speed switching point address and the END point address. • Correct the sequence program.
	220									○		• During position follow-up control with "degrees" set as the system-of-units, the commanded address violated the 0 to 35999999 range. • The address designated for position follow-up control is outside the stroke limit range.	Deceleration to stop. (M200[ ] OFF)	• When the control system-of-units is "degrees", designate an address within the 0 to 35999999 range. • Set the address in the stroke limit range.
	225					○						• During constant speed control, the speed at an intermediate point violated the speed limit value.	Operation occurs at the speed limit speed.	• Designate speed within the "1 to speed limit value" range.
	300	○	○	○	○	○	○	○		○		• A present value change was designated while motion was in progress at the relevant axis. • A present value change was designated at an axis which hasn't been started. • A present value change was designated at an axis where the servo is OFF.	The present value will not be changed.	• Establish an interlock condition for the devices shown below, and avoid present value changes during axis motion. (1) Relevant axis' START accept signal (M2001 to M2008/M2001 to M2004) OFF. (2) Servo START signal (M1615+20n) ON.
	302	○				○						• A speed change was designated at an axis where circular interpolation is in progress.	The speed will not be changed.	• Do not make speed changes during circular interpolation.
	303	○	○		○	○				○		• A speed change was designated following the start of automatic deceleration during positioning.		• Do not make speed changes following the start of positioning deceleration.
	304						○		○			• A speed change was attempted during deceleration which was occurring in response to the JOG START signal (M1402+20n, M1403+20n) being switched OFF.		• Do not make speed changes during deceleration which is occurring in response to the JOG START signal(M1402+20n, M1403+20n) being switched OFF.
	305				○		○			○		• The speed following a speed change violated the "0 to speed limit value" range.	Operation will occur at the speed limit speed	• Designated the post-change speed within the "0 to speed limit value" range.
		○	○	○		○						• The absolute value of the speed following a speed change violated the "0 to speed limit value" range.	Operation will occur at the speed limit speed.	• Designated the absolute value of the post-change speed within the "0 to speed limit value" range.
	309											• A present value change which violated the range 0 to 35999999 ($\times 10^{-5}$ degrees) was designated at a "degrees" axis.	The present value will not be changed.	• Designate a value within the 0 to 35999999 ($\times 10^{-5}$ degrees) range.
Major Errors	1151								○			• A172SENC/A171SENC or encoder hardware fault • Discontinuity in encoder cable	Immediate input stop	• Check the A172SENC/A171SENC, or the encoder (H/W replacement). • Check the encoder cable.
	1152								○			• Low voltage at A172SENC/A171SENC battery.	Operation is continued.	• Replace the battery.
	1153								○			• No battery or disconnected battery at A172SENC/A171SENC.		• Replace battery, or check the hardware at the A172SENC/A171SENC.

11.4 Servo Errors

(1) Servo amplifier errors (2000 to 2799)

The servo amplifier errors are errors detected by the servo amplifier and are assigned error codes 2000 to 2799.

In the following tables, the types of servo amplifier are indicated for MR-[ ]-B.

The servo error detection signal (M1608+ 20n) comes ON when a servo error occurs. Eliminate the cause of the error, reset the error by turning ON the servo error reset signal (M1808+ 20n), and reset operation. (Note that the servo error detection signal will not come ON in response to error codes in the range 2100 to 2499 because these codes are for warnings.)

Note: 1. When an excessive regeneration error (code 2030), or overload 1 or 2 error (codes 2050, 2051) occurs, the state that applied when the error occurred is stored in the servo amplifier even after the protection circuit has operated. The memory contents are cleared if the external power supply is turned OFF, but are not cleared by the RESET signal.

2. Repeated resetting by turning OFF the external power supply after occurrence of error code 2030, 2050, or 2051, may cause devices to be destroyed by overheating. Only restart operation after eliminating the cause of the error.

Details of servo errors are given in Table 11.3.

⚠ CAUTION
⚠ If a controller or servo amplifier self-diagnosis error occurs, check the points stated in this manual and clear the error.

Table 11.3 Servo Amplifier Error List (2000 to 2799)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2010	Low voltage	• The power supply voltage is less than 160 VAC. • A momentary power, interruption of 15ms or longer has occurred. • The power supply voltage dropped, for example when motion control started, due to insufficient power capacity.	At any time during operation.	Immediate stop	• Measure the input voltage (R, S, T) with a voltmeter. • Monitor with an oscilloscope to check whether a momentary power interruption has occurred. • Review the power capacity.
2012	Memory error 1	• Servo amplifier SRAM is faulty. • Servo amplifier EPROM check sum error.	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON		• Replace the servo amplifier.
2013	Clock error	• Servo amplifier clock fault.	At any time during operation		• Replace the servo amplifier.
2014	Watchdog	• Servo amplifier hardware fault • Servo system CPU hardware fault			• Replace the servo amplifier. • Replace the servo system CPU.
2015	Memory error 2	• Servo amplifier EEPROM fault	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON		• Replace the servo amplifier.
2016	Position sensor error 1	• Fault in communication with the encoder	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON		• Check if the connector of the encoder cable is loose. • Replace the servomotor. • Replace the encoder cable. • Check the combination of the cable types (2-wire and 4-wire encoder cables) and servo parameters.
2017	PCB error	• Faulty device in the servo amplifier PCB.	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON		• Replace the servo amplifier.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2019	Memory error 3	• Servo amplifier flash ROM check sum error	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON	Immediate stop	• Replace the servo amplifier.
2020	Position sensor error 2	• Fault in communication with the encoder	At any time during operation		• Check if the connector of the encoder cable is loose. • Replace the servomotor. • Replace the encoder cable.
2024	Output ground fault	• U, V, or W of the servo amplifier output grounded	At any time during operation		• Use a multimeter to check between the U, V, and W terminals and the case. • Use a multimeter and megger to check between the U, V, and W terminals of the motor and the core.
2025	Battery alarm	• The voltage of the supercapacitor inside the absolute position sensor has dropped.	• When the servo amplifier power is turned ON • At the leading edge of the PC READY flag (M2000) • When a servo error is reset • When the power to the servo system CPU is turned ON		• Turn the power ON for 2 to 3 minutes to charge the supercapacitor, switch the power OFF then ON again, and execute a home position return.
		• The battery voltage is low.			• Turn the servo amplifier power OFF, then measure the battery voltage.
		• Failure of battery cable or battery. (Home position return must be reexecuted after clearing the error.)			• Replace the servo amplifier battery.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2030	Excessive regeneration	• The frequency of ON/OFF switching of the power transistor for regeneration is too high. (Caution is required since the regenerative resistor could overheat.)	At any time during operation	Immediate stop	• Reduce the frequency of acceleration and deceleration or feed speed while checking the servo monitor regeneration level (%). • Reduce the load. • Increase the servomotor capacity.
		• Servo parameter (system settings) setting error			• Check the servo parameters (regenerative resistor and motor type settings in the system settings).
		• Incorrect wiring of regenerative resistor			• Connect the regenerative resistor correctly.
		• Failure of regenerative resistor			• Replace the regenerative resistor.
		• Power transistor for regeneration damaged by short circuit			• Replace the servo amplifier.
2031	Overspeed	• The motor rpm has exceeded 115% of the rated rpm.			• Check the motor rpm in the servo parameters. • Check if the number of pulses per revolution and travel value per revolution in the fixed parameters match the machine specifications.
		• An overshoot has occurred because the acceleration time constant is too small.			• If an overshoot occurs during acceleration, check the acceleration time and deceleration time in the fixed parameters.
		• An overshoot has occurred because the servo system is unstable.			• If overshoot occurs, increase the speed integral compensation by adjusting the position loop gain / position control gain 1, 2, speed loop gain / speed control gain 1, 2 in the servo parameters.
		• Position sensor fault.			• Check if the encoder cable is disconnected. • Replace the servomotor.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2032	Overcurrent	• U, V, W in the servo amplifier outputs have short circuited with each other.	At any time during operation	Immediate stop	• Check if there is a short circuit between U, V, W of the servo amplifier outputs.
		• U, V, W in the servo amplifier outputs have shorted to ground.			• Check if U, V, W of the servo amplifier outputs have been grounded to the ground terminal. Check if U, V, W of the servomotor are grounded to the core. If grounding is found, replace the servo amplifier and/or motor.
		• Incorrect wiring of U, V, W phases in the servo amplifier outputs.			• Correct the wiring.
		• The servo amplifier transistor is damaged.			• Replace the servo amplifier.
		• Failure of coupling between servomotor and encoder			• Replace the servomotor.
		• Encoder cable failure			• Replace the encoder cable.
		• A servomotor that does not match the setting has been connected.			• Check the connected motor set in the system settings.
		• The servomotor oscillated.			• Check and adjust the gain value set in the servo parameters.
		• Noise entered the overcurrent detection circuit.			• Check if any relays or valves are operating in the vicinity.
2033	Overvoltage	• The converter bus voltage has reached 400 V or more. • The frequency of acceleration and deceleration was too high for the regenerative ability. • The regenerative resistor has been connected incorrectly.			• Increase the acceleration time and deceleration time in the fixed parameters. • Check the connection between C and P of the terminal block for the terminal block for regenerative resistance.
		• The regenerative resistor in the servo amplifier is destroyed.			• Measure between C and P of the terminal block for regenerative resistance with a multimeter; if abnormal, replace the servo amplifier. (Measure about 3 minutes after the charge lamp has gone out.)
		• The power transistor for regeneration is damaged.			• Replace the servo amplifier.
		• The power supply voltage is too high.			• Measure the input voltage (R, S, T) with a voltmeter.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2034	Communications error	• Error in data received from the servo system CPU	At any time during operation	Immediate stop	• Check the connection of the motion bus cable. • Check if there is a disconnection in the motion us cable. • Check if the motion bus cable is clamped correctly.
2035	Data error	• There is excessive variation in the position commands from the servo system CPU; commanded speed is too high.			• Check the commanded speed, and the number of pulses per revolution and travel value per revolution in the fixed parameters.
		• Noise has entered the commands from the servo system CPU.			• Check the connection of the motion bus cable connector. • Check if the motion bus cable is clamped correctly. • Check if the motion bus cable is clamped correctly. • Check if any relays or valves are operating in the vicinity.
2036	Transmission error	• Fault in communication with the servo system CPU			• Check the connection of the motion bus cable connector. • Check if there is a disconnection in the motion bus cable. • Check if the motion bus cable is clamped correctly.
2042	Feedback error	• Encoder signal fault			• Replace the servomotor.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2045	Fin overheating	• The heat sink in the servo amplifier is overheated. • Amplifier error (rated output exceeded) • Power repeatedly switched ON/OFF during overload. • Cooling fault	At any time during operation	Immediate stop	• If the effective torque of the servomotor is high, reduce the load. • Reduce the frequency of acceleration and deceleration. • Check if the amplifier's fan has stopped. (MR-H150B or higher) • Check if the passage of cooling air is obstructed. • Check if the temperature inside the panel is too high (range: 0 to +55°C). • Check if the electromagnetic brake was actuated from an external device during operation. • Replace the servo amplifier.
2046	Motor overheating	• The servomotor is overloaded. • The servomotor and regenerative option are overheated. • The thermal protector incorporated in the encoder is faulty.			• If the effective torque of the servomotor is high, reduce the load. • Check the ambient temperature of the servomotor (range: 0 to +40°C). • Replace the servomotor.
2050	Overload 1	• An overload current of about 200% has been continuously supplied to the servo amplifier and servomotor.			• Check if there has been a collision at the machine. • If the load inertia is very large, either increase the time constant for acceleration and deceleration or reduce the load. • If hunting occurs, adjust the position loop gain in the servo parameters. • Check the connection of U, V, W of the servo amplifier and servomotor. • Check for disconnection of the encoder cable. • Replace the servomotor.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2051	Overload 2	• The servo amplifier and servomotor were overloaded at a torque close to the maximum torque (95% or more of the current control value).	At any time during operation	Immediate stop	• Check if there has been a collision at the machine. • If the load inertia is very large, either increase the time constant for acceleration and deceleration or reduce the load. • If hunting occurs, adjust the position loop gain / position control gain 1, 2, speed loop gain/ speed control gain 1, 2 in the servo parameters. • Check the connection of U, V, W of the servo amplifier and servomotor. • Check for disconnection of the encoder cable. • Replace the servomotor. • If the voltage of the bus in the servo amplifier has dropped (charge lamp has gone out), replace the servo amplifier.
2052	Excessive error	• The difference between the servo amplifier command pulses and feedback pulses has exceeded 80000 pulses.			• Check if there has been a collision at the machine. • Increase the time constant for acceleration and deceleration. • Increase the position loop gain / position control gain 1, 2, in the servo parameters. • Check for disconnection of the encoder cable. • Replace the servomotor. • If the voltage of the bus in the servo amplifier has dropped (charge lamp has gone out), replace the servo amplifier.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

