



PROGRAMMABLE CONTROLLERS
MELSEC-F

FX3U-1PG



USER'S MANUAL



FX3U


Safety Precautions

(Read these precautions before use.)

Before installation, operation, maintenance or inspection of this product, thoroughly read through and understand this manual and all of the associated manuals. Also, take care to handle the module properly and safely.


This manual classifies the safety precautions into two categories:  **WARNING** and  **CAUTION**.


 WARNING	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
 CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight personal injury or physical damage.

Depending on the circumstances, procedures indicated by  **CAUTION** may also cause severe injury. It is important to follow all precautions for personal safety.

Store this manual in a safe place so that it can be taken out and read whenever necessary. Always forward it to the end user.

1. DESIGN PRECAUTIONS

 WARNING	Reference
<ul style="list-style-type: none"> • Make sure to have the following safety circuits outside of the PLC to ensure safe system operation even during external power supply problems or PLC failure. Otherwise, malfunctions may cause serious accidents. <ol style="list-style-type: none"> 1) Most importantly, have the following: an emergency stop circuit, a protection circuit, an interlock circuit for opposite movements (such as normal vs. reverse rotation), and an interlock circuit (to prevent damage to the equipment at the upper and lower positioning limits). 2) Note that when the PLC CPU detects an error, such as a watchdog timer error, during self-diagnosis, all outputs are turned off. Also, when an error that cannot be detected by the PLC CPU occurs in an input/output control block, output control may be disabled. External circuits and mechanisms should be designed to ensure safe machinery operation in such a case. 3) Note that when an error occurs in a relay, triac or transistor output device, the output could be held either on or off. For output signals that may lead to serious accidents, external circuits and mechanisms should be designed to ensure safe machinery operation in such a case. 	15 27


 CAUTION	Reference
<ul style="list-style-type: none"> • Make sure to observe the following precautions in order to prevent any damage to the machinery or accidents due to abnormal data written to the PLC under the influence of noise: <ol style="list-style-type: none"> 1) Do not bundle the main circuit line together with or lay it close to the main circuit, high-voltage line or load line. Otherwise, noise disturbance and/or surge induction are likely to take place. As a guideline, lay the control line at least 100mm (3.94") or more away from the main circuit or high-voltage lines. 2) Ground the shield wire or shield of a shielded cable. Do not use common grounding with heavy electrical systems. • Install module so that excessive force will not be applied to the terminal blocks. Failure to do so may result in wire damage/breakage or PLC failure. 	15 27

Safety Precautions

(Read these precautions before use.)


2. INSTALLATION PRECAUTIONS

 WARNING	Reference
<ul style="list-style-type: none">• Make sure to cut off all phases of the power supply externally before attempting installation work. Failure to do so may cause electric shock or damage to the product.	21

 CAUTION	Reference
<ul style="list-style-type: none">• Use the product within the generic environment specifications described in PLC main unit manual (Hardware Edition). Never use the product in areas with excessive dust, oily smoke, conductive dusts, corrosive gas (salt air, Cl₂, H₂S, SO₂, or NO₂), flammable gas, vibration or impacts, or expose it to high temperature, condensation, or rain and wind. If the product is used in such conditions, electric shock, fire, malfunctions, deterioration or damage may occur.• Do not touch the conductive parts of the product directly. Doing so may cause device failures or malfunctions.• Install the product securely using a DIN rail or mounting screws.• Install the product on a flat surface. If the mounting surface is rough, undue force will be applied to the PC board, thereby causing nonconformities.• When drilling screw holes or wiring, make sure that cutting and wiring debris do not enter the ventilation slits. Failure to do so may cause fire, equipment failures or malfunctions.• Be sure to remove the dust proof sheet from the PLC's ventilation slits when installation work is completed. Failure to do so may cause fire, equipment failures or malfunctions.• Make sure to attach the top cover, offered as an accessory, before turning on the power or initiating operation after installation or wiring work. Failure to do so may cause electric shock.• Connect extension cables securely to their designated connectors. Loose connections may cause malfunctions.	21

3. WIRING PRECAUTIONS


 WARNING	Reference
<ul style="list-style-type: none">• Make sure to cut off all phases of the power supply externally before attempting wiring work. Failure to do so may cause electric shock or damage to the product.	24


 CAUTION	Reference
<ul style="list-style-type: none">• Connect the DC power supply wiring to the dedicated terminal described in this manual. If an AC power supply is connected to a DC input/output terminal or DC power supply terminal, the PLC will burn out.• Make sure to attach the top cover, offered as an accessory, before turning on the power or initiating operation after installation or wiring work. Failure to do so may cause electric shock.• When drilling screw holes or wiring, make sure that cutting and wiring debris do not enter the ventilation slits. Failure to do so may cause fire, equipment failures or malfunctions.• Make sure to properly wire the extension equipment in accordance with the following precautions. Failure to do so may cause electric shock, equipment failures, a short-circuit, wire breakage, malfunctions, or damage to the product.<ul style="list-style-type: none">- The disposal size of the cable end should follow the dimensions described in the manual.- Tightening torque should follow the specifications in the manual.	24

Safety Precautions

(Read these precautions before use.)

4. STARTUP AND MAINTENANCE PRECAUTIONS


 WARNING	Reference
<ul style="list-style-type: none">• Do not touch any terminal while the PLC's power is on. Doing so may cause electric shock or malfunctions.• Before cleaning or retightening terminals, cut off all phases of the power supply externally. Failure to do so may cause electric shock.• Before modifying or disrupting the program in operation or running the PLC, carefully read through this manual and the associated manuals and ensure the safety of the operation. An operation error may damage the machinery or cause accidents.	111 118

 CAUTION	Reference
<ul style="list-style-type: none">• Do not disassemble or modify the PLC. Doing so may cause fire, equipment failures, or malfunctions. For repair, contact your local Mitsubishi Electric representative.• Turn off the power to the PLC before connecting or disconnecting any extension cable. Failure to do so may cause equipment failures or malfunctions.• Turn off the power to the PLC before attaching or detaching the following devices. Failure to do so may cause equipment failures or malfunctions.<ul style="list-style-type: none">- Peripheral devices, display modules, expansion boards and special adapters- I/O extension units/blocks, FX Series terminal block and the special function units/blocks- Battery and memory cassette	111 118

5. DISPOSAL PRECAUTIONS

 CAUTION	Reference
<ul style="list-style-type: none">• Please contact a certified electronic waste disposal company for the environmentally safe recycling and disposal of your device.	15

6. TRANSPORTATION AND STORAGE PRECAUTIONS

 CAUTION	Reference
<ul style="list-style-type: none">• The PLC is a precision instrument. During transportation, avoid impacts larger than those specified in the general specifications of the PLC main unit manual by using dedicated packaging boxes and shock-absorbing pallettes. Failure to do so may cause failures in the PLC. After transportation, verify operation of the PLC and check for damage of the mounting part, etc.	15

Safety Precautions

(Read these precautions before use.)

MEMO

FX3U-1PG

User's Manual

Manual number	JY997D47301
Manual revision	B
Date	4/2015

Foreword

This manual describes the FX3U-1PG pulse output block and should be read and understood before attempting to install the hardware.

Store this manual in a safe place so that you can take it out and read it whenever necessary. Always forward it to the end user.

This manual confers no industrial property rights or any rights of any other kind, nor does it confer any patent licenses. Mitsubishi Electric Corporation cannot be held responsible for any problems involving industrial property rights which may occur as a result of using the contents noted in this manual.

Outline Precautions

- This manual provides information for the use of the FX3U-1PG pulse output block. The manual has been written to be used by trained and competent personnel. The definition of such a person or persons is as follows;
 - 1) Any engineer who is responsible for the planning, design and construction of automatic equipment using the product associated with this manual should be of a competent nature, trained and qualified to the local and national standards required to fulfill that role. These engineers should be fully aware of all aspects of safety with aspects regarding to automated equipment.
 - 2) Any commissioning or maintenance engineer must be of a competent nature, trained and qualified to the local and national standards required to fulfill the job. These engineers should also be trained in the use and maintenance of the completed product. This includes being familiar with all associated manuals and documentation for the product. All maintenance should be carried out in accordance with established safety practices.
 - 3) All operators of the completed equipment should be trained to use that product in a safe and coordinated manner in compliance with established safety practices. The operators should also be familiar with documentation that is connected with the actual operation of the completed equipment.
- Note:** The term 'completed equipment' refers to a third party constructed device that contains or uses the product associated with this manual.
- This product has been manufactured as a general-purpose part for general industries, and has not been designed or manufactured to be incorporated in a device or system used in purposes related to human life.
 - Before using the product for special purposes such as nuclear power, electric power, aerospace, medicine or passenger movement vehicles, consult with Mitsubishi Electric.
 - This product has been manufactured under strict quality control. However when installing the product where major accidents or losses could occur if the product fails, install appropriate backup or failsafe functions into the system.
 - When combining this product with other products, please confirm the standards and codes of regulation to which the user should follow. Moreover, please confirm the compatibility of this product with the system, machines, and apparatuses to be used.
 - If there is doubt at any stage during installation of the product, always consult a professional electrical engineer who is qualified and trained in the local and national standards. If there is doubt about the operation or use, please consult your local Mitsubishi Electric representative.
 - Since the examples within this manual, technical bulletin, catalog, etc. are used as reference; please use it after confirming the function and safety of the equipment and system. Mitsubishi Electric will not accept responsibility for actual use of the product based on these illustrative examples.
 - The content, specification etc. of this manual may be changed for improvement without notice.
 - The information in this manual has been carefully checked and is believed to be accurate; however, if you notice any doubtful point, error, etc., please contact your local Mitsubishi Electric representative.

Registration

- The company name and the product name to be described in this manual are the registered trademarks or trademarks of each company.

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Standards

Certification of UL, cUL standards

FX3U-1PG units comply with the UL standards (UL, cUL).

UL, cUL File number: E95239

Regarding the standards that comply with the main unit, please refer to either the FX series product catalog or consult with your nearest Mitsubishi product provider.

Compliance with EC directive (CE Marking)

This document does not guarantee that a mechanical system including this product will comply with the following standards.

Compliance to EMC directive and LVD directive for the entire mechanical module should be checked by the user/manufacturer. For more information please consult with your nearest Mitsubishi product provider.

Regarding the standards that comply with the main unit, please refer to either the FX series product catalog or consult with your nearest Mitsubishi product provider.

Requirement for Compliance with EMC directive

The following products have shown compliance through direct testing (of the identified standards below) and design analysis (through the creation of a technical construction file) to the European Directive for Electromagnetic Compatibility (2004/108/EC) when used as directed by the appropriate documentation.

Attention

- This product is designed for use in industrial applications.

Note

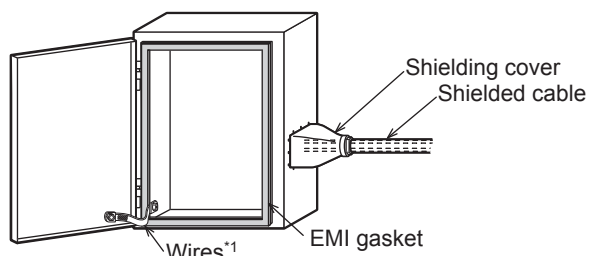
- Authorized Representative in the European Community:
Mitsubishi Electric Europe B.V.
Gothaer Str. 8, 40880 Ratingen, Germany

Type: Programmable Controller (Open Type Equipment)
 Models: MELSEC FX3U series manufactured
 from September 1st, 2012 FX3U-1PG

Standard	Remark
EN61131-2: 2007 Programmable controllers - Equipment requirements and tests	Compliance with all relevant aspects of the standard. EMI <ul style="list-style-type: none"> • Radiated Emission • Conducted Emission EMS <ul style="list-style-type: none"> • Radiated electromagnetic field • Fast transient burst • Electrostatic discharge • High-energy surge • Voltage drops and interruptions • Conducted RF • Power frequency magnetic field

Caution to conform with EC Directives

- Installation in Enclosure
 Programmable logic controllers are open-type devices that must be installed and used within conductive control cabinets. Please use the programmable logic controller while installed within a conductive shielded control cabinet. Please secure the cabinet door to the control cabinet (for conduction). Installation within a control cabinet greatly affects the safety of the system and aids in shielding noise from the programmable logic controller.
- Control cabinet
 - The control cabinet must be conductive.
 - Ground the control cabinet with the thickest possible grounding cable.
 - To ensure that there is electrical contact between the control cabinet and its door, connect the cabinet and its doors with thick wires.
 - In order to suppress the leakage of radio waves, the control cabinet structure must have minimal openings. Also, wrap the cable holes with a shielding cover or other shielding devices.
 - The gap between the control cabinet and its door must be as small as possible by attaching EMI gaskets between them.



*1. These wires are used to improve the conductivity between the door and control cabinet.

- Note for compliance with EN61131-2: 2007
 General note on the use of the power supply cable.
 The FX3U-1PG unit requires that the cable used for power supply is 30 m or less.
- The shield of the twisted pair cable used for the FP, RP, PG0, and CLR signal wires should be grounded at both ends of the cable.
- Please attach a ferrite core less than 200 mm from the other end of the FP, RP, PG0, and CLR signal wires. The ferrite core should be a product equivalent to ZCAT3035-1330 by TDK Corp.

Associated Manuals

Only the installation manual is packed together with the FX3U-1PG pulse output block.
 For a detailed explanation of the FX3U-1PG pulse output block, refer to this manual.
 For the hardware information and instructions on the PLC main unit, refer to the respective manuals.

⊙: Refer to these manuals

○: Refer to the appropriate equipment manual

△: For a detailed explanation, refer to an additional manual

		Title of manual	Document number	Description	Model code
Manual for the Main Unit					
FX3U Series PLCs Main Unit					
△	Supplied Manual	FX3U Series Hardware Manual	JY997D50301	Describes FX3U Series PLC specification for I/O, wiring and installation extracted from the FX3U User's Manual - Hardware Edition. For details, refer to FX3U Series User's Manual - Hardware Edition.	-
⊙	Additional Manual	FX3U Series User's Manual - Hardware Edition	JY997D16501	Describes FX3U Series PLC specification details for I/O, wiring, installation and maintenance.	09R516
FX3UC Series PLCs Main Unit					
△	Supplied Manual	FX3UC (D, DS, DSS) Series Hardware Manual	JY997D50501	Describes FX3UC (D, DS, DSS) Series PLC specification for I/O, wiring and installation extracted from the FX3UC Series User's Manual - Hardware Edition. For details, refer to FX3UC Series User's Manual - Hardware Edition.	-
△	Supplied Manual	FX3UC-32MT-LT-2 Hardware Manual	JY997D31601	Describes FX3UC-32MT-LT-2 specification for I/O, wiring and installation extracted from the FX3UC User's Manual - Hardware Edition. For details, refer to FX3UC Series User's Manual - Hardware Edition.	-
△	Supplied Manual	FX3UC-32MT-LT Hardware Manual (Only Japanese document)	JY997D12701	Describes FX3UC-32MT-LT specification for I/O, wiring and installation extracted from the FX3UC User's Manual - Hardware Edition. For details, refer to FX3UC Series User's Manual - Hardware Edition.	-
⊙	Additional Manual	FX3UC Series User's Manual - Hardware Edition	JY997D28701	Describes FX3UC Series PLC specification details for I/O, wiring, installation and maintenance.	09R519
Programming					
⊙	Additional Manual	FX3S/FX3G/FX3GC/FX3U/FX3UC Series Programming Manual - Basic & Applied Instruction Edition	JY997D16601	Describes FX3S/FX3G/FX3GC/FX3U/FX3UC Series PLC programming for basic/applied instructions and devices.	09R517
○	Additional Manual	MELSEC-Q/L/F Structured Programming Manual (Fundamentals)	SH-080782	Programming methods, specifications, functions, etc. required to create structured programs.	13JW06
○	Additional Manual	FX CPU Structured Programming Manual [Device & Common]	JY997D26001	Devices, parameters, etc. provided in structured projects of GX Works2.	09R925
○	Additional Manual	FX CPU Structured Programming Manual [Basic & Applied Instruction]	JY997D34701	Sequence instructions provided in structured projects of GX Works2.	09R926
○	Additional Manual	FX CPU Structured Programming Manual [Application Functions]	JY997D34801	Application functions provided in structured projects of GX Works2.	09R927
○	Additional Manual	FX3S/FX3G/FX3GC/FX3U/FX3UC Series User's Manual - Positioning Control Edition	JY997D16801	Provides detailed information on the positioning functions incorporated in the FX3S/FX3G/FX3GC/FX3U/FX3UC Series.	09R620

FX3U-1PG User's Manual

		Title of manual	Document number	Description	Model code
Manuals for FX3U-1PG pulse output block					
△	Supplied Manual	FX3U-1PG Installation Manual	JY997D47101	Describes installation specifications for the FX3U-1PG pulse output block extracted from the FX3U-1PG User's Manual. For details, refer to FX3U-1PG User's Manual.	-
⊙	Additional Manual	FX3U-1PG User's Manual (This Manual)	JY997D47301	Describes details of the FX3U-1PG pulse output block.	09R629

Generic Names and Abbreviations Used in the Manual

Generic name or abbreviation	Description
PLC	
FX3U series	Generic name for FX3U Series PLC
FX3U PLC or main unit	Generic name for FX3U Series PLC main unit
FX3UC series	Generic name for FX3UC Series PLC
FX3UC PLC or main unit	Generic name for FX3UC Series PLC main unit
Expansion board	Generic name for expansion board The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
Special adapter	Generic name for high-speed input/output special adapter, communication special adapter, analog special adapter, and CF card special adapter. The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
I/O extension unit/block	Generic name for input/output powered extension unit and input/output extension block The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
Special function unit/block or Special extension unit	Generic name for special function unit and special function block The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
Special function unit	Generic name for special function unit
Special function block	Generic name for special function block
FX3U-1PG	Abbreviated name for FX3U-1PG pulse output block
Memory cassette	Generic name for memory cassette. The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
Battery	Abbreviated name for FX3U-32BL
FX Series terminal block	Generic name for FX Series terminal block. The number of connectable units, however, depends on the type of main unit. To check the number of connectable units, refer to the User's Manual - Hardware Edition of the main unit to be used for your system.
Peripheral unit	
Peripheral unit	Generic name for programming software, handy programming panel, and indicator
Programming tool	
Programming tool	Generic name for programming software and handy programming panel
Programming software	Generic name for programming software
GX Works2	Abbreviation of programming software packages SW□DNC-GXW2-E
GX Developer	Abbreviation of programming software packages SW□D5C-GPPW-E
Handy programming panel (HPP)	Generic name for FX-30P and FX-20P-E
Indicator	
GOT1000 series	Generic name for GT16, GT15, GT14, GT11 and GT10
Manual	
FX3U Hardware Edition	Abbreviation of FX3U Series User's Manual - Hardware Edition
FX3UC Hardware Edition	Abbreviation of FX3UC Series User's Manual - Hardware Edition
Programming manual	Abbreviation of FX3s/FX3G/FX3GC/FX3U/FX3UC Series Programming Manual - Basic and Applied Instruction Edition
Communication control Edition	Abbreviation of FX Series User's Manual - Data Communication Edition
Analog control Edition	Abbreviation of FX3s/FX3G/FX3GC/FX3U/FX3UC Series User's Manual - Analog Control Edition
Positioning control Edition	Abbreviation of FX3s/FX3G/FX3GC/FX3U/FX3UC Series User's Manual - Positioning Control Edition

Reading the Manual

In this manual, the following formats are used for describing the common items.

- Shows the manual title.**
This area shows the manual title for the current page.
- Shows the title of the chapter and the title of the section.**
This area shows the title of the chapter and the title of the section for the current page.
- Indexes the chapter number.**
The right side of each page indexes the chapter number for the page currently opened.

FX3U-1PG User's Manual
2.4 Input Specifications

2.4 Input Specifications

2.4.1 Input specifications

Item	Specification
Input signal name	Group 1 STOP: Deceleration stop input or used for interrupt input of External command positioning, Interrupt 2-speed positioning operation DOG: Used for DOG input of DOG type mechanical zero return operation or used for interrupt input of External command positioning, Interrupt 1-speed positioning, Interrupt stop, Interrupt 2-speed positioning operation
	Group 2 PGO: Zero point signal input Used for DOG type mechanical zero return operation
Group 1	Signal voltage 24 V DC (Power is supplied from S/S terminal.)
	Input current 7.0 mA
	ON current 4.5 mA or more
	OFF current 1.5 mA or less
	Signal form No-voltage contact input Sink input: NPN open collector transistor Source input: PNP open collector transistor
Response time DOG input: 1 ms STOP input: 4 ms	
Circuit insulation Photo-coupler insulation	
Operation display LED ON at input ON	
Group 2	Signal voltage 5 to 24 V DC
	Input current 20 mA or less
	ON current 4.0 mA or more
	OFF current 0.5 mA or less
	Signal form NPN open collector transistor
Response time 4 μs or more	
Circuit insulation Photo-coupler insulation	
Operation display LED ON at input ON	

2.4.2 Internal input circuit

For the internal input circuit diagram, refer to the following.

→ Refer to Section 5.1.

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Shows the reference.
The "→" mark indicates a reference destination and reference manual.

The above is different from the actual page, as it is provided for explanation only.

12

1. Introduction

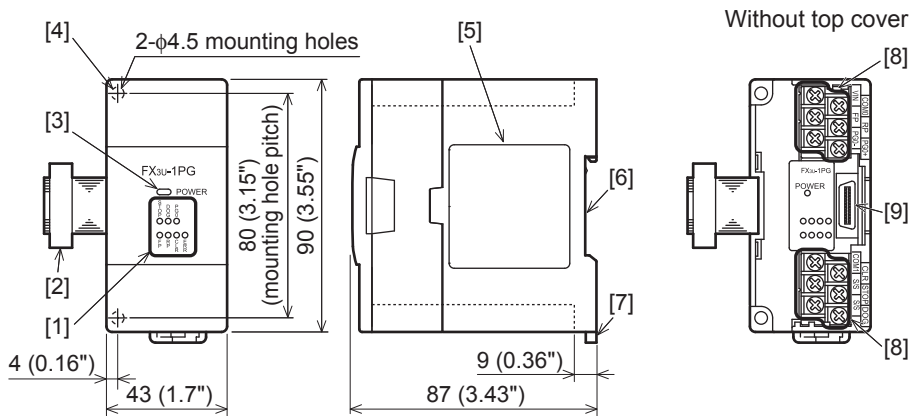
1.1 Outline

FX3U-1PG Pulse Output Block (hereinafter referred to as FX3U-1PG) is a special function block that can output a maximum 200 kHz pulse train and drive one servo motor or stepping motor through the servo amplifier or stepping motor driver.

1.1.1 Major Features of the FX3U-1PG

- FX3U-1PG controls the positioning operation of one servo motor or stepping motor per unit.
 - A pulse train of max. 200 kHz can be output. (transistor output)
 - The connected FX3U/FX3UC^{*1} PLC reads/writes the positioning data from/to the FX3U-1PG.
- *1. An FX2NC-CNV-IF or FX3UC-1PS-5V is necessary to connect the FX3U-1PG to the FX3UC PLC.

1.2 External Dimensions and Part Names



Unit: mm (inches)
 MASS (Weight): Approx. 0.2 kg (0.44 lbs)
 Accessories: Special unit/block No. label,
 Dust proof protection sheet,
 Manual supplied with product

- | | |
|---|---|
| [1] Status LEDs (red)
→ Refer to Section 1.4. | [6] DIN rail mounting groove
(DIN rail: DIN46277, 35 mm (1.38") width) |
| [2] Extension cable | [7] DIN rail mounting hook |
| [3] Power LED (green) | [8] Terminal block (M3 screw) |
| [4] Direct mounting hole: 2 holes of $\phi 4.5$ (0.18")
(mounting screw: M4 screw) | [9] Extension connector |
| [5] Name plate | |

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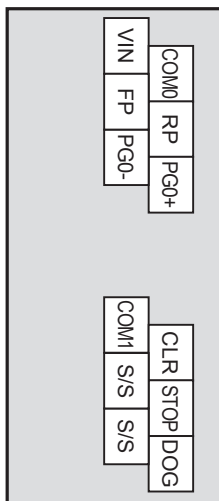
9 Positioning Control

10 Program Example

1.3 Status LEDs

LED display	LED color	Status	Description
POWER	Green	OFF	5 V DC is not being supplied from the PLC
		ON	5 V DC is being supplied from the PLC
STOP	Red	OFF	STOP input OFF
		ON	STOP input ON
DOG	Red	OFF	DOG input OFF
		ON	DOG input ON
PG0	Red	OFF	Zero point signal OFF
		ON	Zero point signal ON
FP	Red	OFF	Forward pulse or pulse train interrupted
		Flicker	Forward pulses or pulse train is being output
RP	Red	OFF	Reverse pulse or directional output interrupted
		Flicker	Reverse pulses is being output
		ON	Directional output is being output
CLR	Red	OFF	CLR signal is not output
		ON	CLR signal is being output
ERR	Red	OFF	Operating normally
		Flicker	Error occurred
		ON	CPU error occurred

1.4 Terminal Layout



Terminal name	Description
VIN	Power terminal for pulse output
COM0	Common terminal for pulse output
FP	Terminal which outputs forward pulse or pulse train
RP	Terminal which outputs reverse pulse or direction signal
PG0-	Input terminal for zero point signal
PG0+	Power terminal for zero point signal
COM1	Common terminal for CLR signal output
CLR	Terminal for CLR signal output
S/S	24 V DC power terminal for STOP input and DOG input
STOP	Terminal for STOP input or interrupt input 1
DOG	Terminal for DOG input or interrupt input 0

- Terminal block screw size and tightening torque
Terminal block screw: M3 screw
Tightening torque: 0.5 to 0.8 N•m
Do not tighten terminal block mounting screws with a torque outside the above-mentioned range. Failure to do so may cause equipment failures or malfunctions.

2. Specification

DESIGN PRECAUTIONS



- Make sure to have the following safety circuits outside of the PLC to ensure safe system operation even during external power supply problems or PLC failure. Otherwise, malfunctions may cause serious accidents.
 - 1) Most importantly, have the following: an emergency stop circuit, a protection circuit, an interlock circuit for opposite movements (such as normal vs. reverse rotation), and an interlock circuit (to prevent damage to the equipment at the upper and lower positioning limits).
 - 2) Note that when the PLC CPU detects an error, such as a watchdog timer error, during self-diagnosis, all outputs are turned off. Also, when an error that cannot be detected by the PLC CPU occurs in an input/output control block, output control may be disabled. External circuits and mechanisms should be designed to ensure safe machinery operation in such a case.
 - 3) Note that when an error occurs in a relay, triac or transistor output device, the output could be held either on or off. For output signals that may lead to serious accidents, external circuits and mechanisms should be designed to ensure safe machinery operation in such a case.

DESIGN PRECAUTIONS



- Make sure to observe the following precautions in order to prevent any damage to the machinery or accidents due to abnormal data written to the PLC under the influence of noise:
 - 1) Do not bundle the main circuit line together with or lay it close to the main circuit, high-voltage line or load line. Otherwise, noise disturbance and/or surge induction are likely to take place. As a guideline, lay the control line at least 100mm (3.94") or more away from the main circuit or high-voltage lines.
 - 2) Ground the shield wire or shield of a shielded cable. Do not use common grounding with heavy electrical systems.
- Install module so that excessive force will not be applied to the terminal blocks. Failure to do so may result in wire damage/breakage or PLC failure.

DISPOSAL PRECAUTIONS



- Please contact a certified electronic waste disposal company for the environmentally safe recycling and disposal of your device.

TRANSPORTATION AND STORAGE PRECAUTIONS



- The PLC is a precision instrument. During transportation, avoid impacts larger than those specified in the general specifications of the PLC main unit manual by using dedicated packaging boxes and shock-absorbing palletes. Failure to do so may cause failures in the PLC. After transportation, verify operation of the PLC and check for damage of the mounting part, etc.

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2.1 General Specifications

Items other than the following are equivalent to those of the PLC main unit.
For general specifications, refer to the manual of the PLC main unit.

→ Refer to FX3U Hardware Edition.
→ Refer to FX3UC Hardware Edition.

Item	Specification
Dielectric withstand voltage	500 V AC for one minute
Insulation resistance	5 MΩ or more by 500 V DC Megger
Between all terminals and ground terminal	

2.2 Power Supply Specifications

Item	Specification	
Drive power supply	Input signal	24 V DC $\pm 10\%$ Current consumption 40 mA or less
	Output signal	For pulse output: 5 to 24 V DC Current consumption 35 mA or less For CLR signal: 5 to 24 V DC Current consumption 20 mA or less
	Inner control	5 V DC Current consumption 150 mA (Power is supplied through the extension cable from the PLC.)

2.3 Performance Specifications

Item	Specification	
Number of control axes	One axis	
Positioning program	Created by sequence programs (using FROM/TO instruction or direct specification of the buffer memory etc. on the MOV instruction etc.*1)	
Positioning	Method	Increment, Absolute
	Unit	PLS, μm , 10^{-4} inch, mdeg
	Unit magnification	1, 10, 100, 1000-fold
	Range	-2,147,483,648 to 2,147,483,647 PLS
	Operation speed	Hz, cm/min, inch/min, 10deg/min
	Output frequency	1 Hz to 200 kHz
	Acceleration/ deceleration process	Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms
Starting time	Motor system: 1 ms or less Machine system: 2 ms or less	
Number of I/O occupied points	8 points (taken from either the input or output points of the PLC)	

*1. For details of other applied instructions and methods, refer to the FX3S/FX3G/FX3GC/FX3U/FX3UC Programming Manual.

2.4 Input Specifications

2.4.1 Input specifications

Item		Specification
Input signal name	Group 1	STOP: Deceleration stop input or used for interrupt input of External command positioning, Interrupt 2-speed positioning operation DOG: Used for DOG input of DOG type mechanical zero return operation or used for interrupt input of External command positioning, Interrupt 1-speed positioning, Interrupt stop, Interrupt 2-speed positioning operation
	Group 2	PG0: Zero point signal input Used for DOG type mechanical zero return operation
Group 1	Signal voltage	24 V DC (Power is supplied from S/S terminal.)
	Input current	7.0 mA
	ON current	4.5 mA or more
	OFF current	1.5 mA or less
	Signal form	No-voltage contact input Sink input: NPN open collector transistor Source input: PNP open collector transistor
	Response time	DOG input: 1 ms STOP input: 4 ms
	Circuit insulation	Photo-coupler insulation
	Operation display	LED ON at input ON
Group 2	Signal voltage	5 to 24 V DC
	Input current	20 mA or less
	ON current	4.0 mA or more
	OFF current	0.5 mA or less
	Signal form	NPN open collector transistor
	Response time	4 μ s or more
	Circuit insulation	Photo-coupler insulation
	Operation display	LED ON at input ON

2.4.2 Internal input circuit

For the internal input circuit diagram, refer to the following.