Error Code	Error Cause		When Error Checked	Error Processing	Corrective Action
	Name	Description			
2086	RS232 communication error	• Parameter unit communication error	At any time during operation	Operation continues	• Check for disconnection of the parameter unit cable. • Replace the parameter unit.
2102	Battery warning	• The voltage of the battery installed in the servo amplifier has become low.			• Replace the battery. (MR-JBAT-[ ])
2103	Battery disconnection warning	• The power supply voltage to the absolute position sensor has become low.			• Replace the battery. • Check for disconnection of the encoder cable. • Replace the servomotor. • Replace the servo amplifier.
2140	Excessive regeneration warning	• An excessive regeneration error (2030) is likely to occur (regeneration of 85% of the maximum load capacity for the regenerative resistor has been detected).			• Refer to the details on the excessive regeneration error (2030).
2141	Overload warning	• An overload error (2050, 2051) is likely to occur (85% of overload level detected).			• Refer to the details on the overload errors (2050, 2051).
2146	Servo emergency stop	• The connection between 1A and 1B (emergency stop input) of CN6 of the servo amplifier encoder has been broken.			• Establish a short circuit between 1A and 1B of CN6 of the servo amplifier encoder.
2147	Emergency stop	• An emergency stop (EMG) signal has been input from the servo system CPU.			• Release the emergency stop.
2149	Main circuit OFF warning	• The servo ON (SON) signal was turned ON while the contactor was OFF. • The main circuit bus voltage fell to 215 V or lower at 50 rpm or lower.			• Turn the main circuit contactor or circuit power supply ON.
2196	Home position setting error warning	• After a home position set command, the droop pulses did not come within the in-position range.			• Re-attempt home position return.

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

<table>
<tr><th rowspan="2">Error Code</th><th colspan="2">Error Cause</th><th rowspan="2">When Error Checked</th><th rowspan="2">Error Processing</th><th rowspan="2">Corrective Action</th></tr>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>2301 to 2336</td><td>Parameter error</td><td>• Out-of-range parameter setting has been designated.
Incorrect parameter values are ignored and the values before setting are retained.
<table><tr><td>2301</td><td>Amplifier setting</td></tr><tr><td>2302</td><td>Regenerative resistance</td></tr><tr><td>2303</td><td>Motor type</td></tr><tr><td>2304</td><td>Motor capacity</td></tr><tr><td>2305</td><td>Motor rpm</td></tr><tr><td>2306</td><td>Number of feedback pulses</td></tr><tr><td>2307</td><td>Rotating direction setting</td></tr><tr><td>2308</td><td>Automatic tuning setting</td></tr><tr><td>2309</td><td>Servo responsibility</td></tr><tr><td>2310</td><td>Torque limit (forward)</td></tr><tr><td>2311</td><td>Torque limit (reverse)</td></tr><tr><td>2312</td><td>Load inertia ratio</td></tr><tr><td>2313</td><td>Position control gain 1</td></tr><tr><td>2314</td><td>Speed control gain 1</td></tr><tr><td>2315</td><td>Position control gain 2</td></tr><tr><td>2316</td><td>Speed control gain 2</td></tr><tr><td>2317</td><td>Speed integral compensation</td></tr><tr><td>2318</td><td>Notch filter</td></tr><tr><td>2319</td><td>Feed forward coefficient</td></tr><tr><td>2320</td><td>In-position range</td></tr><tr><td>2321</td><td>Electromagnetic brake sequence output</td></tr><tr><td>2322</td><td>Monitor output mode selection</td></tr><tr><td>2323</td><td>Optional function 1</td></tr><tr><td>2324</td><td>Optional function 2</td></tr><tr><td>2325</td><td>Optional function 3</td></tr><tr><td>2326</td><td>Optional function 4</td></tr><tr><td>2327</td><td>Monitor output 1 offset</td></tr><tr><td>2328</td><td>Monitor output 2 offset</td></tr><tr><td>2329</td><td>Pre-alarm data selection</td></tr><tr><td>2330</td><td>Zero speed</td></tr><tr><td>2331</td><td>Excessive error alarm level</td></tr><tr><td>2332</td><td>Optional function 5</td></tr><tr><td>2333</td><td>Optional function 6</td></tr><tr><td>2334</td><td>PI-PID switching position droop</td></tr><tr><td>2335</td><td>Torque limit compensation factor</td></tr><tr><td>2336</td><td>Speed integral compensation (actual speed differential compensation)</td></tr></table></td><td>At any time during operation</td><td>Operation continues</td><td>• Check the servo parameter setting range.</td></tr>
</table>

Table 11.3 Servo Amplifier Error List (2000 to 2799) (Continued)

<table>
<tr><th rowspan="2">Error Code</th><th colspan="2">Error Cause</th><th rowspan="2">When Error Checked</th><th rowspan="2">Error Processing</th><th rowspan="2">Corrective Action</th></tr>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>2601
to
2636</td><td>Initial parameter error</td><td>• The set parameter values are incorrect.
• The parameter data has been destroyed.
<table><tr><td>2601</td><td>Amplifier setting</td></tr><tr><td>2602</td><td>Regenerative resistance</td></tr><tr><td>2603</td><td>Motor type</td></tr><tr><td>2604</td><td>Motor capacity</td></tr><tr><td>2605</td><td>Motor rpm</td></tr><tr><td>2606</td><td>Number of feedback pulses</td></tr><tr><td>2607</td><td>Rotating direction setting</td></tr><tr><td>2608</td><td>Automatic tuning setting</td></tr><tr><td>2609</td><td>Servo responsibility</td></tr><tr><td>2610</td><td>Torque limit (forward)</td></tr><tr><td>2611</td><td>Torque limit (reverse)</td></tr><tr><td>2612</td><td>Load inertia ratio</td></tr><tr><td>2613</td><td>Position control gain 1</td></tr><tr><td>2614</td><td>Speed control gain 1</td></tr><tr><td>2615</td><td>Position control gain 2</td></tr><tr><td>2616</td><td>Speed control gain 2</td></tr><tr><td>2617</td><td>Speed integral compensation</td></tr><tr><td>2618</td><td>Notch filter</td></tr><tr><td>2619</td><td>Feed forward coefficient</td></tr><tr><td>2620</td><td>In-position range</td></tr><tr><td>2621</td><td>Electromagnetic brake sequence output</td></tr><tr><td>2622</td><td>Monitor output mode selection</td></tr><tr><td>2623</td><td>Optional function 1</td></tr><tr><td>2624</td><td>Optional function 2</td></tr><tr><td>2625</td><td>Optional function 3</td></tr><tr><td>2626</td><td>Optional function 4</td></tr><tr><td>2627</td><td>Monitor output 1 offset</td></tr><tr><td>2628</td><td>Monitor output 2 offset</td></tr><tr><td>2629</td><td>Pre-alarm data selection</td></tr><tr><td>2630</td><td>Zero speed</td></tr><tr><td>2631</td><td>Excessive error alarm level</td></tr><tr><td>2632</td><td>Optional function 5</td></tr><tr><td>2633</td><td>Optional function 6</td></tr><tr><td>2634</td><td>PI-PID switching position droop</td></tr><tr><td>2635</td><td>Torque limit compensation factor</td></tr><tr><td>2636</td><td>Speed integral compensation (actual speed differential compensation)</td></tr></table></td><td>• When the servo amplifier power supply is turned ON
• At the leading edge of the PC READY flag (M2000)
• When a servo error is reset
• When the power to the servo system CPU is turned ON</td><td>Immediate stop</td><td>• Check and change the set parameter values, then switch the power to the servo system CPU OFF then ON again, press the reset key, or turn the PC READY flag (M2000) OFF then ON again.</td></tr>
</table>