→ Refer to Section 5.1.

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2.5 Output Specifications

2.5.1 Output specifications

Item		Specification
Output signal name	Group 1	FP: Forward pulse or pulse train RP: Reverse pulse or direction signal
	Group 2	CLR: CLR signal
Group 1	Output form	Transistor
	Output system	Forward (FP) and reverse (RP) pulse or pulse (PLS) with direction (DIR) can be selected.
	Output frequency	1 Hz to 200 kHz
	Rated load voltage	5 to 24 V DC
	Max. load current	20 mA or less
	VIN current consumption	5 to 24 V DC 35 mA or less
	Output ON voltage	1.0 V or less
	Operation display	LED ON at output ON
Group 2	Output form	Transistor
	Output system	Pulse (Output pulse width: 20 ms)
	Rated load voltage	5 to 24 V DC
	Max. load current	20 mA or less
	Output ON voltage	1.5 V or less
	Operation display	LED ON at output ON

2.5.2 Internal output circuit

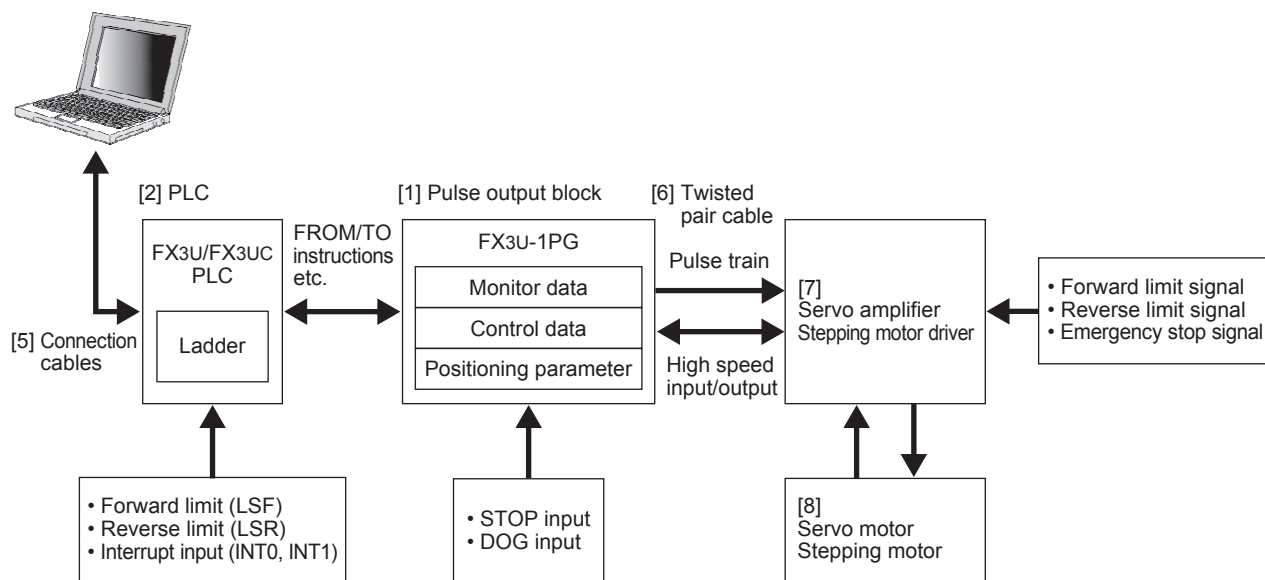
For the internal output circuit diagram, refer to the following.

→ Refer to Section 5.2.

3. System Configuration

3.1 General Configuration

- [3] PC software
- [4] Personal computer



Component list

Part name	Model name	Remarks
[1] Pulse output block	FX3U-1PG	-
[2] PLC	FX3U/FX3UC PLC	-
[3] PC software	GX Works2 GX Developer	PLC programming software.
[4] Personal computer	-	-
[5] Connection cable	FX-USB-AW	-
	F2-232CAB-1 FX-232AWC-H FX-422CAB0	-
	-	-
[6] Twisted pair cable	-	Use shielded twisted-pair cables for connecting cables.
[7] Servo amplifier Stepping motor driver	-	-
[8] Servo motor Stepping motor	-	-

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3.2 Applicable PLC

Model name	Applicability	Maximum number of connectable units
FX3U Series PLC	Ver. 2.20 and later	8 units
FX3UC Series PLC*1	Ver. 2.20 and later	6 units

The version number can be checked by reading the last three digits of device D8001/D8101.

*1. An FX2NC-CNV-IF or FX3UC-1PS-5V is necessary to connect the FX3U-1PG with the FX3UC PLC.

3.3 Connection with PLC

The FX3U-1PG connects to a PLC via an extension cable.

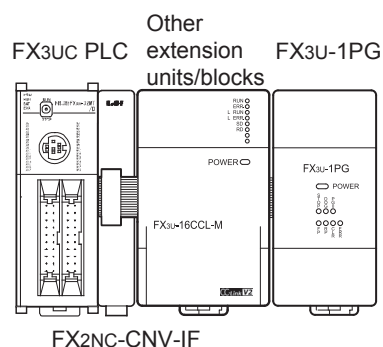
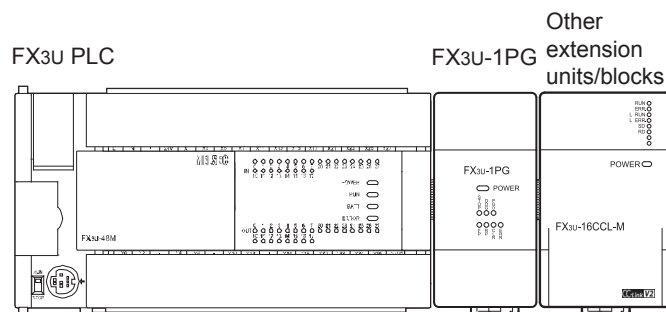
The FX3U-1PG is handled as a special extension block of the PLC. The unit number of the FX3U-1PG is automatically assigned No. 0 to No. 7 (Unit No. 1 to No. 7 is assigned when the main unit is an FX3UC-32MT-LT(-2).) starting from the special function unit/block closest to the PLC main unit.

(This unit number is used in FROM/TO instructions.)

For details on the assignment of the I/O number and unit number of the PLC, refer to the following manual corresponding to the connected PLC.

→ Refer to FX3U Hardware Edition.

→ Refer to FX3UC Hardware Edition.



- An FX2NC-CNV-IF or FX3UC-1PS-5V is necessary to connect the FX3U-1PG to the FX3UC PLC.
- For extension, the separately available FX0N-65EC/FX0N-30EC extension cable and FX2N-CNV-BC are used. One extension cable can be used per system.
- The number of I/O points occupied by the FX3U-1PG is eight. Make sure that the total number of I/O points (occupied I/O points) of the main unit, extension unit(s), extension block(s) and the number of points occupied by special function blocks does not exceed the maximum number of I/O points of the PLC.

For information on the maximum number of I/O points of the PLC, refer to the respective product manual.

→ Refer to FX3U Hardware Edition.

→ Refer to FX3UC Hardware Edition.

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4. Installation

INSTALLATION PRECAUTIONS		WARNING
<ul style="list-style-type: none"> Make sure to cut off all phases of the power supply externally before attempting installation work. Failure to do so may cause electric shock or damage to the product. 		

INSTALLATION PRECAUTIONS		CAUTION
<ul style="list-style-type: none"> Use the product within the generic environment specifications described in PLC main unit manual (Hardware Edition). Never use the product in areas with excessive dust, oily smoke, conductive dusts, corrosive gas (salt air, Cl2, H2S, SO2, or NO2), flammable gas, vibration or impacts, or expose it to high temperature, condensation, or rain and wind. If the product is used in such conditions, electric shock, fire, malfunctions, deterioration or damage may occur. Do not touch the conductive parts of the product directly. Doing so may cause device failures or malfunctions. Install the product securely using a DIN rail or mounting screws. Install the product on a flat surface. If the mounting surface is rough, undue force will be applied to the PC board, thereby causing nonconformities. When drilling screw holes or wiring, make sure that cutting and wiring debris do not enter the ventilation slits. Failure to do so may cause fire, equipment failures or malfunctions. Be sure to remove the dust proof sheet from the PLC's ventilation slits when installation work is completed. Failure to do so may cause fire, equipment failures or malfunctions. Make sure to attach the top cover, offered as an accessory, before turning on the power or initiating operation after installation or wiring work. Failure to do so may cause electric shock. Connect extension cables securely to their designated connectors. Loose connections may cause malfunctions. 		

Only one FX3U-1PG unit can be connected to the right side of the main unit, extension unit or extension block. To connect to an FX3UC PLC or FX2NC PLC extension block, the FX2NC-CNV-IF or FX3UC-1PS-5V is necessary. For details, refer to the respective PLC manual.

→ Refer to FX3u Hardware Edition.

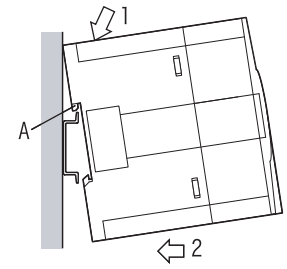
→ Refer to FX3uc Hardware Edition.

The FX3U-1PG may be installed in a control cabinet with a 35 mm wide DIN46277 DIN rail mounting or M4 screw direct mounting.

4.1 DIN rail Mounting

The product may be mounted on a 35 mm wide DIN46277 (DIN rail).

- 1 Fit the upper edge (A in the figure to the right) of the DIN rail mounting groove onto the DIN rail.
- 2 Push the product onto the DIN rail.



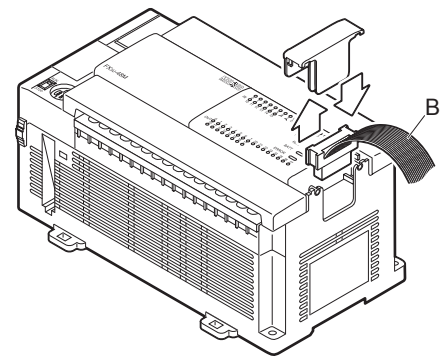
- An interval space of 1 to 2 mm (0.04" to 0.08") between each unit is necessary.

- 3 Connect the extension cable.

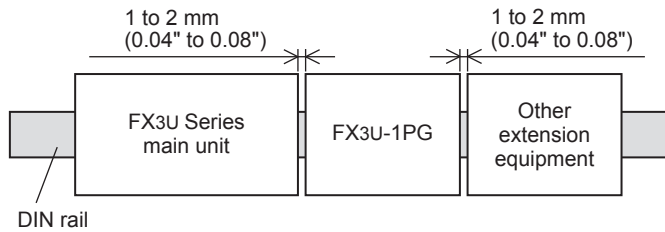
Connect the extension cable (B in the figure to the right) to the main unit, I/O extension unit/block or special function unit/block on the left side of the product.

For information on the extension cable connection procedure, refer to the respective product PLC manual.

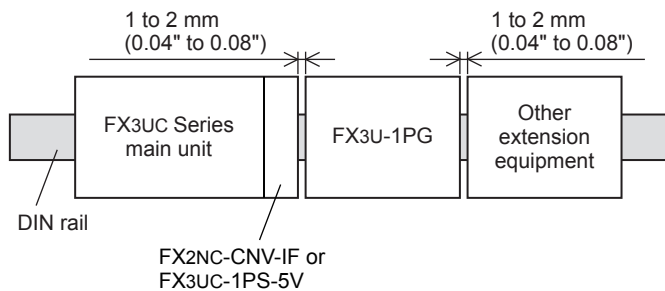
- Refer to FX3u Hardware Edition.
- Refer to FX3uc Hardware Edition.



- Example of installation on DIN rail
 - In the case of the FX3U PLC



- In the case of the FX3UC PLC



4.2 Direct Mounting

The product can be installed directly with screws.
An interval space of 1 to 2 mm (0.04" to 0.08") between each unit is necessary.
For installation details, refer to the following respective PLC manual.

→ For mounting hole pitches, refer to Section 1.2.
→ Refer to FX3U Hardware Edition.
→ Refer to FX3UC Hardware Edition.

1 Create mounting holes in the mounting surface according to the external dimensions diagram.

2 Fit the FX3U-1PG (A in the figure to the right) to the mounting holes and tighten with M4 screws (B in the figure to the right).

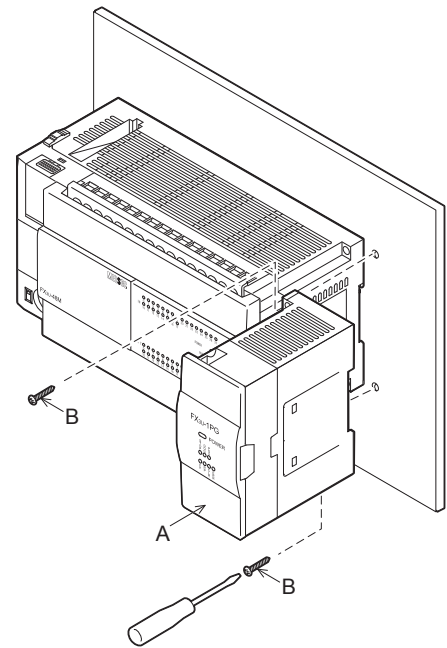
For the screw position and quantity, refer to the dimensioned drawing specified below.
→ For dimensions, refer to Section 1.2.

3 Connect the extension cable.

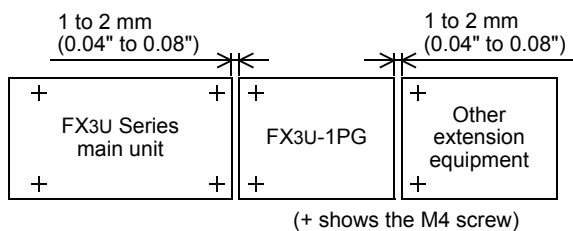
Connect the extension cable to the main unit, I/O extension unit/block or special function unit/block on the left side of the product.

(Refer to Step 3 in Section 4.1.)

For information on the extension cable connection procedure, refer to the respective PLC manual.
→ Refer to FX3U Hardware Edition.
→ Refer to FX3UC Hardware Edition.



- Example of direct installation



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5. Wiring

WIRING PRECAUTIONS



WARNING

- Make sure to cut off all phases of the power supply externally before attempting wiring work. Failure to do so may cause electric shock or damage to the product.