11.5 Output Module Errors

(1) Output module errors at REAL→VIRTUAL mode switching (4000 to 5990)

Table 11.4 Output Module Error List (4000 to 5990)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Minor Errors	4050	405[ ]			○		• The [stroke lower limit setting device value] + [stroke setting device value] exceeded 2^{31}-1 (set system-of-units). (In 2-way cam mode.)	START disabled at related systems.	• Because the present value cannot be calculated within 1 cam shaft revolution, return to the REAL mode and designate a correct No. at the device.
	4060	406[ ]	○	○	○	○	• When the drive module is the synchronous encoder connected to the manual pulse generator inputs, and the connected clutch is in the "external input mode", multiple settings existed at the ON/OFF command bit device. Or, the external input mode clutch setting is incorrect.		• A one-to-one setting should be designated for the external input mode clutch and the synchronous encoder. • Return to the REAL mode, switch the programmable controller READY signal OFF, then correct and register the clutch setting.
	4070	407[ ]	○	○	○	○	• The connected clutch is in the external input mode for a A172SENC/A171SENC set for high-speed reading.		• Do not used the clutch in the external input mode for a A172SENC/A171SENC set for high-speed reading.
	5000	500[ ]		○	○	○	• The "feed present value" is outside the applicable range. • For cams, the feed present value is outside the "stroke lower limit to stroke" range. (When in the 2-way cam mode.) (Present value cannot be calculated within 1 cam revolution.)		• Return to the REAL mode and position within the stroke range.
	5060	506[ ]				○	• The "feed present value" is within the stroke range, but the present value cannot be calculated within 1 cam shaft revolution. (cam table error)		• Correct the cam table. • Make sure that stroke ratios of both "0" and "7FFFH" are included in the cam data table. Designate 0 to 7FFFH points in the cam table.
	5080	508[ ]	○	○	○	○	• Torque limit setting range violation.	The default setting of 300% will be adopted.	• Designate the torque limit value within the stipulated setting range.
	5100	510[ ]				○	• Although the limit switch output is set to the "present value within 1 cam axis revolution" mode, there is no limit switch output data registered at the file register area.	Operation continues with limit switch output OFF.	• Check the limit switch output data. • Verify that the installed memory cassette is a model A3NMCA-24 or newer.
	5200	520[ ]				○	• Stroke lower limit storage devices start with an odd-numbered device.	Operation is enabled, but monitoring is impossible.	• Designate an even number as the first device number.
	5210	521[ ]	○	○	○	○	• The clutch ON address setting devices start with an odd-numbered device.	START disabled at related systems.	
	5220	522[ ]	○	○	○	○	• The clutch OFF address setting devices start with an odd-numbered device.		
	5230	523[ ]			○	○	• The "present value within 1 virtual axis revolution" storage devices (at main shaft side) start with an odd-numbered device.	Operation is enabled, but monitoring is impossible.	
	5240	524[ ]			○	○	• The "present value within 1 virtual axis revolution" storage devices (at auxiliary input shaft side) start with an odd-numbered device.		
	5250	525[ ]	○	○	○	○	• When "amount of slip designation" is set as the clutch smoothing method, the "amount of slip setting device" value is outside the applicable range (0 to 2147483647).	A smoothing amount of "0" (direct clutch) is adopted.	• Designate a value within the range 0 to 2147483647.

Table 11.4 Output Module Error List (4000 to 5990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Minor Errors	5260	526[ ]				○	• Stroke setting device is out of range.	Related systems inoperative	• Set in the range 1 to (2^{31}–1)
	5270	527[ ]				○	• Cam number setting device is out of range.		• Correct the cam number setting.
	5280	528[ ]	○	○	○	○	• Clutch mode setting device is out of range.		• Correct the clutch mode setting.
	5290	529[ ]	○	○	○	○	• Clutch ON address setting device is out of range.		• Correct the clutch ON address setting.
	5300	530[ ]	○	○	○	○	• Clutch OFF address setting device is out of range.		• Correct the clutch OFF address setting.
	5310	531[ ]	○	○	○	○	• Clutch ON/OFF command device is out of range.		• Correct the clutch ON/OFF command.
	5320	532[ ]	○	○	○	○	• Speed change gear ratio setting device is out of range.		• Correct the speed change gear ratio setting.
	5330	533[ ]	○	○	○	○	• Amount of slip setting device is out of range.	Amount of slip = 0 (controlled as direct clutch)	• Correct the amount of slip setting.
	5340	534[ ]	○	○	○	○	• Torque control limit setting device is out of range.	Controlled with 300% offset	• Correct the torque control limit setting.
	5350	535[ ]			○	○	• Present value in one virtual axis revolution storage device (main shaft side) is out of range.	Monitoring of present value in one virtual axis revolution (main shaft side) not possible	• Correct the present value in one virtual axis revolution (main shaft side) setting.
	5360	536[ ]			○	○	• Present value in one virtual axis revolution storage device (auxiliary input shaft side) storage device is out of range.	Monitoring of present value in one virtual axis revolution (auxiliary input shaft side) not possible	• Correct the present value in one virtual axis revolution (auxiliary input shaft side) setting.
	5370	537[ ]				○	• Stroke lower-limit value storage device is out of range.	Monitoring of stroke lower-limit value not possible	• Correct the stroke lower-limit value setting.
	5380	538[ ]	○	○	○	○	• Number of gear teeth at input shaft setting device is out of range.	Related systems inoperative	• Correct the number of gear teeth at input shaft setting.
	5390	539[ ]	○	○	○	○	• Number of gear teeth at output shaft setting device is out of range.		• Correct the number of gear teeth at output shaft setting.
	5400	540[ ]	○	○	○	○	• Number of gear teeth at input shaft setting device is set to zero.		• Correct the number of gear teeth at input shaft setting.
	5410	541[ ]	○	○	○	○	• Number of gear teeth at output shaft setting device is set to zero.		• Correct the number of gear teeth at output shaft setting.

(2) "No-clutch/clutch ON/clutch status ON" output module errors (6000 to 6990)

Table 11.4 Output Module Error List (6000 to 6990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Minor Errors	6000	600[ ]	○	○	○	○	• The servo OFF command (M1815+20n) switched ON during operation.	Operation continues. The servo ON status is maintained.	• The servo ON status is maintained. • Switch the clutch OFF, then establish the servo OFF status.
	6010	601[ ]	○	○	○		• The output speed exceeded the speed limit value during operation. (Speed clamp processing in accordance with the speed limit value is not executed.)		• Correct the drive module's speed, gear ratio, and speed change ratio so that the speed remains within the speed limit.
	6020	602[ ]	○	○	○	○	• The deviation counter value exceeded the "permissible number of droop pulses" value during operation.		• Stop the drive module, then correct the drive module's speed, gear ratio, and speed change gear ratio so that the speed remains within the speed limit.
	6030	603[ ]		○	○		• The feed present value violated the stroke limit range during operation.		• Stop the drive module, then correct the drive module's speed, gear ratio, and speed change gear ratio so that the speed remains within the speed limit.
	6040	604[ ]				○	• The cam No. setting device value violates the "used cam Nos" range. (Operation continues with the current cam No.)		• Correct the cam No. setting.
	6050	605[ ]				○	• The stroke setting device value violates the "1 to $2^{31}-1$" range. • The designated value doesn't conform to the following requirement: [stroke lower limit] + [stroke] ≤ $[2^{31}-1]$. (Operation continues with the current stroke)	Operation continues with the current cam No. and stroke.	• Correct the stroke setting.
	6060	606[ ]				○	• A control mode (feed/2-way) discrepancy occurred at cam No. switching.	Operation continues	• Stop the drive module and correct the control mode setting.
	6080	608[ ]	○	○	○	○	• The torque limit setting device value violates the stipulated range.	The default value of 300% is adopted.	• Designate a torque limit value within the setting range.
	6090	609[ ]	○	○	○	○	• After servo amplifier (MR- [ ]-B) power ON, and when a servo OFF command (M1815+20n OFF) is executed, the designated axis is a no-clutch axis, or a clutch ON status exists.	Servo ON will be disabled.	• After designating a clutch OFF command, designate a servo OFF command.
	6120	612[ ]				○	• The present value in one cam axis revolution was changed to an out-of-range value.	The present value is unchanged.	• Designate a value within the range 1 to (pulses in one cam axis revolution - 1).
	6130	613[ ]	○	○	○	○	• The number of gear teeth at input shaft is set by indirect device setting, and the device value became zero when the drive module present value was changed.	The gear ratio is unchanged.	• Designate a value within the range 1 to 65535.
	6140	614[ ]	○	○	○	○	• The number of gear teeth at output shaft is set by indirect device setting, and the device value became zero when the drive module present value was changed.		