WIRING PRECAUTIONS



CAUTION

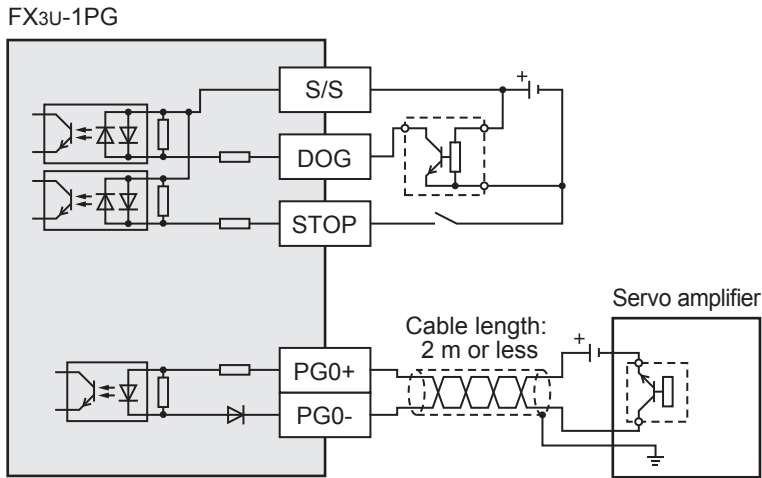
- Connect the DC power supply wiring to the dedicated terminal described in this manual.
If an AC power supply is connected to a DC input/output terminal or DC power supply terminal, the PLC will burn out.
- Make sure to attach the top cover, offered as an accessory, before turning on the power or initiating operation after installation or wiring work.
Failure to do so may cause electric shock.
- When drilling screw holes or wiring, make sure that cutting and wiring debris do not enter the ventilation slits.
Failure to do so may cause fire, equipment failures or malfunctions.
- Make sure to properly wire the extension equipment in accordance with the following precautions.
Failure to do so may cause electric shock, equipment failures, a short-circuit, wire breakage, malfunctions, or damage to the product.
 - The disposal size of the cable end should follow the dimensions described in the manual.
 - Tightening torque should follow the specifications in the manual.

This chapter explains the wiring for input/output.

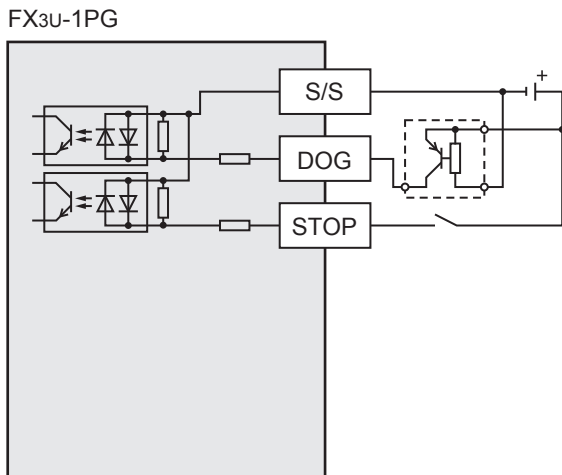
For examples of connection to servo amplifier and stepping motor driver, refer to Appendix B.

5.1 Input Wiring

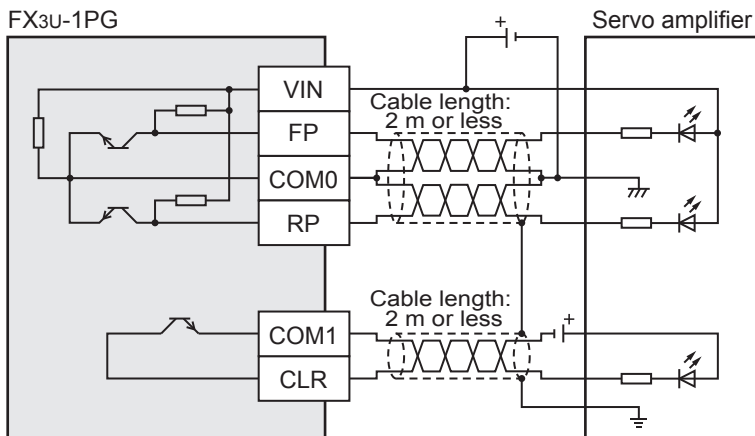
5.1.1 Sink input wiring



5.1.2 Source input wiring



5.2 Output Wiring



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5.3 Wiring Precautions

- 1) The power supply used for FP, RP, PG0, and CLR should be separate from the power supply used for the other signals.
- 2) In an environment with a lot of noise, when malfunctions such as position gap occur, the influence of noise may be mitigated with the following measures.
 - Attach a noise filter (TDK-Lambda Corp. MXB-1210-33 or similar) on the FX3U-1PG power supply line, one on the end nearest the servo amplifier, and one on the end nearest the power supply unit.
 - Attach a ferrite core (TDK Corp. ZCAT3035-1330 or similar) to the VIN, FP, RP, PG0, and CLR signal wires, on the end nearest the servo amplifier.

5.4 Grounding

Ground the cables as follows.

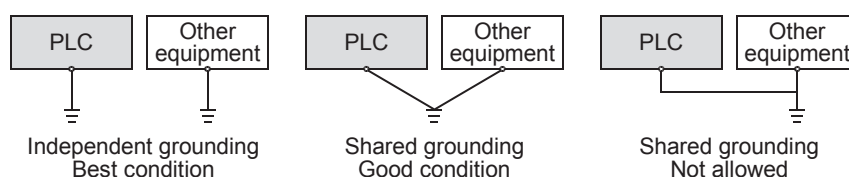
- The grounding resistance should be 100 Ω or less.
- Independent grounding should be established whenever possible.

Independent grounding should be performed for best results.

When independent grounding is not configured, perform "shared grounding" as shown in the following figure.

For details, refer to the respective PLC manual.

→ Refer to FX3U Hardware Edition.
→ Refer to FX3UC Hardware Edition.



- The grounding point should be close to the PLC, and all grounding wires should be as short as possible.

5.5 Screw Size and Tightening Torque

5.5.1 Terminal screw size and tightening torque

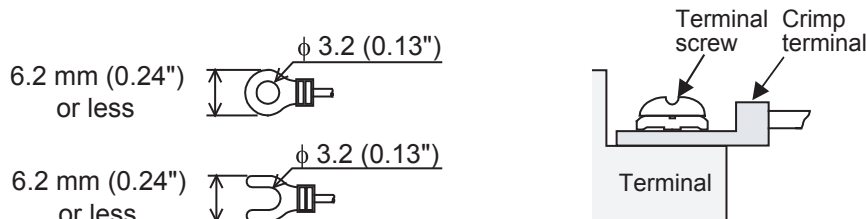
The terminals on the FX3U-1PG use M3 screws.

Refer to the figures below for cable end treatment.

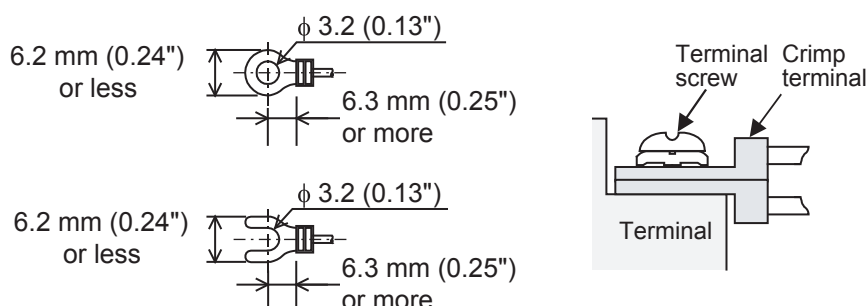
Set the tightening torque to 0.5 to 0.8 N•m.

Do not tighten terminal screws with a torque outside the above-mentioned range. Failure to do so may cause equipment failures or malfunctions.


- When one wire is connected to one terminal




- When two wires are connected to one terminal



6. Before Starting Positioning Operation

DESIGN PRECAUTIONS	 WARNING
<ul style="list-style-type: none"> • Make sure to have the following safety circuits outside of the PLC to ensure safe system operation even during external power supply problems or PLC failure. Otherwise, malfunctions may cause serious accidents. <ol style="list-style-type: none"> 1) Most importantly, have the following: an emergency stop circuit, a protection circuit, an interlock circuit for opposite movements (such as normal vs. reverse rotation), and an interlock circuit (to prevent damage to the equipment at the upper and lower positioning limits). 2) Note that when the PLC CPU detects an error, such as a watchdog timer error, during self-diagnosis, all outputs are turned off. Also, when an error that cannot be detected by the PLC CPU occurs in an input/output control block, output control may be disabled. External circuits and mechanisms should be designed to ensure safe machinery operation in such a case. 3) Note that when an error occurs in a relay, triac or transistor output device, the output could be held either on or off. For output signals that may lead to serious accidents, external circuits and mechanisms should be designed to ensure safe machinery operation in such a case. 	

DESIGN PRECAUTIONS	 CAUTION
<ul style="list-style-type: none"> • Make sure to observe the following precautions in order to prevent any damage to the machinery or accidents due to abnormal data written to the PLC under the influence of noise: <ol style="list-style-type: none"> 1) Do not bundle the main circuit line together with or lay it close to the main circuit, high-voltage line or load line. Otherwise, noise disturbance and/or surge induction are likely to take place. As a guideline, lay the control line at least 100mm (3.94") or more away from the main circuit or high-voltage lines. 2) Ground the shield wire or shield of a shielded cable. Do not use common grounding with heavy electrical systems. • Install module so that excessive force will not be applied to the terminal blocks. Failure to do so may result in wire damage/breakage or PLC failure. 	

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6.1 Various Positioning Operation and Buffer Memory Setting

Setting items of the buffer memory in each operation mode are as follows.

Setting of the positioning parameter selection (BFM#32) determines whether the positioning parameter is used or the extension positioning parameter is used.

For details on the positioning operations and the buffer memory, refer to the following sections.

→ For details on the buffer memory, refer to the Chapter 7.

→ For details on the JOG operation and mechanical zero return operation, refer to the Chapter 8.

→ For details on the positioning operation, refer to the Chapter 9.

BFM No.		Setting items	Operation mode									
Positioning parameter	Extension positioning parameter		JOG operation	DOG type mechanical zero return operation	Data-set type mechanical zero return operation	1-speed positioning operation	Interrupt 1-speed positioning operation	2-speed positioning operation	External command positioning operation	Variable speed operation	Interrupt stop operation	Interrupt 2-speed positioning operation
#0	#34, #33	Pulse rate	Required for machine system and combined system of units.									
#2, #1	#36, #35	Feed rate										
#3	#37	Operation parameter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
#5, #4	#39, #38	Maximum speed	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
#6	#41, #40	Bias speed	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
#8, #7	#43, #42	JOG speed	✓	-	-	-	-	-	-	-	-	-
#10, #9	#45, #44	Zero return speed (high speed)	-	✓	-	-	-	-	-	-	-	-
#11	#47, #46	Zero return speed (creep)	-	✓	-	-	-	-	-	-	-	-
#12	#48	Number of zero-point signal for zero return	-	✓	-	-	-	-	-	-	-	-
#14, #13	#50, #49	Zero-point address	-	✓	✓	-	-	-	-	-	-	-
#15	-	Acceleration/deceleration time	✓	✓	-	✓	✓	✓	✓	□	✓	✓
-	#51	Acceleration time	✓	✓	-	✓	✓	✓	✓	□	✓	✓
-	#52	Deceleration time	✓	✓	-	✓	✓	✓	✓	□	✓	✓
#16		Starting delay time	-	-	-	✓	✓	✓	✓	✓	✓	✓
#18, #17		Target address I	-	-	-	✓	✓	✓	-	-	✓	✓
#20, #19		Operation speed I	-	-	-	✓	✓	✓	✓	✓	✓	✓
#22, #21		Target address II	-	-	-	-	-	✓	-	-	-	-
#24, #23		Operation speed II	-	-	-	-	-	✓	✓	-	-	✓
#25		Operation command	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
#32		Positioning parameter selection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
#54, #53		Target address change value	-	-	-	△	△	△	-	-	△	△
#56, #55		Operation speed change value	△	△	-	△	△	△	△	-	△	△
#57		Operation command II	-	-	-	-	☆	-	☆	-	☆	☆

✓: Setting items necessary for operation

△: Setting items necessary to change operation speed and target address during the operation

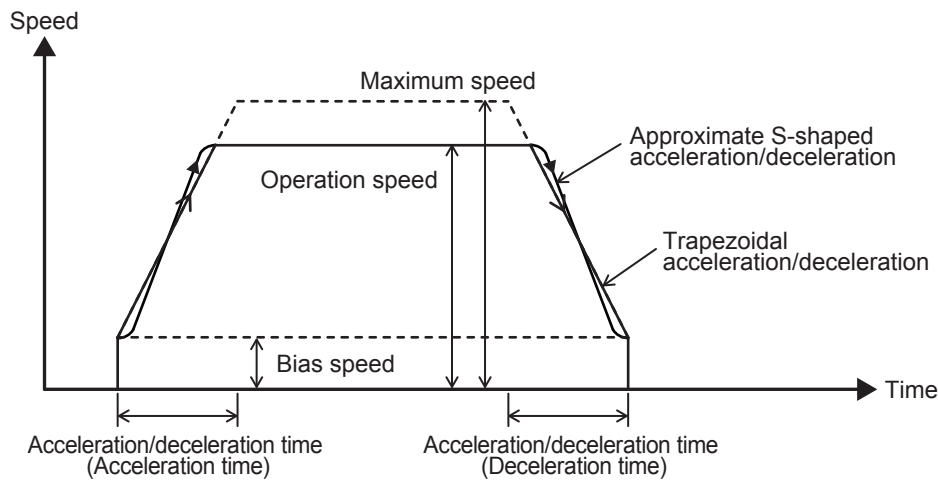
□: Setting items necessary for variable speed operation with acceleration/deceleration

☆: Setting items necessary for interrupt input via PLC

-: Setting not necessary

6.2 Outline of Positioning Operation

The relationship between the operation speed, acceleration/deceleration time and travel distance of the positioning operation is shown below.



Item	BFM No.		Content	
	Positioning parameter	Extension positioning parameter		
Maximum speed	#5, #4	#39, #38	Upper speed limit in each operation mode.	
Bias speed	#6	#41, #40	Lower speed limit in each operation mode.	
Operation speed	Operation speed I	#20, #19	Operation speed in each operation mode.	
	Operation speed II	#24, #23	Operation speed for 2-speed positioning operation, external command positioning operation and Interrupt 2-speed positioning operation.	
Acceleration/deceleration time	Acceleration/deceleration time	#15	-	Time needed to reach the maximum speed from bias speed (bias speed from the maximum speed).
	Acceleration time	-	#51	Time needed to reach the maximum speed from bias speed.
	Deceleration time	-	#52	Time needed to reach bias speed from the maximum speed.
Acceleration/deceleration mode (Operation parameter)	#3 b6	#37 b6	Selection of a control method at the time of acceleration/deceleration. OFF: Operates in the trapezoidal acceleration/deceleration ON: Operates in the approximate S-shaped acceleration/deceleration	
Travel distance	Target address I	#18, #17	Target position (absolute address) or travel distance (relative address) in each positioning operation.	
	Target address II	#22, #21	Target position (absolute address) or travel distance (relative address) for 2-speed positioning operation.	

Point

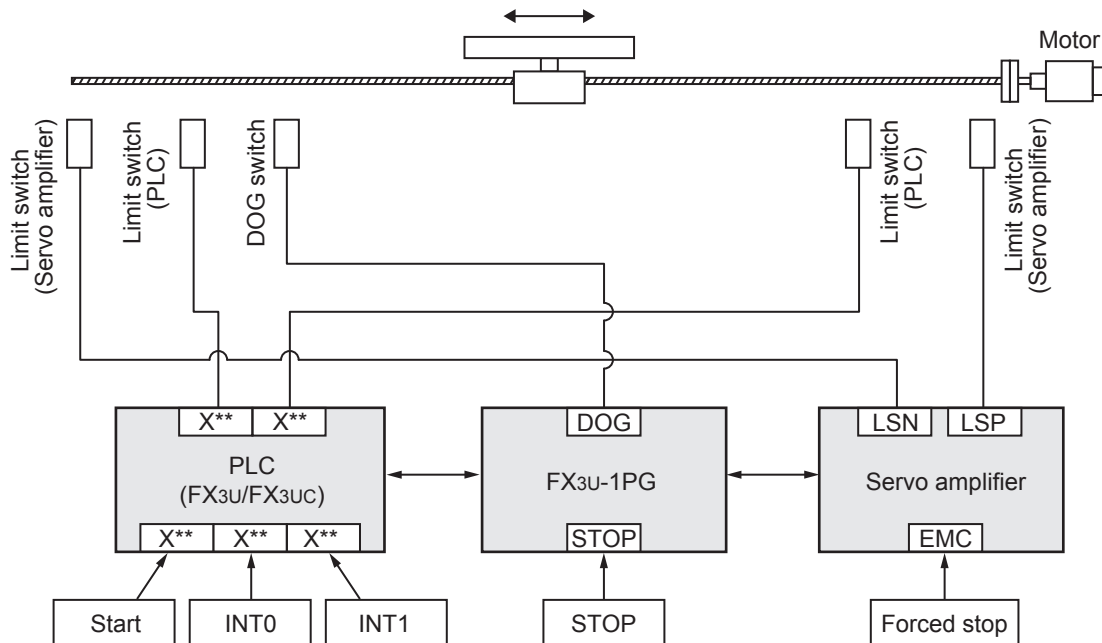
- Setting of the positioning parameter selection (BFM#32) determines whether the positioning parameter is used or the extension positioning parameter is used. Set the buffer memories that correspond to the selected positioning parameter.
- The gradient of acceleration/deceleration is determined by the maximum speed, bias speed, acceleration time and deceleration time.
- Set the acceleration/deceleration time for approximate S-shaped acceleration/deceleration within the range from 1 ms to 5000 ms.
- When the operation speed I, operation speed II, JOG speed, zero return speed (high speed), and zero return speed (creep) is at the bias speed or slower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the operation speed I, operation speed II, JOG speed, zero return speed (high speed), and zero return speed (creep) is at the maximum speed or faster, the operation is executed at the maximum speed.

6.3 System Wiring

6.3.1 System wiring example

Set the system wiring of the FX3U/FX3UC series PLC, FX3U-1PG, and the servo amplifier as below.

System wiring example



- Wire the limit switches to the PLC and the servo amplifier, with the inner limit switch connected to the PLC and the outer limit switch connected to the servo amplifier.
- Wire the Forced stop signal to the servo amplifier.
- Wire the DOG switch to the FX3U-1PG.
- Wire the Start signal for the positioning operation to the PLC.
- Wire the STOP signal for the positioning operation to the PLC or to the FX3U-1PG.
- Wire the INT0 (interrupt input 0) and the INT1 (interrupt input 1) for the positioning operation to the PLC.

6.3.2 For DOG terminal, STOP terminal

In each operation mode, various inputs are connected to the DOG terminal and the STOP terminal.

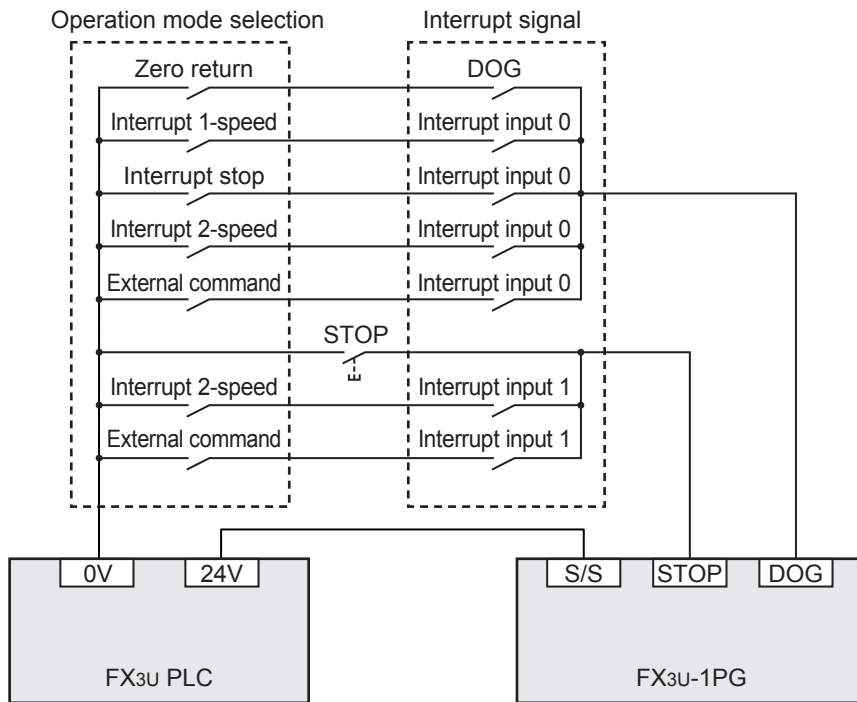
The DOG terminal is used for the DOG input for the mechanical zero return operation, and for the interrupt input 0 for the external command positioning operation, the interrupt 1-speed positioning operation, the interrupt stop operation, and the interrupt 2-speed positioning operation.

The STOP terminal is used for the decelerate stop input, the external command positioning operation, and the interrupt input 1 for the interrupt 2-speed positioning operation. In addition, ON/OFF polarities of these inputs invert depending on the setting of the DOG input polarity (b12) and the STOP input polarity (b14) of BFM#3/BFM#37.

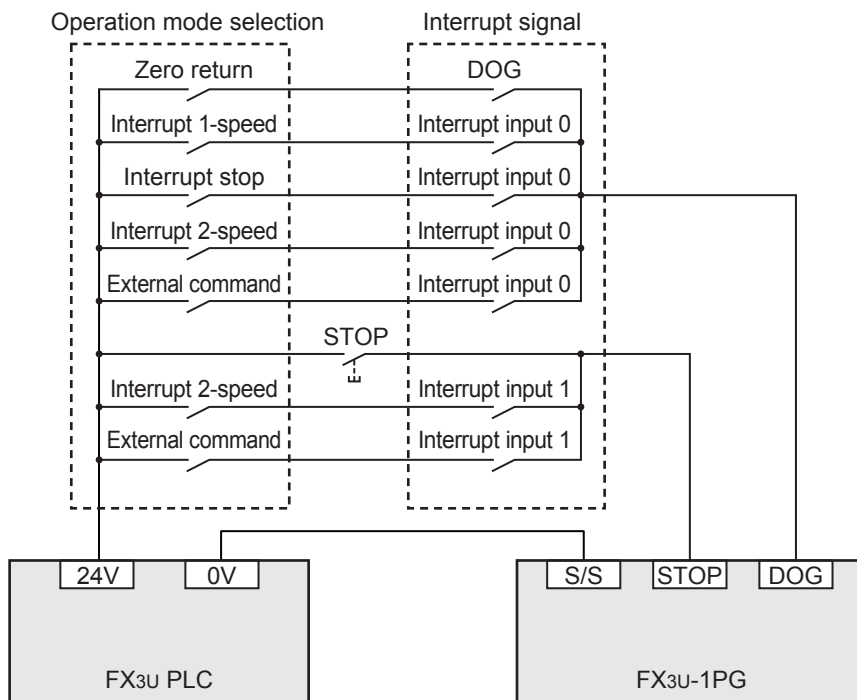
Examples of connections which express the above description are shown below.

Operation mode selection indicates the operation mode to be used. Interrupt signal indicates the signals used in the given operation mode.

- When a normally opened contact is used in the BFM#3 (b14=0, b12=0) and BFM#37 (b14=0, b12=0)
 - In case of sink input

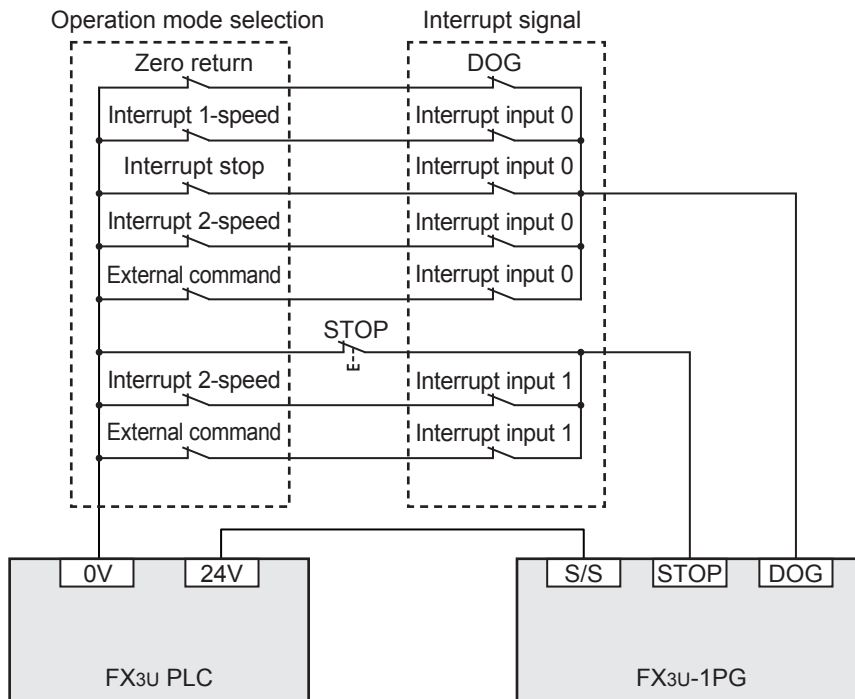


- In case of source input

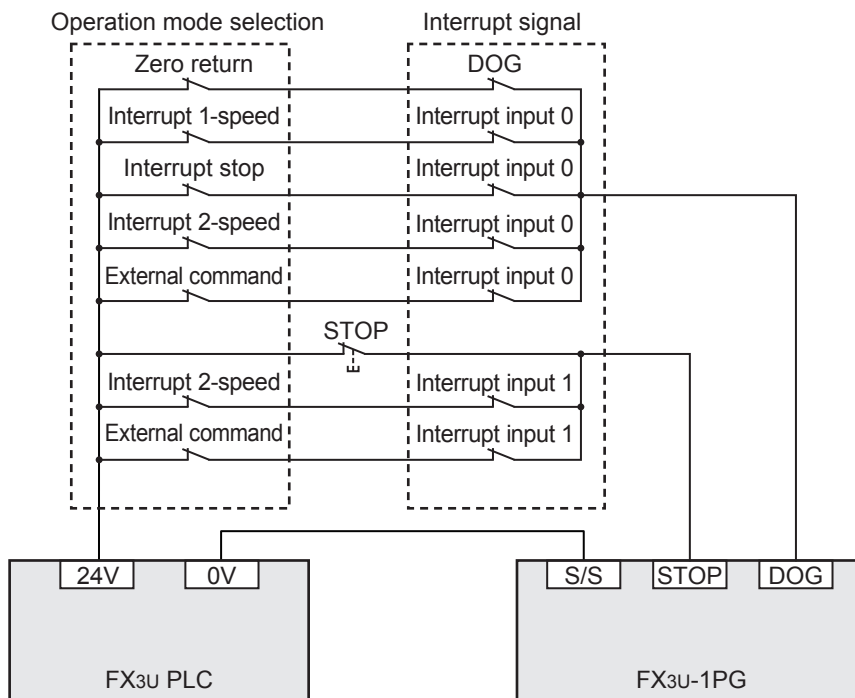


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- When a normally closed contact is used in the BFM#3 (b14=1, b12=1) and BFM#37 (b14=1, b12=1)
 - In case of sink input



- In case of source input



- Response times when using the STOP or DOG terminal as an interrupt input
 - For STOP terminal
 - During operation at 1 kHz or higher: within 6 ms
 - During operation at less than 1 kHz: within 6 pulses
 - For DOG terminal
 - During operation at 1 kHz or higher: within 3 ms
 - During operation at less than 1 kHz: within 3 pulses

6.3.3 Interrupt input via PLC (BFM)

In the interrupt 1-speed positioning operation, the interrupt stop operation, the interrupt 2-speed positioning operation, and the external command positioning operation, interrupt input (INT0, INT1) via PLC (BFM) can be used.

When interrupt input via PLC (BFM) is used, select a terminal to be used for the interrupt input in the interrupt input setting BFM#3 (b3, b2), BFM#37 (b3, b2) and turn on operation command II BFM#57 (b1, b0) by the PLC input.

Interrupt input setting [BFM#3 (b3, b2), BFM#37 (b3, b2)]

BFM#3 or BFM#37		Interrupt input 0	Interrupt input 1	Content
b3	b2			
0	0	DOG	STOP	The DOG terminal is used for interrupt input 0. The STOP terminal is used for interrupt input 1.
0	1	DOG	INT1	The DOG terminal is used for the interrupt input 0. Interrupt input 1 (INT1) via PLC is used for interrupt input 1.
1	0	INT0	STOP	Interrupt input 0 (INT0) via PLC is used for interrupt input 0. The STOP terminal is used for interrupt input 1.
1	1	INT0	INT1	Interrupt input 0 (INT0) via PLC is used for interrupt input 0. Interrupt input 1 (INT1) via PLC is used for interrupt input 1.

Point

Interrupt input via PLC (BFM) will be used for INT0 and INT1.

The DOG terminal and STOP terminal of the FX3U-1PG are used for DOG and STOP.

Operation command II (BFM#57)

BFM No.		Item	Content
#57	b0	INT0	The interrupt input is executed via the PLC (BFM). The INT0 turns to ON when b0 = ON.
	b1	INT1	The interrupt input is executed via the PLC (BFM). The INT1 turns to ON when b1 = ON.

Point

Connect and link an arbitrary input of the PLC (X000, X001, etc.) to the INT0 (b0), INT1 (b1) of the operation command II (BFM#57).

Response time

Response time of INT0, INT1 is as follows.