(3) Output module errors when clutch OFF and clutch OFF command issued (6500 to 6990)

Table 11.4 Output Module Error List (6500 to 6990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Minor Errors	6500	650[ ]	○	○	○	○	• A servo OFF status existed when a clutch ON command occurred.	Clutch remains OFF.	• Return to the clutch OFF command, and repeat the clutch ON command after executing a servo ON command.
	6510	651[ ]				○	• The feed present value violated the stroke range when a cam axis servo OFF command(M1815+ 20n OFF) was executed. (In the 2-way cam mode) • The stroke range was violated during a follow-up operation.	Servo remains ON.	• After returning to within the stroke range, execute the servo OFF command again.
	6520	652[ ]				○	• The [stroke lower limit] + [stroke] ≤ [2^{31}–1] condition was not satisfied when a cam axis servo OFF command (M1815+ 20n OFF) was executed. (In the 2-way cam mode)		• Designate a value which satisfies the [stroke lower limit] + [stroke] ≤ [2^{31}–1] condition.
	6530	653[ ]		○	○	○	• The home position return request signal (M1609+ 20n) was ON when a clutch ON command occurred. (Incremental axis MR-[ ]-B power switched from OFF to ON.)	Clutch remains OFF.	• Return to the REAL mode, execute a home position return, then switch back to the VIRTUAL mode.
	6540	654[ ]				○	• When a servo ON command was executed, the feed present value was within the stroke limit range, but the present value couldn't be calculated within 1 cam axis revolution. (Cam table error)	Servo remains ON.	• Return to the REAL mode, then correct the cam data settings. • Designate the setting for the stroke from the stroke lower limit as a ratio in the range 0 to 7FFFH. Designate 0 to 7FFFH points at the cam table.

(4) System error (9000 to 9990)

Table 11.4 Output Module Error List (9000 to 9990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Minor Errors	9000	900[ ]	○	○	○	○	• When the servo amplifier power was turned on, the motor type actually installed was different from the motor type set in the system settings. (Checked only when MR-J2-B is used)	Further operation is impossible.	• Correct the motor type setting in the system settings.
	9010	901[ ]	○	○	○	○	• When the servo amplifier power is turned on, the amount of motor travel while the power was OFF is found to have exceeded the "POWER OF ALLOWED TRAVELING POINTS" in the system settings.	The "VIRTUAL mode continuation disabled warning device" comes ON. Further operation is impossible.	• Check the position. Check encoder battery.

(5) Output module errors at VIRTUAL servo mode axis START (10000 to 10990)

Table 11.4 Output Module Error List (10000 to 10990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Major Errors	10000	1000[ ]		○	○	○	• The home position return request (M1609 + 20n) is ON.	START disabled at related systems.	• Return to the REAL mode and execute a home position return. • If position is not established after executing a home position return at all axes, VIRTUAL mode operation will be disabled.
	10010	1001[ ]	○	○	○	○	• The servo error detection signal (M1608 + 20n) is ON.		• Execute a servo error reset in the REAL mode.
	10020	1002[ ]	○	○	○	○	• A servo OFF (M1615 + 20n ON) status exists at an output module where a "clutch ON" or "no clutch" setting is designated at either the main shaft or auxiliary input shaft.		• Switch the clutch OFF, then establish the servo ON status.
	10030	1003[ ]	○	○	○	○	• An external input signal (STOP) is ON at an output module where a "clutch ON" or "no clutch" setting is designated at either the main shaft or auxiliary input shaft.		• Switch the stop signal (STOP) OFF.

(6) "No-clutch/clutch ON/clutch status ON" output module errors (11000 to 11990)

Table 11.4 Output Module Error List (11000 to 11990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Major Errors	11000	1100[ ]	○	○	○	○	• The servo error detection signal (M1608+ 20n) switched ON during operation.	After an immediate stop at the relevant output module, the servo will be switched OFF.	• Eliminate the servo error cause (see section 11.4).
	11010	1101[ ]	○	○	○	○	• A servo OFF status (M1615+ 20n ON) occurred during operation. • MR-[ ]-B power supply was interrupted.	• Operation continues at "no-clutch" axes. • At axes with clutches, control is executed in accordance with the operation mode at the time of the error. • Operation continues. • All clutches switch OFF at the relevant systems.	• When an "operation continuation" setting is designated, execute stop processing at the user's sequence program.
	11020	1102[ ]	○	○	○	○	• The stop signal (STOP) switched ON.		
	11030	1103[ ]	○	○	○	○	• The upper limit LS signal (FLS) switched OFF during forward (address increase direction) travel.		
	11040	1104[ ]	○	○	○	○	• The lower limit LS signal (RLS) switched OFF during reverse (address decrease direction) travel.		

(7) Errors when using an absolute position system (12000 to 12990)

Table 11.4 Output Module Error List (12000 to 12990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Major Errors	12010*	1201[ ]	○	○	○	○	• When the separate amplifier power supply was turned ON in the VIRTUAL mode, a sum-check error occurred in the back-up data (reference values). • Home position return not conducted.	Home position return requires turns ON.	• Return to the REAL mode and execute home position return.
	12120*	1202[ ]	○	○	○	○	• When the servo amplifier power is turned ON, a communication error in communication between the servo amplifier and encoder occurs.	Home position return requires turns ON.	• Check the motor and encoder cables and perform home position return again.
	12030*	1203[ ]	○	○	○	○	• During operation, the amount of change in the encoder present value complies with the following expression: "Amount of change in encoder present value/3.5 ms >180° of motor revolution" After the servo amplifier power has been turned ON, a continual check is performed (in both servo ON and OFF states).	No processing	• Check the motor and encoder cables.
	12040*	1204[ ]	○	○	○	○	• During operation, the following expression holds: "Encoder present value (PLS) ≠ feedback present value (PLS) (number of bits in encoder's feedback present value counting range)". After the servo amplifier power has been turned ON, a continual check is performed (in both servo ON and OFF states).		

*: These errors occur only when using MR-H-B and MR-J2-B servo amplifiers.

(8) System errors at all-axes servo ON (15000 to 15990)

Table 11.4 Output Module Error List (15000 to 15990) (Continued)

Error Class	Error Code		Output Module				Error Cause	Processing	Corrective Action
	Output Module	Drive Module	Roller	Ball Screw	Rotary Table	Cam			
Major Errors	15010	1501[ ]	○	○	○	○	• 24 VDC is not being supplied when an A172SENC/A171SENC brake setting is designated.	All-axes ON will not occur in response to an all-axes servo ON command. If the error occurs while an all-axes servo ON status is in effect, an emergency stop will occur, and the system will return to the REAL mode OS.	• Check at the all-axes servo ON command, and while an all-axes servo ON status is in effect.

11.6 Errors At REAL ↔ VIRTUAL Mode Switching

Table 11.5 REAL↔VIRTUAL Mode Switching Error Code List

Error Codes Stored at D9195		Error Description	Corrective Action
Decimal Display	Hexadecimal Display		
1 to 255	0001 to 00FF	• M2043 OFF → ON switching occurred when all axes were not stopped.	• Execute M2043 OFF → ON switching when M2001 to M2008/M2001 to M2004 are all OFF.
257 to 511	0101 to 01FF	• M2043 ON → OFF switching occurred when all axes were not stopped.	• Execute M2043 ON → OFF switching when M2001 to M2008/M2001 to M2004 are all OFF.
512	0200	• M2043 OFF → ON switching occurred when no mechanical system program was registered.	• Write a mechanical system program to the servo system CPU.
		• M2043 OFF → ON switching occurred when a discrepancy existed between the axis No. designated at the system settings, and that designated at the mechanical system program (output shaft No.).	• Designate the same axis No. at both the system settings and the mechanical system program, then write the data to the servo system CPU.
513	0201	• M2043 OFF → ON switching occurred when the programmable controller READY signal (M2000) or the PCPU READY signal (M9074) was OFF.	• After switching the PC READY and PCPU READY signals ON, execute M2043 OFF → ON switching.
514	0202	• M2043 OFF → ON switching occurred when the all-axes servo START command flag (M2042) was OFF.	• Switch M2042 ON, switch the all-axes servo START accept flag ON, then execute M2043 OFF → ON switching.
515	0203	• M2043 OFF → ON switching occurred when the external emergency stop (EMG) signal was ON.	• Switch the external emergency stop signal OFF, then execute M2043 OFF → ON switching.
516	0204	• M2043 OFF → ON switching occurred during servo START processing which was occurring in response to an ADU axis servo error reset command (M1808+ 20n).	• When a servo error reset occurred by switching the M1808+ 20n signal ON, switch the servo error detection signal (M1608+ 20n) OFF, then execute M2043 OFF → ON switching.
769 to 1023	0301 to 03FF	• M2043 OFF → ON switching occurred when the home position return request signal was ON at an axis whose output module is not a roller.	• After executing a home position return (servo program "zero execute"), and switching M1609+ 20n OFF, execute M2043 OFF → ON switching.
1025 to 1279	0401 to 04FF	• M2043 OFF → ON switching occurred when an all-axes normal status (M1608+ 20n: ON) did not exist at the MR-[ ]-B.	• Check the MR-[ ]-B, servo motor, and the wiring.
1281 to 1535	0501 to 05FF	• M2043 OFF → ON switching occurred when a system-of-units setting discrepancy existed between the fixed parameter and output module settings for an axis whose output module is not a roller.	• Correct the fixed parameter or output module system-of-units setting, then write the data to the servo system CPU.
1537 to 1791	0601 to 06FF	• M2043 OFF → ON switching occurred when a cam is set as the output module, but no cam data has been registered.	• Write the cam data to the servo system CPU.
2049 to 2303	0801 to 08FF	• M2043 OFF → ON switching occurred when no cam No. has been designated at the cam No. setting device. (When setting in cam No. setting device is "0".)	• After writing the cam No. (No. used at cam parameters) to the cam No. setting device, execute M2043 OFF→ON switching.

Table 11.5 REAL↔VIRTUAL Mode Switching Error Code List (Continued)

Error Codes Stored at D9195		Error Description	Corrective Action
Decimal Display	Hexadecimal Display		
2305 to 2559	0901 to 09FF	• The setting value at the cam stroke setting device violates the "1 to (2^{31}–1)" range.	• After designating a cam stroke setting device value within the "1 to (2^{31}–1)" range, execute M2043 OFF→ON switching.
2817 to 3071	0B01 to 0BFF	• An odd number has been designated at the cam stroke setting device.	• Designate an even number at the cam stroke setting device.
– 4094	F002	• During VIRTUAL mode operation, the programmable controller READY signal (M2000) switched OFF, and the system returned to the REAL mode. • The servo system CPU stopped during VIRTUAL mode operation.	• Switch M2000 ON. • Designate the servo system CPU "RUN" status.
– 4095	F001	• During VIRTUAL mode operation, the servo error signal (M1608+ 20n) switched ON, and the system returned to the REAL mode.	• Check the servo error code register to determine the error cause at the axis in question, then eliminate the error cause (see section 11.4).
– 4096	F000	• During VIRTUAL mode operation, the external emergency stop (EMG) signal switched ON, and the system returned to the REAL mode.	• Switch the external emergency stop signal OFF.

APPENDICES

APPENDIX 1 Cam Curves

The cam acceleration curve formulas used in the VIRTUAL mode are shown below.

(1) Acceleration curve formula

<Symbols used>

- A : Dimensionless acceleration
- Am : Dimensionless maximum acceleration
- T : Dimensionless time
- Ta, Tb, Tc : T borderlines when section divisions are used

(a) Discontinuous curve

1) Constant speed curve

$A = C0$

2) Uniform acceleration curve

Section I ($0 \le T \le 0.5$)

$A = 4 + C0$

Section II ($0.5 < T \le 1$)

$A = -4 + C0$

(b) Both-side stationary symmetrical curve

1) 5th curve

$A = 120T^3 - 180T^2 + 60T + C0$

2) Cycloid curve

$Am = 2\pi$

$A = 2\pi \sin 2t\pi T + C0$

3) Distorted trapezoid curve

$$Ta = \frac{1}{8}$$

$$Am = \frac{1}{\frac{1}{4} - Ta + \frac{2}{\pi} Ta}$$

Section I ($0 \le T \le Ta$)

$$A = Am \sin \frac{\pi}{2Ta} T + C0$$

Section II ($Ta < T \le 0.5 - Ta$)

$A = Am + C0$

Section III ($0.5 - Ta < T \le 0.5 + Ta$)

$$A = Am \overline{\cos} \frac{\pi(T - 0.5 + Ta)}{2Ta} + C0$$

Section IV ($0.5 - Ta < T \le 1 - Ta$)

$A = -Am + C0$

Section V ($1 - Ta < T \le 1$)

$$A = -Am \overline{\cos} \frac{\pi(T - 1 + Ta)}{2Ta} + C0$$

4) Distorted sine curve

$$Ta = \frac{1}{8}$$

$$Am = \frac{1}{\frac{2Ta}{\pi} + \frac{2 - 8Ta}{\pi^2}}$$

Section I ($0 \le T \le Ta$)

$$A = Amsin\ \frac{\pi T}{2Ta} + C0$$

Section II ($Ta < T \le 1 - Ta$)

$$A = Am\overline{cos}\ \frac{\pi(T - Ta)}{1 - 2Ta} + C0$$

Section III ($1 - Ta < T \le 1$)

$$A = -Am\overline{cos}\ \frac{\pi(T - 1 + Ta)}{2Ta} + C0$$

5) Distorted constant speed curve

$$Ta = \frac{1}{16}$$

$$Ta = \frac{1}{4}$$

$$Am = \frac{1}{\frac{2}{\pi}\left\{(2 - \frac{8}{\pi})TaTb + (\frac{4}{\pi} - 2)\,Tb^2 + Tb\right\}}$$

Section I ($0 \le T \le Ta$)

$$A = Amsin\ \frac{\pi T}{2Ta} + C0$$

Section II ($Ta < T \le Tb$)

$$A = Am\overline{cos}\ \frac{\pi(T - Ta)}{2(Tb - Ta)} + C0$$

Section III ($Tb < T \le 1 - Tb$)

$$A = 0 + A0$$

Section IV ($1 - Tb < T \le 1 - Ta$)

$$A = -Amsin\ \frac{\pi(T - 1 + Ta)}{2(Tb - Ta)} + C0$$

Section V ($1 - Ta < T \le 1$)

$$A = -Am\overline{cos}\ \frac{\pi(T - 1 + Ta)}{2Ta} + C0$$

(c) Both-side stationary asymmetrical curve

1) Trapecloid curve

$$Ta = \frac{1}{8}$$

$$Tb = \frac{2 - 6Ta + \pi Ta}{2 + \pi}$$

$$Tc = \frac{2 - 2Ta + 3\pi Ta}{2 + \pi}$$

$$Am = \frac{1}{(-\frac{3}{2} + \frac{4}{\pi} + \frac{4}{\pi^2})\,T^2a + (1 + \frac{2}{\pi})\,TaTb + \frac{1}{2}\,T^2b + (\frac{2}{\pi} - \frac{4}{\pi^2})\,(1 - Tc)^2}$$

Section I ($0 \le T \le Ta$)

$$A = Am\sin\frac{\pi T}{2Ta} + C0$$

Section II ($Ta < T \le Tb$)

$$A = Am + C0$$

Section III ($Tb < T \le Tc$)

$$A = Am\overline{\cos}\,\frac{\pi(T - T6)}{2Ta} + C0$$

Section IV ($Tc < T \le 1$)

$$A = -Am\overline{\cos}\,\frac{\pi(T - Tc)}{2(1 - Tc)} + C0$$

2) Reverse trapecloid curve

$$Ta = \frac{1}{8}$$

$$Tb = \frac{2 - 6Ta + \pi Ta}{2 + \pi}$$

$$Tc = \frac{2 - 2Ta + 3\pi Ta}{2 + \pi}$$

$$Am = \frac{1}{(-\frac{3}{2} + \frac{4}{\pi} + \frac{4}{\pi^2})\,T^2a + (1 + \frac{2}{\pi})\,TaTb + \frac{1}{2}\,T^2b + (\frac{2}{\pi} - \frac{4}{\pi^2})\,(1 - Tc)^2}$$

$$Va = \frac{2TaA}{\pi}m$$

$$Vb = Am(Tb - Ta) + Va$$

$$Sa = \frac{2T^2aAm}{\pi} - \frac{4T^2aAm}{\pi^2}$$

$$Sb = \frac{Am}{2}\,(Tb - Ta)^2 + Va\,(Tb - Ta) + Sa$$

$$Sc = \frac{8T^2aAm}{\pi^2} + 2VbTa + Sb$$

Section I ($0 \le T \le 1 - Tc$)

$$A = Am\cos\,\frac{\pi(1 - Tc - T)}{2\,(1 - Tc)} + C0$$

Section II ($1 - Tc < T \le 1 - Tb$)

$$A = -Am\cos\,\frac{\pi(1 - Tb - T)}{2Ta} + C0$$

Section III ($1 - Tb < T \le 1 - Ta$)

$$A = -Am + C0$$

Section IV ($1 - Ta < T \le 1$)

$$A = Am\sin\,\frac{\pi\,(1 - T)}{2Ta} + C0$$

(d) One-side stationary curve

1) Multiple hypotenuse curve

$$A = \frac{\pi^2}{2} \ (\cos\pi T - \cos 2\pi T) + C0$$

(e) Non-stationary curve

1) Single hypotenuse curve

$$A = \frac{\pi^2}{2} \ \cos\pi T + C0$$

(2) Cam curve coefficient

Distorted trapezoid

Section I

0<Section I <0.25(1/4) Default Value: 0.125(1/8)

Distorted sine

Section I

0<Section I <0.5(1/2) Default Value: 0.125(1/8)

Distorted constant speed

Section I

0<Section I <0.125(1/4) Default Value: 0.0625(1/16)

Section II

0<Section II <0.5(1/2) Default Value: 0.25(1/4)

Trapecloid

Section I

0<Section I <0.25(1/4) Default Value: 0.125(1/8)

Reverse trapecloid

Section I

0<Section I <0.25(1/4) Default Value: 0.125(1/8)

APPENDIX 2 Processing Time List

Shown below are each processing time signal and command when position control is carried out in relation to the servo system CPU.

(1) Motion operation cycle (ms)

CPU	A172SH	A171SH
Number of set axes	1 to 8	1 to 4
Operation cycle	3.5ms	3.5ms

(2) SCPU instruction processing times (μs)

CPU		A172SH	A171SH
Number of set axes		1 to 8	1 to 4
SVST	1 axis started	48	
	2 to 3 axes started	105	
	Error	50	
DSFRP	1 axis started	48	
	2 to 4 axes started	65	
	Error	60	
CHGV		27	
DSFLP (Speed change)	Normal	28	
	Error	50	
CHGA		32	
DSFLP (Present value change)	Normal	28	
	Error	50	
CHGT		24	
END		1400	

(3) CPU processing time (ms)

CPU	A172SH	A171SH
Number of set axes	1 to 8	1 to 4
Servo program start processing time (*1)	4 to 11	4 to 11
Speed change response	0 to 4	0 to 4
Torque limit value change response	0 to 4	0 to 4
Simultaneous start processing time (*2)	7 to 17	7 to 17
Time from PC ready flag (M2000) ON to PCPU ready flag (M9074) ON	50 to 600	50 to 350

(*1) The FEED instruction varies greatly depending on the condition (whether other axes are operating or being stopped).

(*2) This processing time varies depending on the commands to be started simultaneously. Use this time merely for reference.