- During operation at 1 kHz or higher: within 3 ms
- During operation at less than 1 kHz: within 3 pulses

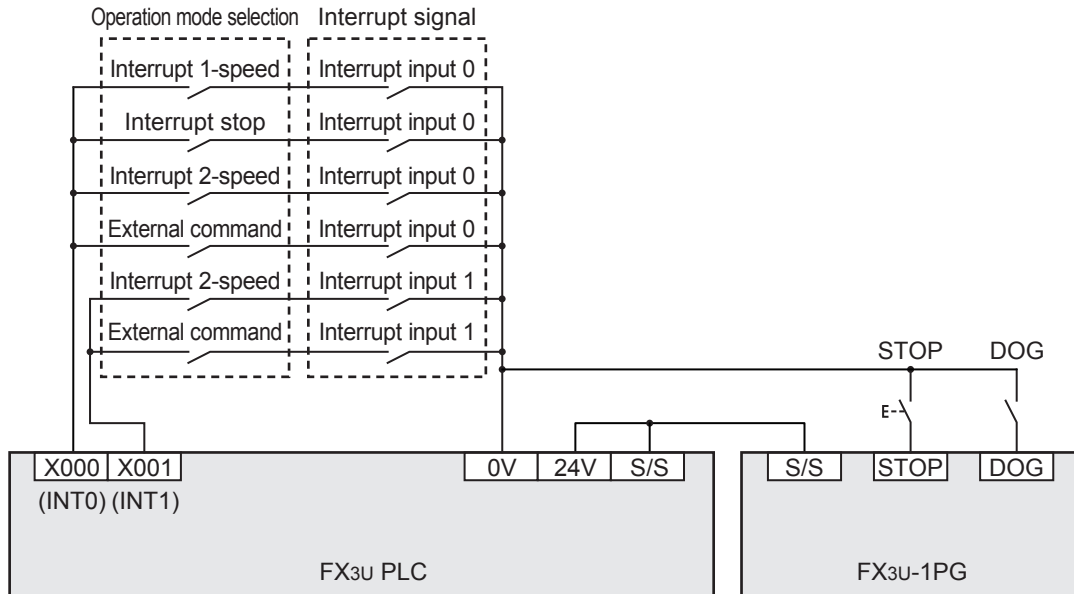
Caution of interrupt input is used

When both INT0 and INT1 are set to ON at the same time in the external command positioning or interrupt 2-speed positioning, INT0 is effective.

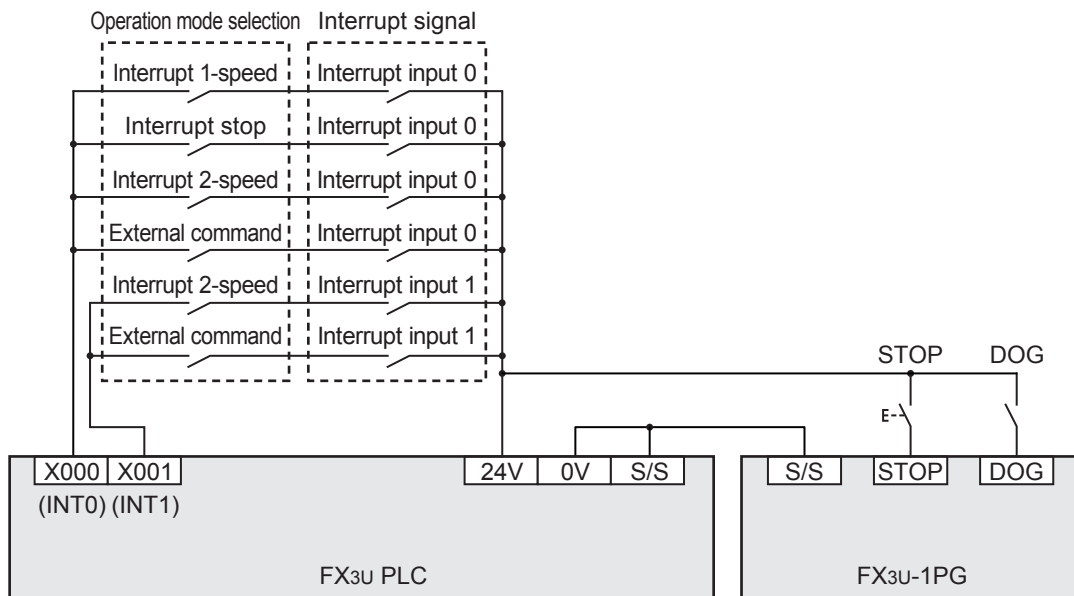
A connection example of interrupt input via PLC (BFM) is shown below.

Operation mode selection indicates the operation mode to be used. Interrupt signal indicates the signals used in the given operation mode. INT0, INT1 is connected to X000, X001 of the FX3U PLC.

- When interrupt input via PLC (BFM) is used
 - When interrupt input via PLC (BFM) is used, BFM#3 (b3=1, b2=1) and BFM#37 (b3=1, b2=1)
 - In case of sink input

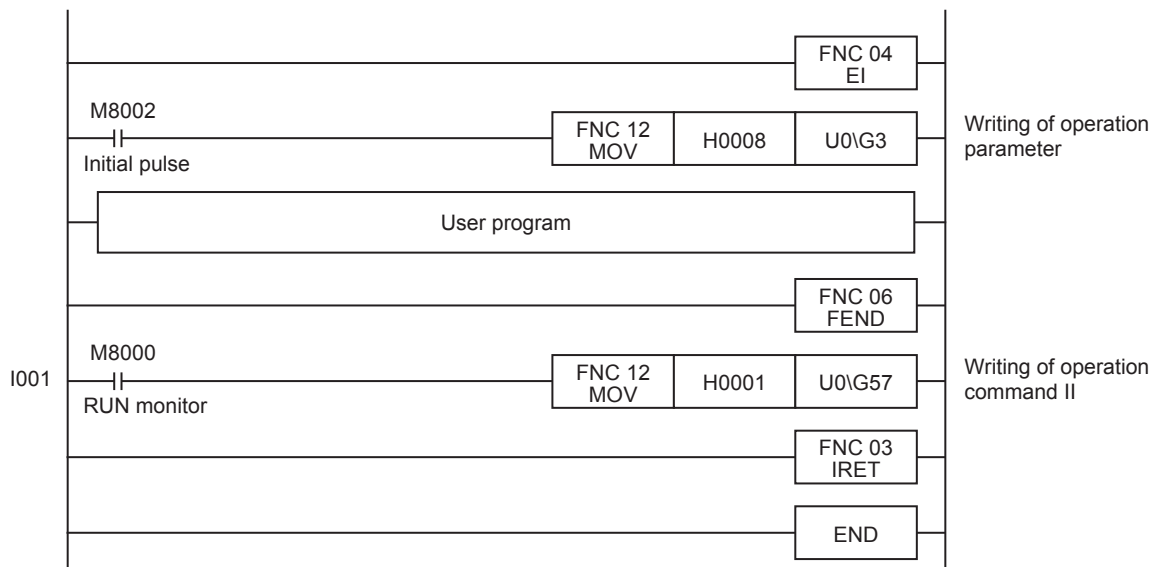


- In case of source input



Program description example

The following program is the example of a program which uses interrupt input via PLC (BFM). X000 of the PLC is used as interrupt input 0 (INT0). Interrupt input 0 (INT0) turns ON, at the rising edge of X000.

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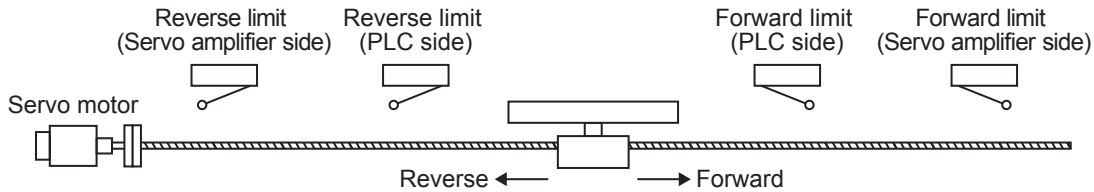
Program Example

6.4 Handling the Forward Limit and Reverse Limit

6.4.1 Handling the forward limit and reverse limit

The FX3U-1PG does not have a terminal for connecting the forward or reverse limit switch. Connect the limit switch to the PLC and turn on/off the forward limit (BFM#25 b2) or the reverse limit (BFM#25 b3) at each input.

Set the forward/reverse limit switches at the servo amplifier side as well as the PLC side for safety. At this time, the limit switch at the PLC side reacts a little earlier than the limit switch at the servo amplifier side.



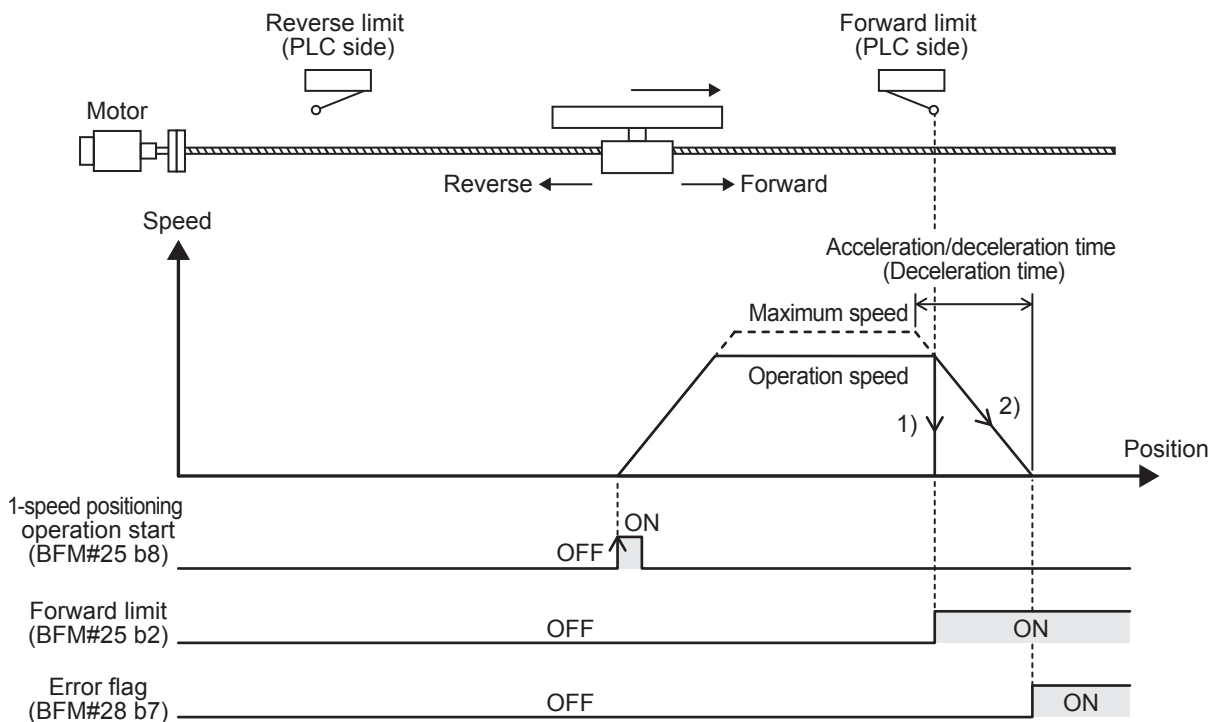
Point

- The stepping motor driver does not have terminals for connecting limit switches. Connect limit switches to the PLC.
- Do not use the forward limit/reverse limit for any purposes other than limiting.

6.4.2 Operations at forward limit/reverse limit

Operations when the forward limit/reverse limit is turned on change depending on the setting of the limit deceleration mode (BFM#3 b11/BFM#37 b11).

- Operation when the limit deceleration mode is OFF (Refer to Fig. 1 below.)
When the forward limit/reverse limit in the operating direction turns on during operation, the forward pulse/reverse pulse is immediately stopped, and the CLR signal is output. (The output pulse width of the CLR signal is 20 ms.)
- Operation when the limit deceleration mode is ON (Refer to Fig. 2 below.)
When the forward limit/reverse limit in the operating direction turns on during operation, the operation decelerates and stops. The CLR signal is not output. In addition, at this time, the acceleration/deceleration time (BFM#15) or the deceleration time (BFM#52) is applied for the deceleration time.



6.4.3 Restarting method after the forward limit/reverse limit operation

When the forward limit/reverse limit in the operation direction turns on during operation, the forward limit and reverse limit error is output (error code: K6). Moving to the activated forward limit/reverse limit direction cannot be executed.

Use the JOG operation in opposite direction to avoid the limit error. At that time, forward limit/reverse limit error is also reset. In addition, it is also possible to avoid the limit error by using the positioning operation in the opposite direction of the forward limit/reverse limit after resetting the error.

6.5 Handling the STOP Command

6.5.1 Operation by the STOP command

The STOP command in any positioning operation is always valid. Deceleration stop or immediate stop by input from the STOP terminal or input (BFM#25 b1) from the BFM is possible. (Refer to the following table.) However, if the STOP command is input during the deceleration stop of a positioning operation, the STOP command is ignored. The positioning completion flag turns on.

Operation mode	Stop operation
Variable speed operation (Without acceleration/deceleration)	Immediate stop
Data-set type mechanical zero return	Ignore
Any other operation	Deceleration stop

When the input from the STOP terminal is set to interrupt input 1 by the operation parameter (BFM#3 b3, b2 or BFM#37 b3, b2), operation varies depending on the operation mode.

- External command positioning operation or interrupt 2-speed positioning operation
The input from the STOP terminal functions as an interrupt input.
→ **For the external command positioning operation, refer to Section 9.5.**
→ **For the interrupt 2-speed positioning operation, refer to Section 9.8.**
- In any operation other than the external command positioning operation or interrupt 2-speed positioning operation
The input from the STOP terminal functions as the STOP input.

In case of input from the STOP terminal, the operation varies depending on the setting of the STOP input polarity (BFM#3 b14 or BFM#37 b14).

- When STOP input polarity = 0: Input is ON, STOP becomes valid.
- When STOP input polarity = 1: Input is OFF, STOP becomes valid.

In case of input from the BFM, STOP becomes valid when BFM#25 b1 is ON.

Point

When input from the STOP terminal is used as interrupt input 1, the external command positioning operation and the interrupt 2-speed positioning operation become different from other positioning operations.

6.5.2 Remaining distance operation

When the STOP command is used to stop the positioning operation, the restart operation changes depending on the STOP input mode (BFM#3 b15 or BFM#37 b15) setting.

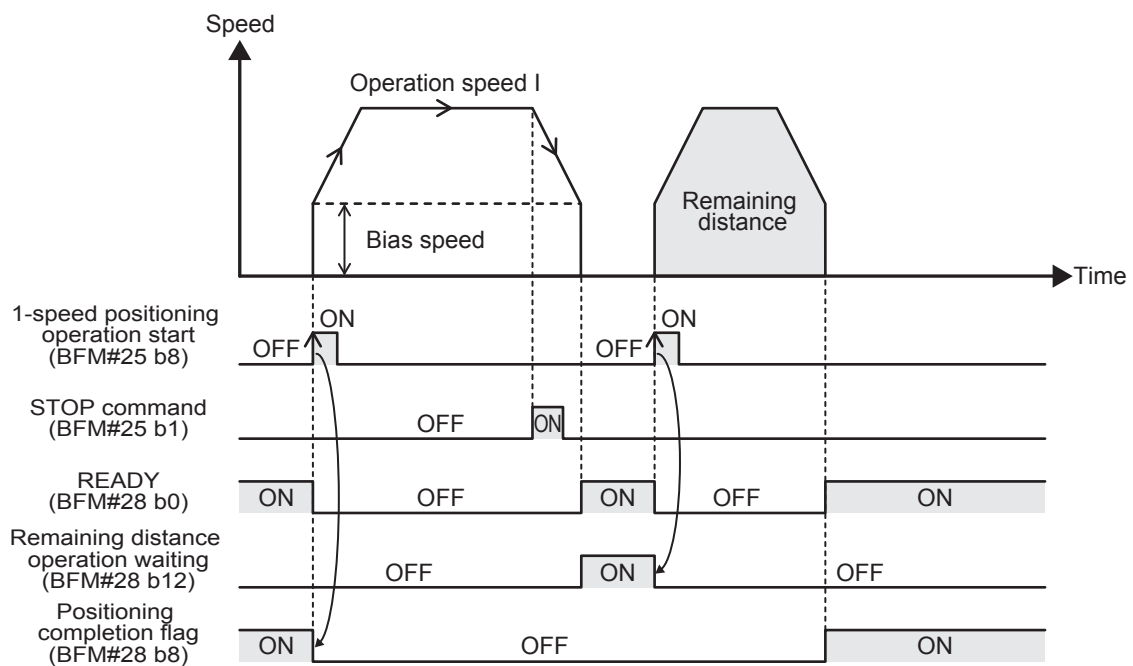
When the STOP input mode is OFF, the remaining distance operation is executed by the restart command. After the positioning operation completes, the positioning completion flag turns ON.