(4) Virtual servo motor axis / synchronous encoder axis calculation cycle

CPU		A172SH	A171SH
Number of output axes set		1 to 8	1 to 4
Number of axes used by virtual servo motor	1 to 4 axes	3.5ms	3.5ms
	5 to 8 axes	3.5ms	
Number of axes used by synchronous encoder	1 axes	3.5ms	3.5ms

(5) Each axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1600 to M1619	M1600 to M1619	
2	M1620 to M1639	M1620 to M1639	
3	M1640 to M1659	M1640 to M1659	
4	M1660 to M1679	M1660 to M1679	
5	M1680 to M1699		
6	M1700 to M1719		
7	M1720 to M1739		
8	M1740 to M1759		

(O Valid)

	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball screw	Rotary table	Cam			
0	Positioning start completed	O	OFF	OFF	OFF	OFF	SCPU← PCPU	—	
1	Positioning completed	O	OFF	OFF	OFF	OFF			
2	In-position	O	O	O	O	O		3.5ms	
3	Command in-position	O	OFF	OFF	OFF	OFF		—	
4	Speed control in progress	O	OFF	OFF	OFF	OFF			
5	Speed/position switching latch	O	OFF	OFF	OFF	OFF			
6	Zero pass	O	O	O	O	O		3.5ms	
7	Error detection	O	O	O	O	O		Immedi-ately	
8	Servo error detection	O	O	O	O	O		3.5ms	
9	Home position return request	O	O	O	O	O		10ms	
10	Home position return completed	O	O	O	O	O		3.5ms	
11	External signal FLS	O	O	O	O	O		10ms	
12	External signal RLS	O	O	O	O	O			
13	External signal STOP	O	O	O	O	O			
14	External signal DOG/CHANGE	O	O	O	O	O			
15	Servo ON/OFF	O	O	O	O	O		3.5ms	
16	Torque control in progress	O	O	O	O	O			
17	(External signal DOG/CHANGE)	O	O	O	O	O		10ms	
18	Virtual mode intermittent actuation disabled warning	O	O	O	O	O			
19	M code output in progress	O	OFF	OFF	OFF	OFF		—	

(6) Command signals of each axis

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1800 to M1819	M1800 to M1819	
2	M1820 to M1839	M1820 to M1839	
3	M1840 to M1859	M1840 to M1859	
4	M1860 to M1879	M1860 to M1879	
5	M1880 to M1899		
6	M1900 to M1919		
7	M1920 to M1939		
8	M1940 to M1959		

(O Valid)

	Signal Name	REAL	VIRTUAL				Signal Direction	Refresh Cycle	Fetch Cycle
			Roller	Ball screw	Rotary table	Cam			
0	Stop command	O	×	×	×	×	SCPU→ PCPU		—
1	Rapid stop command	O	×	×	×	×			
2	Forward JOG start	O	×	×	×	×			
3	Reverse JOG start	O	×	×	×	×			
4	End signal OFF command	O	×	×	×	×			
5	Speed/position switching enabled	O	×	×	×	×			
6	Limit switch output enabled	O	×	O	O	O			3.5ms
7	Error reset	O	O	O	O	O			10ms
8	Servo error reset	O	×	×	×	×			—
9	External STOP input valid/invalid when starting	O	×	×	×	×			
10	Unusable	—	—	—	—	—			
11	Unusable	—	—	—	—	—			
12	Feed present value update request command	O	×	×	×	×			
13	Address clutch reference setting	×	×	×	O	O			REAL to VIR-TUAL switch
14	Cam reference position setting	×	×	×	×	O			
15	Servo OFF	O	O	O	O	O			3.5ms
16	Unusable	—	—	—	—	—			—
17	Unusable	—	—	—	—	—			
18	Control loop setting	O	O	O	O	O			10ms
19	FIN signal	O	×	×	×	×			—

(7) Virtual servo motor axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1200 to M1219	M1200 to M1219	(○ Valid)
2	M1220 to M1239	M1220 to M1239	
3	M1240 to M1259	M1240 to M1259	
4	M1260 to M1279	M1260 to M1279	
5	M1280 to M1299		
6	M1300 to M1319		
7	M1320 to M1339		
8	M1340 to M1390		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Positioning start completed	Backup	○	SCPU←PCPU	3.5ms	
1	Positioning completed					
2	Unusable		—		—	
3	Command in-position		○		3.5ms	
4	Speed control in progress					
5	Unusable		—		—	
6	Unusable					
7	Error detection		○		Immediately	
8	Unusable		—		—	
9	Unusable					
10	Unusable					
11	Unusable					
12	Unusable					
13	Unusable					
14	Unusable					
15	Unusable					
16	Unusable					
17	Unusable					
18	Unusable					
19	M code output in progress				3.5ms	

(8) Virtual servo motor axis command signals

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1400 to M1419	M1400 to M1419	(○ Valid)
2	M1420 to M1439	M1420 to M1439	
3	M1440 to M1459	M1440 to M1459	
4	M1460 to M1479	M1460 to M1479	
5	M1480 to M1499		
6	M1500 to M1519		
7	M1520 to M1539		
8	M1540 to M1590		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Stop command	×	○	SCPU→PCPU		3.5ms
1	Rapid stop command					
2	Forward JOG start					10ms
3	Reverse JOG start					
4	End signal OFF command					
5	Unusable	—	—			—
6	Unusable					
7	Error reset	×	○			10ms
8	Unusable	—	—			—
9	External STOP input valid/invalid when starting	×	○			Start timing
10	Unusable	—	—			—
11	Unusable					
12	Unusable					
13	Unusable					
14	Unusable					
15	Unusable					
16	Unusable					
17	Unusable					
18	Unusable					
19	FIN signal	×	○			3.5ms

(9) Synchronous encoder axis status

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1360 to M1363	M1360 to M1363	(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error detection	○	○	SCPU←PCPU	Immediately	
1	External signal TREN				10ms	
2	Virtual mode intermittent actuation disabled warning					
3	Unusable	—	—		—	

(10) Synchronous encoder axis command signals

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	M1560 to M1563	M1560 to M1563	(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Error detection	×	○	SCPU→PCPU		10ms
1	Unusable	—	—			—
2	Unusable					
3	Unusable					

(11) Common devices

A172SHCPU

Device Number	Signal Name	(○ Valid) REAL	(○ Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
M1960	Unusable (24 points)	—	—	—	—	—
M1961						
M1962						
M1963						
M1964						
M1965						
M1966						
M1967						
M1968						
M1969						
M1970						
M1971						
M1972						
M1973						
M1974						
M1975						
M1976						
M1977						
M1978						
M1979						
M1980						
M1981						
M1982						
M1983						

A171SHCPU

Device Number	Signal Name	(○ Valid) REAL	(○ Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
M1960	Unusable (24 points)	—	—	—	—	—
M1961						
M1962						
M1963						
M1964						
M1965						
M1966						
M1967						
M1968						
M1969						
M1970						
M1971						
M1972						
M1973						
M1974						
M1975						
M1976						
M1977						
M1978						
M1979						
M1980						
M1981						
M1982						
M1983						

A172SHCPU

Device Number	Signal Name			(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
M1984	Output axis 1	Main shaft side	Clutch status	Backup	○	SCPU← PCPU	3.5ms	
M1985		Auxiliary input axis side						
M1986	Output axis 2	Main shaft side						
M1987		Auxiliary input axis side						
M1988	Output axis 3	Main shaft side						
M1989		Auxiliary input axis side						
M1990	Output axis 4	Main shaft side						
M1991		Auxiliary input axis side						
M1992	Output axis 5	Main shaft side						
M1993		Auxiliary input axis side						
M1994	Output axis 6	Main shaft side						
M1995		Auxiliary input axis side						
M1996	Output axis 7	Main shaft side						
M1997		Auxiliary input axis side						
M1998	Output axis 8	Main shaft side						
M1999		Auxiliary input axis side						
M2000	PC READY flag			○	○	SCPU→ PCPU		10ms
M2001	Axis 1	Start accept flag (8 points)		○	○	SCPU← PCPU	10ms	
M2002	Axis 2							
M2003	Axis 3							
M2004	Axis 4							
M2005	Axis 5							
M2006	Axis 6							
M2007	Axis 7							
M2008	Axis 8							
M2009	All-axes servo ON accept flag							
M2010	Unusable (2 points)			——	——		——	——
M2011								
M2012	Manual pulse generator 1 enabled			○	×	SCPU→ PCPU		10ms
M2013	Unusable (2 points)			——	——		——	——
M2014								
M2015	JOG simultaneous start command			○	○	SCPU→ PCPU		10ms
M2016	Unusable (4 points)			——	——		——	——
M2017								
M2018								
M2019								
M2020	START buffer full			○	○	SCPU← PCPU	END	
M2021	Axis 1	Speed change in program flag (8 points)						
M2022	Axis 2							
M2023	Axis 3							
M2024	Axis 4							
M2025	Axis 5							
M2026	Axis 6							
M2027	Axis 7							
M2028	Axis 8							
M2029	Unusable (6 points)			——	——		——	——
M2030								
M2031								
M2032								
M2033								
M2034	PC link communication error flag			○	○	SCPU← PCPU	END	
M2035	Unusable (5 points)			——	——		——	——
M2036								
M2037								
M2038								
M2039								
M2040	CPU completion point setting			○	○	SCPU→ PCPU		Start timing
M2041	System setting error flag			○	○	SCPU← PCPU	END	
M2042	All-axes servo ON command			○	○	SCPU→ PCPU		3.5ms
M2043	REAL/VIRTUAL mode switching request			○	○			10ms
M2044	REAL/VIRTUAL mode switching status			○	○	SCPU← PCPU	END	
M2045	REAL/VIRTUAL mode switching error			○	○			
M2046	Synchronization discrepancy warning			○	○			
M2047	Motion slot module error detection flag			○	○			