When the STOP input mode is ON, the remaining distance operation is not executed, and the positioning ends at the stop position. The positioning completion flag remains off.

1. Positioning operations where remaining distance operation is possible

Operations applicable to the remaining distance operation	Operations not applicable to the remaining distance operation
1-speed positioning operation	JOG operation
2-speed positioning operation	DOG type mechanical zero return (high speed)
Interrupt stop operation	DOG type mechanical zero return (creep)
-	Data-set type mechanical zero return
-	Interrupt 1-speed positioning operation
-	External command positioning operation
-	Variable speed operation
-	Interrupt 2-speed positioning operation

2. Operation

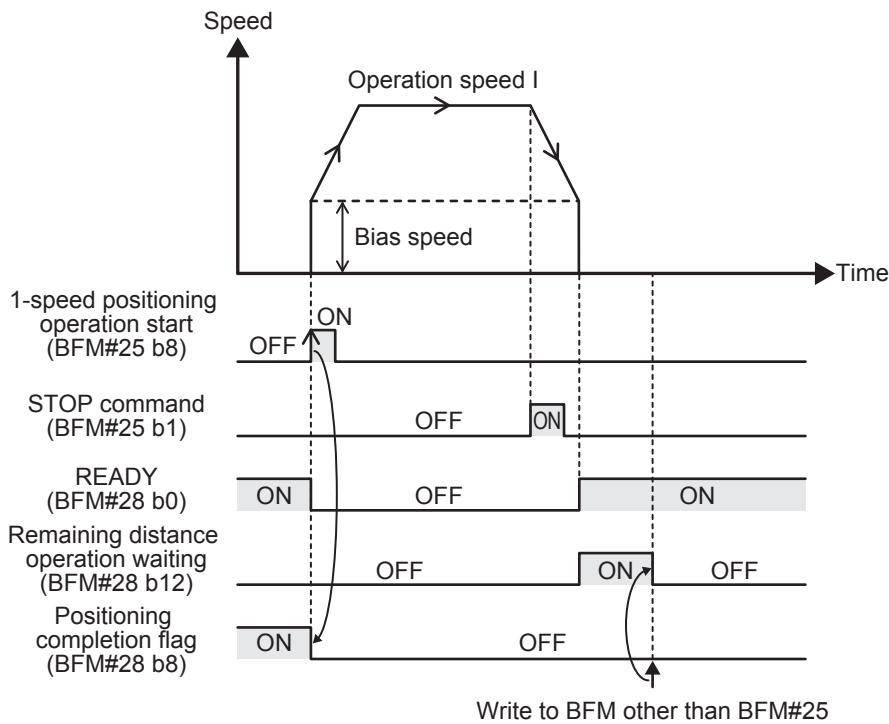


Cancelling the remaining distance operation

The following operation cancels the remaining distance operation. When the remaining distance operation is cancelled, the positioning completion flag remains off.

- When the start command of a different operation command is turned on during remaining distance operation waiting, the remaining distance operation is cancelled, and the command input later starts the operation.
In addition, even in the same operation command, when an operation is started by switching the address specification method (relative/absolute), the remaining distance operation is cancelled, and the operation starts with the newly set address specification method.
- When a write operation is executed to a buffer memory other than BFM#25 during the remaining distance operation waiting, the remaining distance operation is cancelled, and the operation ends.

Operation during cancellation of the remaining distance operation



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6.6 Operation Speed Change Function

This function changes the speed of the positioning operation to the specified speed. When starting the positioning operation, the value of the operation speed I (BFM#20, #19) is written to the operation speed change value (BFM#56, #55). Then, when a new value is written to the operation speed change value, the operation speed changes. When the 2-speed is changed in the 2-speed positioning operation, interrupt 2-speed positioning operation and external command positioning operation, the value of the operation speed II (BFM#24, #23) is written to the operation speed change value after the operation at the first speed is completed. Then, when a new value is written to the operation speed change value, the operation speed changes.

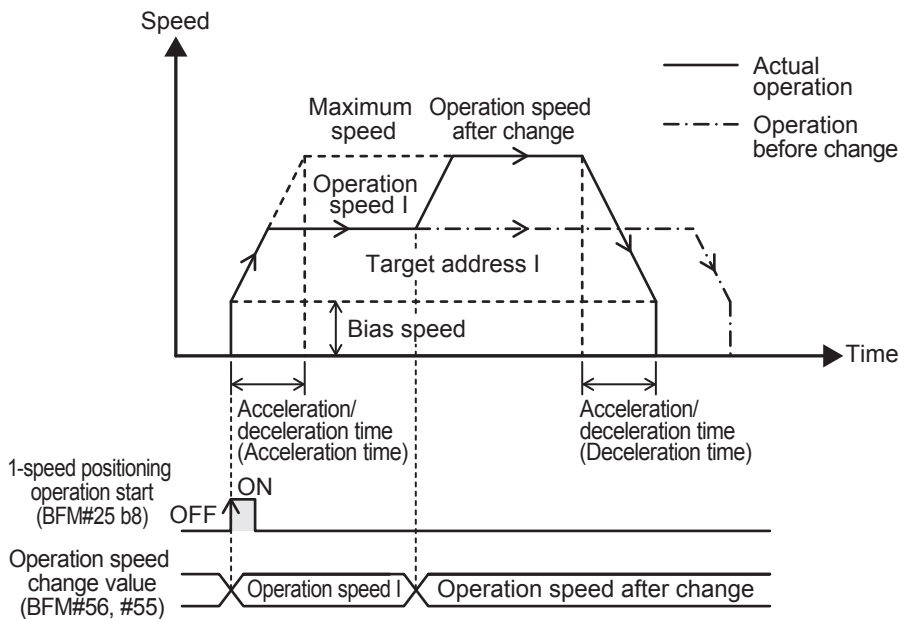
Point

- Even when a value is written to the operation speed change value, the operation speed I and the operation speed II values do not change.
- In case of positioning operations for which the operation speed change function is invalid, the operation speed is not written to the operation speed change value. The operation speed change value remains as what was written for the last time.
- When the operation is stopped by the STOP command and the remaining distance operation is executed after the operation speed is changed, operation resumes with the changed speed.

1. Positioning operations for which operation speed change function can be used

Operations applicable to the operation speed change function	Operations not applicable to the operation speed change function
JOG operation	DOG type mechanical zero return (creep)
DOG type mechanical zero return (high speed)	Data-set type mechanical zero return
1-speed positioning operation	Variable speed operation
Interrupt 1-speed positioning operation	-
2-speed positioning operation	-
External command positioning operation	-
Interrupt stop operation	-
Interrupt 2-speed positioning operation	-

2. Operation



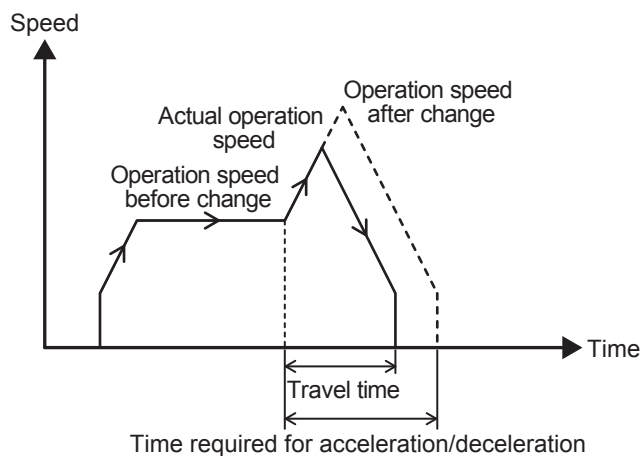
3. Update time for the operation speed change value

After the operation speed change value is updated, the time required until the operation speed changes is as follows.

- During operation at 1 kHz or higher: Within 3 ms
- During operation at less than 1 kHz: Within 3 pulses

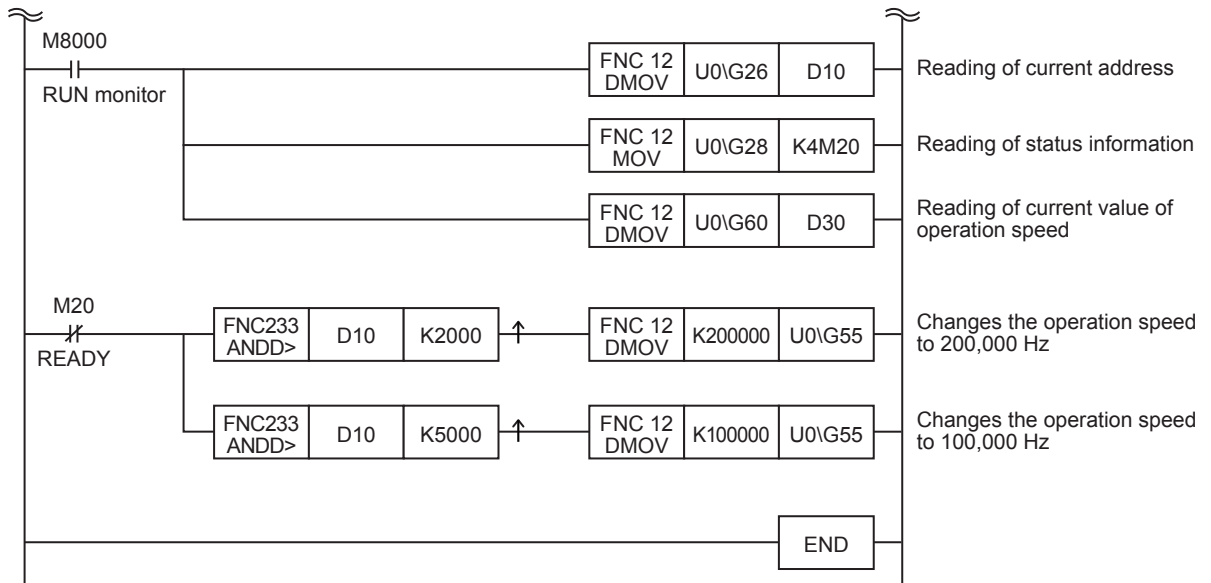
Cautions when the operation speed change function is used

- In the following conditions, writing a value to the operation speed change value does not validate the operation speed change. No error will occur either.
 - During deceleration by the STOP command (STOP, forward limit, reverse limit)
 - During deceleration and stopping of the positioning operation
 - Operation that the operation speed change function cannot be used
 - During use of the approximate S-shaped acceleration/deceleration function
 - In JOG operation inching movement
 - During remaining distance operation waiting (remaining distance operation is cancelled)
 - After interrupt input detection of the interrupt stop operation
- When the value set for the speed change value is larger than the maximum speed, the operation will be executed in the maximum speed. When the value set for the speed change value is at the bias speed or smaller, the operation will be executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the value set for the speed change value is at the creep speed or smaller, the operation will be executed at the creep speed. (In DOG type mechanical zero return operation)
- If the travel time is shorter than the required acceleration/deceleration time, the operation speed set by the speed change value cannot be reached.



4. Program description example

In the program below, the operation speed is changed as follows.
 Operation speed will be changed to 200,000 Hz if the current address exceeds K2,000.
 Operation speed will be changed to 100,000 Hz if the current address exceeds K5,000.



6.7 Target Address Change Function

This function changes the target address of the positioning operation to the specified target address. When the positioning operation is started, the value of the target address I (BFM#18, #17) is written to the target address change value (BFM#54, #53). Then, when a new value is written to the target address change value, the target address changes.

In case of the 2-speed positioning operation, the value of the target address II (BFM#22, #21) is written to the target address change value after the completion of the 1-speed operation. Then, when a new value is written to the target address change value, the target address changes.

Point

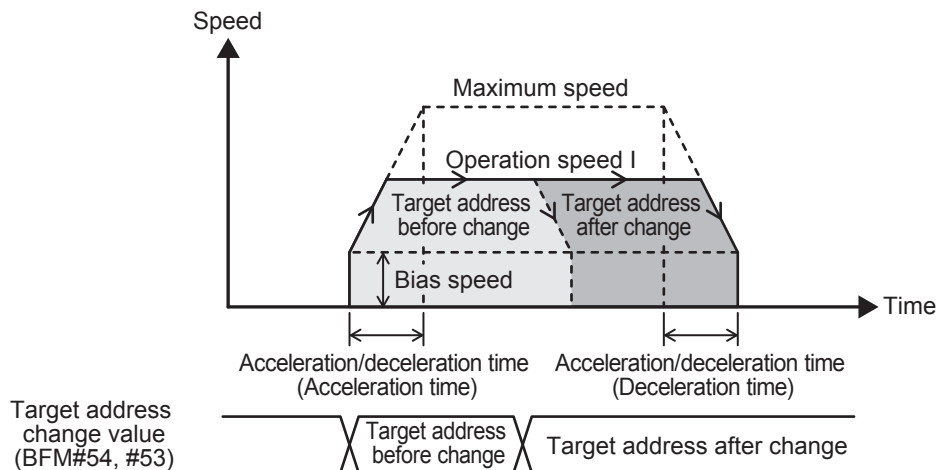
When the target address is changed by specifying the relative address, the relative travel distance from the start position of the positioning operation changes. When the 2-speed is changed in the 2-speed positioning operation, the relative travel distance from the 2-speed start position changes. It is not the travel distance from the target address change position.

1. Positioning operations for which the target address change function can be used

Operations applicable to the target address change function	Operations not applicable to the target address change function
1-speed positioning operation	JOG operation
Interrupt 1-speed positioning operation	DOG type mechanical zero return (high speed)
2-speed positioning operation	DOG type mechanical zero return (creep)
Interrupt stop operation	Data-set type mechanical zero return
Interrupt 2-speed positioning operation	External command positioning operation
-	Variable speed operation

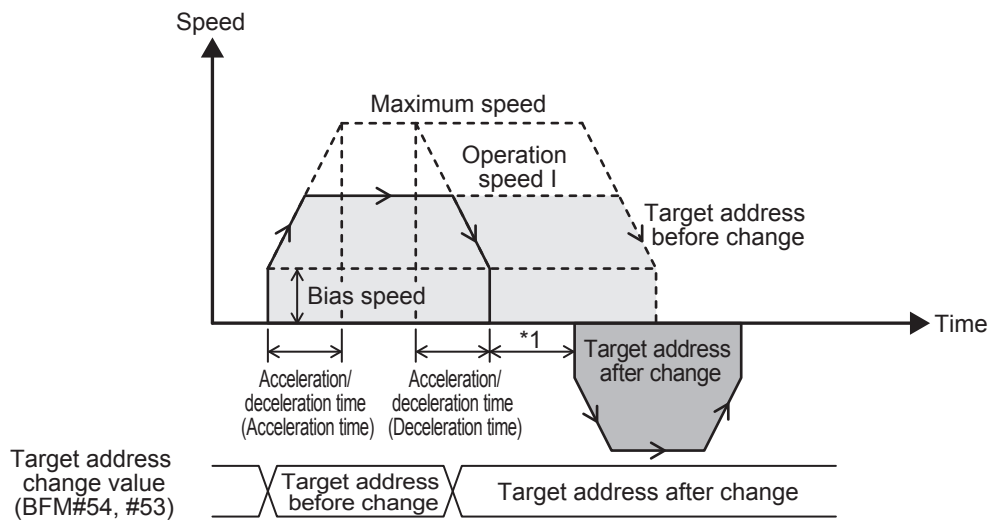
2. Operation

- When the operation direction does not change after the target address is changed Operates in a same direction as the operation direction.