A171SHCPU

Device Number	Signal Name			(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
M1984	Output axis 1	Main shaft side	Clutch status	Backup	○	SCPU← PCPU	3.5ms	
M1985		Auxiliary input axis side						
M1986	Output axis 2	Main shaft side						
M1987		Auxiliary input axis side						
M1988	Output axis 3	Main shaft side						
M1989		Auxiliary input axis side						
M1990	Output axis 4	Main shaft side						
M1991		Auxiliary input axis side						
M1992	Unusable (8 points)			——	——		——	——
M1993								
M1994								
M1995								
M1996								
M1997								
M1998								
M1999								
M2000	PC READY flag			○	○	SCPU→ PCPU		10ms
M2001	Axis 1	Start accept flag (4 points)		○	○	SCPU← PCPU	10ms	
M2002	Axis 2							
M2003	Axis 3							
M2004	Axis 4							
M2005	Unusable (4 points)			——	——		——	——
M2006								
M2007								
M2008								
M2009	All-axes servo ON accept flag					SCPU← PCPU	10ms	
M2010	Unusable (2 points)			——	——		——	——
M2011								
M2012	Manual pulse generator 1 enabled			○	×	SCPU→ PCPU		10ms
M2013	Unusable (2 points)			——	——		——	——
M2014								
M2015	JOG simultaneous start command			○	○	SCPU→ PCPU		10ms
M2016	Unusable (4 points)			——	——		——	——
M2017								
M2018								
M2019								
M2020	START buffer full			○	○	SCPU← PCPU	END	
M2021	Axis 1	Speed change in progress flag (4 points)						
M2022	Axis 2							
M2023	Axis 3							
M2024	Axis 4							
M2025	Unusable (9 points)			——	——		——	——
M2026								
M2027								
M2028								
M2029								
M2030								
M2031								
M2032								
M2033								
M2034	PC link communication error flag			○	○	SCPU← PCPU	END	
M2035	Unusable (5 points)			——	——		——	——
M2036								
M2037								
M2038								
M2039								
M2040	CPU completion point setting			○	○	SCPU→ PCPU		Start timing
M2041	System setting error flag			○	○	SCPU← PCPU	END	
M2042	All-axes servo ON command			○	○	SCPU→ PCPU		3.5ms
M2043	REAL/VIRTUAL mode switching request			○	○			10ms
M2044	REAL/VIRTUAL mode switching status			○	○	SCPU← PCPU	END	
M2045	REAL/VIRTUAL mode switching error			○	○			
M2046	Synchronization discrepancy warning			○	○			
M2047	Motion slot module error detection flag			○	○			

* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

(12) Monitor devices of each axis

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D800 to D819	D800 to D819	
2	D820 to D839	D820 to D839	
3	D840 to D859	D840 to D859	
4	D860 to D879	D860 to D879	
5	D880 to D899		
6	D900 to D919		
7	D920 to D939		
8	D940 to D959		

(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value/roller cycle	○	○	SCPU←PCPU	3.5ms	
2 3	Actual present value					
4 5	Deviation counter value					
6	Minor error code				Immediately	
7	Major error code					
8	Servo error code				10ms	
9 10	Travel value when the near-zero point DOG/CHANGE is ON	○	Backup		END	
11	Home position return second travel value				3.5ms	
12	Execution program Number	○	○			
13	M code					
14	Torque limit value	○	○			
15 16	Travel value change register	○	×	SCPU→PCPU		3.5ms
17 18	Actual present value when STOP is input	○	×	SCPU←PCPU	END	
19	Data set pointer for constant speed control	○	○		At driving or during driving	

(13) Control change registers

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D960 to D965	D960 to D965	
2	D966 to D971	D966 to D971	
3	D972 to D977	D972 to D977	
4	D978 to D983	D978 to D983	
5	D984 to D989		
6	D990 to D995		
7	D996 to D1001		
8	D1002 to D1007		

(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Present value change register	○	○	SCPU→PCPU		CHGA execution
2 3	Speed change register					CHGV execution
4 5	JOG speed setting register (*1)					At driving

(*1) Represents a backup register.

* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

(14) Virtual servo motor axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D700 to D705	D700 to D705	(O Valid)
2	D706 to D711	D706 to D711	
3	D712 to D717	D712 to D717	
4	D718 to D723	D718 to D723	
5	D724 to D729		
6	D730 to D735		
7	D736 to D741		
8	D742 to D747		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value	Backup	O	SCPU←PCPU	3.5 ms	
2	Minor error code				Immediately	
3	Major error code					
4	Execution program Number				3.5 ms	
5	M code					

(15) Virtual servo motor axis main shaft differential gear present value

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D760 D671	D760 D671	(O Valid)
2	D672 D673	D672 D673	
3	D674 D675	D674 D675	
4	D676 D677	D676 D677	
5	D678 D679		
6	D680 D681		
7	D682 D683		
8	D684 D685		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Virtual servo motor axis main shaft differential gear present value	Backup	O	SCPU←PCPU	3.5 ms	

(16) Synchronous encoder axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D748 to D751	D748 to D751	(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Feed present value	Backup	○	SCPU←PCPU	3.5ms	
2	Minor error code	○ (*2)			Immediately	
3	Major error code					

(*2) Set when the controller power is turned on only in the case of an absolute synchronous encoder.

(17) Synchronous encoder axis main shaft differential gear present value

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D686 D687	D686 D687	(○ Valid)

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0 1	Synchronous encoder axis main shaft differential gear present value	Backup	○	SCPU←PCPU	3.5ms	

(18) Cam axis monitor devices

Axis No.	A172SHCPU Device Number	A171SHCPU Device Number	Signal Name
1	D760 to D764	D760 to D764	(○ Valid)
2	D765 to D769	D765 to D769	
3	D770 to D774	D770 to D774	
4	D775 to D779	D775 to D779	
5	D780 to D784		
6	D785 to D789		
7	D790 to D794		
8	D795 to D799		

	Signal Name	REAL	VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
0	Execution cam No.	Backup	○	SCPU←PCPU	Every END	
1 2	Execution stroke value					
3 4	Cam axis present value within one revolution					

* "Every END" of the refresh cycle is referred to as the sequence program scan time.

(19) Common devices

• A172SHCPU

Device No.	Signal Name		(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
D1008	Limit switch output disabled setting register (4 points)		○	○	SCPU→PCPU		3.5ms
D1009							
D1010							
D1011							
D1012	Setting Register for a axis number controlled with manual pulse generator 1						Manual pulse generator operation enabled
D1013	Unusable (2 points)		———	———		———	———
D1014							
D1015	JOG operation simultaneous start axis setting register		○	○	SCPU→PCPU		At driving
D1016	Axis 1	1 pulse input modification setting register for manual pulse generators (8 points)					Manual pulse generator operation enabled
D1017	Axis 2						
D1018	Axis 3						
D1019	Axis 4						
D1020	Axis 5						
D1021	Axis 6						
D1022	Axis 7						
D1023	Axis 8						

• A171SHCPU

Device No.	Signal Name		(O Valid) REAL	(O Valid) VIRTUAL	Signal Direction	Refresh Cycle	Fetch Cycle
D1008	Limit switch output disabled setting register (2 points)		○	○	SCPU→PCPU		3.5ms
D1009							
D1010	Unusable (2 points)		———	———		———	———
D1011							
D1012	Setting Register for a axis number controlled with manual pulse generator 1		○	○	SCPU→PCPU		Manual pulse generator operation enabled
D1013	Unusable (2 points)		———	———		———	———
D1014							
D1015	JOG operation simultaneous start axis setting register		○	○	SCPU→PCPU		At driving
D1016	Axis 1	1 pulse input modification setting register for manual pulse generator (4 points)					Manual pulse generator operation enabled
D1017	Axis 2						
D1018	Axis 3						
D1019	Axis 4						
D1020	Unusable (4 points)		———	———		———	———
D1021							
D1022							
D1023							

(20) Special Relays

• A172SHCPU/A1712SHCPU

Device No.	Signal Name	(O Valid)		Signal Direction	Refresh Cycle	Fetch Cycle
		REAL	VIRTUAL			
M9073	PCPU WDT error flag					
M9074	PCPU READY flag					
M9075	TEST mode ON flag					
M9076	External emergency stop input flag	○	○	SCPU←PCPU	END	
M9077	Manual pulse generator axis setting error flag					
M9078	TEST mode request flag					
M9079	Servo program setting error flag					

(21) Special Registers

• A172SHCPU/A1712SHCPU

Device No.	Signal Name	(O Valid)		Signal Direction	Refresh Cycle	Fetch Cycle
		REAL	VIRTUAL			
D9180	Limit switch output status storage area	○	○	SCPU←PCPU	3.5ms	
D9181						
D9182						
D9183						
D9184	PCPU WDT error cause				10ms	
D9185	Servo amplifier type					
D9186						
D9187	Manual pulse generator axis setting error				Manual pulse generator operation enabled	
D9188	Test mode request error				TEST mode request	
D9189	Error program number				At driving	
D9190	Error item information					
D9191	Servo amplifier loading information				10 ms	
D9192	Area for setting the manual pulse generator smoothing magnification	○	○	SCPU→PCPU		Manual pulse generator operation enabled
D9193	Unusable	——	——		——	——
D9194	Unusable					
D9195	REAL/VIRTUAL mode switching error information	○	○	SCPU←PCPU	Mode switching 3.5 ms	
D9196	PC link communication error codes					
D9197	Unusable	——	——		——	——
D9198	Unusable					
D9199	Unusable					

* The "END" of the refresh cycle is the longer of 80 ms and the sequence program scan time.

APPENDIX 3 Setting Range of Indirect Setting Devices

Appendix 3.1 Servo program

All settings by servo programs (positioning address, commanded speed, M code, etc.) can be designated indirectly by PC devices, excluding the axis numbers.

(1) Device ranges
The number of device words and device range in indirect designation are shown below.

<table>
<tr><th colspan="2" rowspan="2">Item</th><th rowspan="2">Number of Device Words</th><th colspan="2">Device Setting Range</th><th rowspan="2">Remarks</th></tr>
<tr><th>A172SHCPU</th><th>A171SHCPU</th></tr>
<tr><td rowspan="6">Common</td><td>Address/travel</td><td>2</td><td rowspan="20" colspan="2"></td><td rowspan="13"></td></tr>
<tr><td>Command speed</td><td>2</td></tr>
<tr><td>Dwell time</td><td>1</td></tr>
<tr><td>M code</td><td>1</td></tr>
<tr><td>Torque limit value</td><td>1</td></tr>
<tr><td>Parameter block number</td><td>1</td></tr>
<tr><td rowspan="3">Arc</td><td>Auxiliary point</td><td>2</td></tr>
<tr><td>Radius</td><td>2</td></tr>
<tr><td>Center</td><td>2</td></tr>
<tr><td rowspan="10">Parameter block</td><td>Control unit</td><td>1</td></tr>
<tr><td>Speed limit value</td><td>2</td></tr>
<tr><td>Acceleration time</td><td>1</td></tr>
<tr><td>Deceleration time</td><td>1</td></tr>
<tr><td>Rapid stop deceleration time</td><td>1</td></tr>
<tr><td>Torque limit value</td><td>1</td></tr>
<tr><td>STOP input deceleration</td><td>1</td></tr>
<tr><td>Circular interpolation error allowance range</td><td>2</td></tr>
<tr><td>S curve comparison</td><td>1</td></tr>
<tr><td rowspan="15">Other</td><td>Program number</td><td>1</td><td>Simultaneous start</td></tr>
<tr><td>FIN acceleration/deceleration time</td><td>1</td><td></td></tr>
<tr><td>Start program number</td><td>1</td><td>Cancel & start</td></tr>
<tr><td>Repeat condition (number of repetitions)</td><td>1</td><td></td></tr>
<tr><td>Repeat condition (ON/OFF)</td><td>Bit</td><td rowspan="7" colspan="2">
<table>
<tr><th>Device</th><th>Range</th></tr>
<tr><td>X</td><td>000 to 7FF</td></tr>
<tr><td>Y</td><td>000 to 7FF</td></tr>
<tr><td>M/L</td><td>0 to 2047</td></tr>
<tr><td>M</td><td>9000 to 9255</td></tr>
<tr><td>B</td><td>000 to 3FF</td></tr>
<tr><td>F</td><td>0 to 255</td></tr>
</table>
</td><td rowspan="7"></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Skip command</td><td>Bit</td></tr>
<tr><td>Cancel command</td><td>Bit</td></tr>
<tr><td colspan="2" rowspan="3"></td></tr>
<tr><td colspan="2" rowspan="3">
<table>
<tr><th>Device</th><th>Range</th></tr>
<tr><td>X</td><td>000 to 7FF</td></tr>
<tr><td>Y</td><td>000 to 7FF</td></tr>
<tr><td>M/L</td><td>0 to 2047</td></tr>
<tr><td>M</td><td>9000 to 9255</td></tr>
<tr><td>B</td><td>000 to 3FF</td></tr>
<tr><td>F</td><td>0 to 255</td></tr>
<tr><td>TT (Timer contact)</td><td>0 to 255</td></tr>
<tr><td>TC (Timer coil)</td><td>0 to 255</td></tr>
<tr><td>CT (Counter contact)</td><td>0 to 255</td></tr>
<tr><td>CC (Counter coil)</td><td>0 to 255</td></tr>
</table>
</td></tr>
<tr><td colspan="2"></td></tr>
</table>

POINT

· Be sure to designate even-numbered devices for 2-word designation items. Be sure to use the DMOV(P) instruction when setting data in these devices by sequence programs.

(2) Device data fetch

Data for indirectly designated devices is fetched by the PCPU at the start of the servo program.

For this reason, set data in the devices before starting the servo program, and never change the devices unless servo program start is complete.

The following describes the procedures by start method for setting data in devices and the points to note.

Start Method	Setting Method	Notes
Start by SVST instruction	Designate data in devices. ↓ Set the cancel command device to ON.	Don't change the indirectly designated device until the positioning start completion signal of the start axis goes ON.
Automatic start by cancel & start	Set data in the indirectly designated device chosen by the start program. ↓ Turns the cancel command device ON.	
Designating loop (FOR to NEXT) point data in the CPSTART instruction indirectly	Designate initial command data in the indirectly designated device ↓ Start by SVST (or set the cancel command device to ON). ↓ Read the value of constant speed control data set pointer of the started axis, and update the data fetched by PCPU.	For details, see the positioning signal data register "Monitoring data Area".

Appendix 3.2 Mechanical system program

The device range and setting method for items indirectly set by devices in the parameters of each module of the mechanical system program are given here.

(1) Device ranges
The number of device words and device ranges when settings are made indirectly are given in the table below.

<table>
<tr><th rowspan="2">Module</th><th rowspan="2">Item</th><th rowspan="2">Number of Device Words</th><th colspan="2">Device Setting Range</th><th rowspan="2">Remarks</th></tr>
<tr><th>A172SHCPU</th><th>A171SHCPU</th></tr>
<tr><td rowspan="10">Clutch</td><td>Clutch ON/OFF command device</td><td>Bit</td><td colspan="2" rowspan="10"><table><tr><th>Device</th><th>Range</th></tr><tr><td>X</td><td>000 to 7FF</td></tr><tr><td>Y</td><td>000 to 7FF</td></tr><tr><td>M/L</td><td>0 to 2047</td></tr><tr><td>M</td><td>9000 to 9255</td></tr><tr><td>B</td><td>000 to 3FF</td></tr><tr><td>F</td><td>0 to 255</td></tr><tr><td>TT (Timer contact)</td><td>0 to 255</td></tr><tr><td>TC (Timer coil)</td><td>0 to 255</td></tr><tr><td>CT (Counter contact)</td><td>0 to 255</td></tr><tr><td>CC (Counter coil)</td><td>0 to 255</td></tr></table></td><td rowspan="10"></td></tr>
<tr><td>Mode setting device</td><td>1</td></tr>
<tr><td>Clutch ON address setting device</td><td>2</td></tr>
<tr><td>Clutch OFF address setting device</td><td>2</td></tr>
<tr><td>Slippage amount setting device</td><td>2</td></tr>
<tr><td rowspan="2">Gear</td><td>Number of input axis gear teeth</td><td>1</td></tr>
<tr><td>Number of output axis gear teeth</td><td>1</td></tr>
<tr><td>Speed change gear</td><td>Speed change ratio setting device</td><td>1</td></tr>
<tr><td>Roller</td><td>Torque limit value setting device</td><td>1</td></tr>
<tr><td>Ball screw</td><td>Torque limit value setting device</td><td>1</td></tr>
<tr><td rowspan="3">Rotary table</td><td>Torque limit value setting device</td><td>1</td></tr>
<tr><td>Virtual axis present value within one revolution storage device (main shaft side)</td><td>2</td></tr>
<tr><td>Virtual axis present value within one revolution storage device (auxiliary input axis side)</td><td>2</td></tr>
<tr><td rowspan="6">Cam</td><td>Cam No. setting device</td><td>1</td></tr>
<tr><td>Stroke setting device</td><td>2</td></tr>
<tr><td>Torque limit value setting device</td><td>1</td></tr>
<tr><td>Stroke lower limit value storage device</td><td>2</td></tr>
<tr><td>Virtual axis present value within one revolution storage device (main shaft side)</td><td>2</td></tr>
<tr><td>Virtual axis present value within one revolution storage device (auxiliary input axis side)</td><td>2</td></tr>
</table>

POINTS

- For items set using two words, always set an even numbered device. In addition, when setting data in the sequence program for that device, always use the DMOV (P) command.
- When a two word monitor device leads the sequence program, always acquire it in the user device using the DMOV (P) command. Use the fetched device for carrying out such things as upper/lower comparison and calculations.

(2) Device data fetch

When the data of a device that has been set indirectly is switched from the REAL to VIRTUAL mode, first acquire everything as default values and thereafter carry out fetch control during virtual mode operation for the corresponding module.

Shown in the table below are the fetch timing of each device and the refresh cycle of the set device. The device fetch timing and device refresh cycle are the same for both A172SHCPU and A171SHCPU.

Module	Item	Fetch Device	Refresh Device	Device Fetch Timing		Device Refresh Cycle
				REAL → VIRTUAL Mode Switching	During VIRTUAL Mode Operation	
Clutch	Clutch ON/OFF command device	○	——	○	Fetched every 3.5 ms (calculation cycle)	——
	Mode setting device	○	——	○		
	Clutch ON address setting device	○	——	○		
	Clutch OFF address setting device	○	——	○		
	Slippage setting device	○	——	○	——	
Gear	Number of input axis gear teeth	○	——	○	Fetched when the present value change of the connection source drive module (virtual servo motor axis/synchronous encoder axis) is executed (CHGA) and the gear ratio change is carried out	
	Number of output axis gear teeth	○	——	○		
Speed change gear	Speed ratio setting device	○	——	○	Fetched every 3.5 ms (calculation cycle)	
Roller	Torque limit value setting device	○	——	○		
Ball screw	Torque limit value setting device	○	——	○		
Rotary table	Torque limit value setting device	○	——	○		
	Virtual axis present value within one revolution storage device (main shaft side)	——	○	——	——	3.5ms
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	——	○	——		
Cam	Cam No. setting device	○	——	○	Fetched every 3.5 ms (calculation cycle). However, the cam No. and stroke switching position pass point are enabled.	——
	Stroke setting device	○	——	○		
	Torque limit value setting device	○	——	○	Fetched every 3.5 ms (calculation cycle).	
	Stroke lower limit storage device	——	○	——	——	3.5ms
	Virtual axis present value within one revolution storage device (main shaft side)	——	○	——		
	Virtual axis present value within one revolution storage device (auxiliary input axis side)	——	○	——		

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE:MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
NAGOYA WORKS : 1-14 , YADA-MINAMI 5 , HIGASHI-KU , NAGOYA , JAPAN

IB (NA) 67397-B (9804) MEE Printed in Japan