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- When the operation direction inverts after the target address is changed
After the target address is changed, the motor decelerates and stops once, and then starts rotation in the reverse direction within 1 ms in the case of forward pulse/reverse pulse output or within 2 ms in the case of pulse/direction output.



- *1. In the case of forward pulse/reverse pulse output: Within 1 ms
In the case of pulse/direction output: Within 2 ms

3. Update time for the target address change value

After the target address change value is updated, the time required until the target address is changed will be as follows.

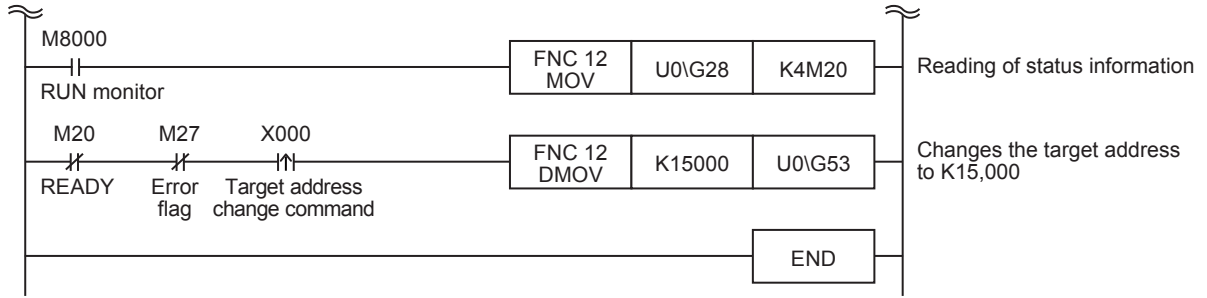
- During operation at 1 kHz or higher: Within 3 ms
- During operation at less than 1 kHz: Within 3 pulses

Caution when the target address change function is used

- In the following conditions, writing a value to the target address change value does not validate the target address change. No error will occur either.
 - During deceleration by the STOP command (STOP, forward limit, reverse limit)
 - During deceleration and stopping of the positioning operation
 - Operation that the target address change function cannot be used
 - During use of the approximate S-shaped acceleration/deceleration function
 - After interrupt input detection of the interrupt stop operation
 - When changing to the target address that requires inverting during the interrupt 1-speed positioning operation or the interrupt 2-speed positioning operation
 - During remaining distance operation waiting (remaining distance operation is cancelled)
- When no change in operation direction occurs after the target address change
 - When the travel distance from the positioning operation start position to the target address after the change exceeds ± 32 bit, the deceleration stop is executed at the position where the target address is changed. The set value overflow error occurs.
- When the operation direction inverts after the target address change
 - When the travel distance from the deceleration stop position to the target address after the change exceeds ± 32 bit, it stops at the deceleration stop position. The set value overflow error occurs.

4. Program description example

In the program below, the target address is changed as follows.
When turning X000 to ON, changes the target address to K15,000.



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6.8 Approximate S-shaped Acceleration/Deceleration Function

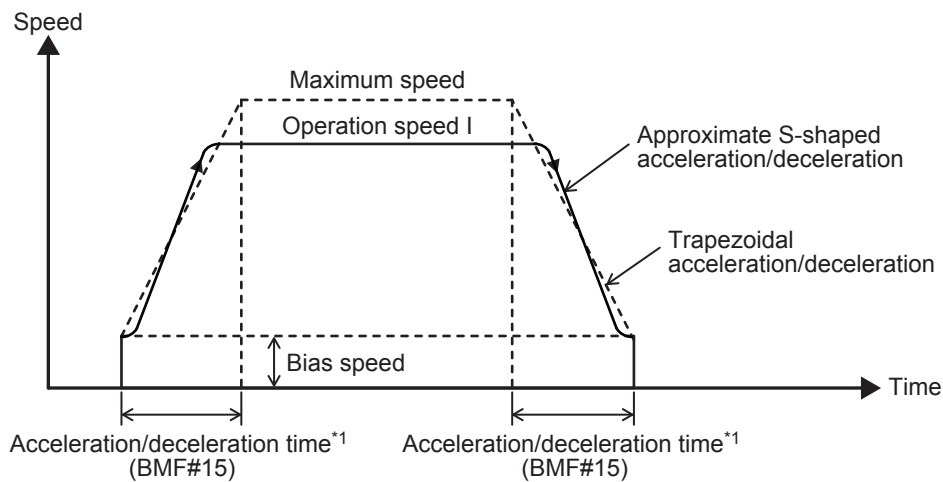
The approximate S-shaped acceleration/deceleration reduces the load applied on the motor at the start of operation and the stop of operation.

When the acceleration/deceleration mode (BFM#3 b6 or BFM#37 b6) is ON, both acceleration and deceleration become approximate S-shaped acceleration/deceleration control.

1. Positioning operations for which approximate S-shaped acceleration/deceleration function can be used

Operations applicable to the approximate S-shaped acceleration/deceleration function	Operations not applicable to the approximate S-shaped acceleration/deceleration function
JOG operation	Mechanical zero return
1-speed positioning operation	2-speed positioning operation
Interrupt 1-speed positioning operation	External command positioning operation
Interrupt stop operation	Variable speed operation
-	Interrupt 2-speed positioning operation

2. Operation

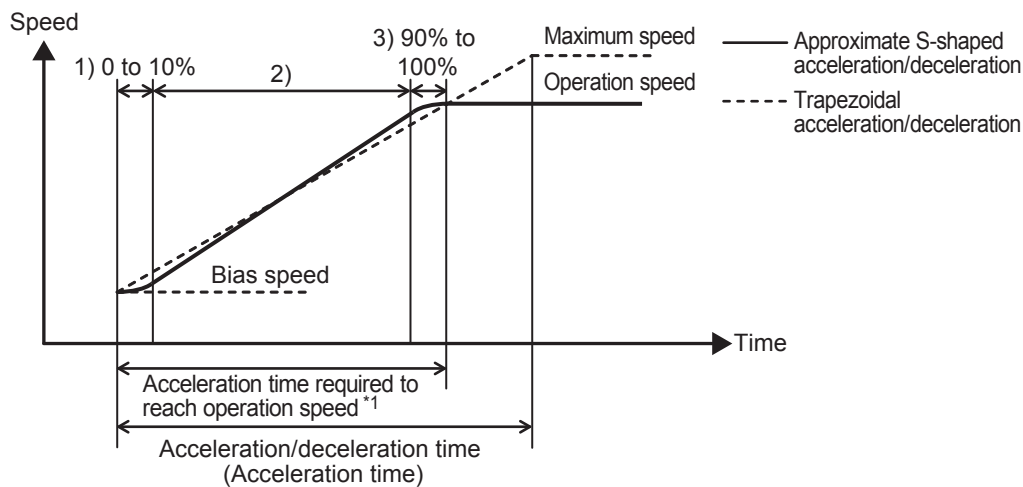


*1. When the acceleration time and the deceleration time are set individually by using the extension positioning parameter, the approximate S-shaped acceleration/deceleration is executed at the value set for the acceleration time.

3. Slope of the approximate S-shaped acceleration/deceleration

The following acceleration and deceleration are executed in the approximate S-shaped acceleration/deceleration.

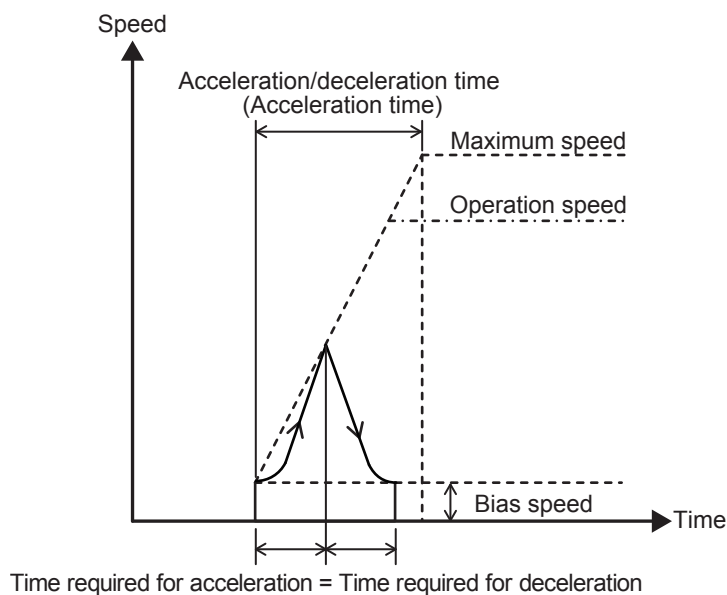
- 1) From the start of operation to 10% of the acceleration/deceleration time required to reach the operation speed I
Acceleration/deceleration using the Sin curve.
- 2) From 10% to 90% of the acceleration/deceleration time required to reach the operation speed I
Linear acceleration/deceleration
The slope at this time is up to 1.2 times the slope of the trapezoidal acceleration/deceleration.
In order to set the same acceleration/deceleration as the trapezoidal acceleration/deceleration, it is necessary to change the acceleration/deceleration time to 1.2 times the original value.
- 3) From 90% to the end of the acceleration/deceleration time required to reach the operation speed I
Acceleration/deceleration using the Sin curve.



*1. Acceleration time required to reach operation speed = Operation speed I ÷ Maximum speed × Acceleration/deceleration time

Caution when the approximate S-shaped acceleration/deceleration function is used

- The acceleration/deceleration time cannot be set individually. Acceleration/deceleration is executed at the set value of the acceleration time.
- Set the acceleration/deceleration time within the range from 1 ms to 5000 ms.
- The operation speed change function and the target address change function cannot be used.
- If deceleration is executed before acceleration ends, the approximate S-shaped acceleration/deceleration is executed at the deceleration start position. At this time, the times required for the acceleration and the deceleration become same.



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6.9 Cautions for Positioning Operation

- Set the relative travel distance (travel distance from the current value to the target address) in the positioning operation to a converted pulse value within ± 32 bits (-2,147,483,648 to +2,147,483,647 PLS). When the relative travel distance exceeds ± 32 bit in the pulse conversion value, the set value overflow error occurs.
- Only in the variable speed operation and the external command positioning operation, can a negative value can be set to operation speed I and operation speed II.
- When operation speed I, operation speed II, JOG speed, zero return speed (high speed), and zero return speed (creep) is at the bias speed or slower, operation is executed at the bias speed. However, if the bias speed is 0, operation is executed at 1 Hz.
- When operation speed I, operation speed II, JOG speed, zero return speed (high speed), and zero return speed (creep) is at the maximum speed or faster, operation is executed at the maximum speed.
- Setting of the positioning parameter selection (BFM#32) determines whether the positioning parameter is used or the extension positioning parameter is used. Set the buffer memories that correspond to the selected positioning parameter.
- For approximate S-shaped acceleration/deceleration, set the acceleration/deceleration time within the range from 1 ms to 5000 ms.
- When several operation start commands turn on at the same time in the operation command (BFM#25 b6, b8 to b15), the positioning operation is not executed. The operation command multiple selection error occurs.
- When another operation command is turned on during operation, the operation command turned on later is ignored, and no error will occur.
- The FX3U-1PG continues the positioning operation even if the PLC mode changes from RUN to STOP during the positioning operation.

6.9.1 Command error when machine system units are used and when combined system units are used

When the pulse rate is A, the feed rate is B and the relative travel distance is C, the value " $C \times (A/B)$ " indicates the pulse quantity which should be generated by the FX3U-1PG.

Even if the value " (A/B) " is not an integer, error is not generated in the command if the value " $C \times (A/B)$ " is integer.

However, when $C \times (A/B)$ is not an integer, an error within 1 pulse when rounding off occurs.

When the operation is executed using the absolute address specification, an error within one pulse by rounding off occurs. When positioning operation is repeatedly made using relative address specification, errors accumulate.

Point

- Error accumulation does not occur in the case of the motor system unit.
- When the travel distance (PLS) exceeds ± 32 bit, the set value overflow error occurs.
- When the maximum speed, bias speed exceeds 200 kHz, the numeral value set failure error occurs.

6.9.2 Stepwise output pulse

The output pulse frequency (f) of FX3U-1PG is stepwise as follows.

$$f = \frac{24 \times 10^6}{n} = 1 \text{ to } 200,000 \text{ Hz}$$

Where, n: Integer in range of 120 to 24,000,000

For example,

n = 120 → f = 200,000 Hz

n = 121 → f = 198,347 Hz

Any pulse whose frequency is between the two values above cannot be generated.

Point

In the operation speed current value (BFM#61, #60), the actual operation speed is stored. Because the actual output pulse is stepwise, it is possible that the current operation speed value is different from the user set operation speed I (BFM#20, #19), the operation speed II (BFM#24, #23), and the operation speed change value (BFM#56, #55).

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7. Buffer Memory

The FX3U-1PG positioning parameter, control data, and monitor data are read/written from/to the PLC via the buffer memory (BFM).

When the FX3U-1PG power supply is off, the buffer memory data is cleared, and initial values are written when the power supply is turned on.

The buffer memory is mainly classified into the following three types.

- Positioning parameters (BFM#0 to #15, #32 to #52)
The positioning parameters to set speed and units of measurement. → For details, refer to Section 7.3.
- Control data (BFM#16 to #25, #53 to #57)
The control data is user-specified data for controlling the positioning control. → For details, refer to Section 7.4.
- Monitor data (BFM#26 to #30, #58 to #62)
Operating conditions for the positioning control are stored as monitor data. → For details, refer to Section 7.5.

Caution

The instruction data format (FROM/TO, DFROM/DTO, etc.) must match the target BFM's data format. When the instruction data format does not match the target BFM's data format (16-bit/32-bit), the FX3U-1PG will not read/write data to the BFM properly, and no error will appear. This may cause an operation error for positioning.

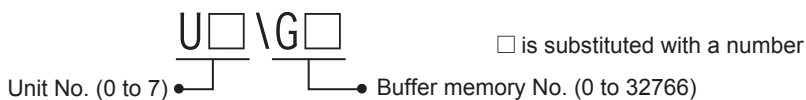
7.1 How to Read/Write from/to Buffer Memory

To read/write from/to buffer memory in the FX3U-1PG, use the FROM/TO instructions or applied instructions that directly specify the buffer memory. For details on the other methods, refer to the following Manual.

→ Refer to Programming manual.

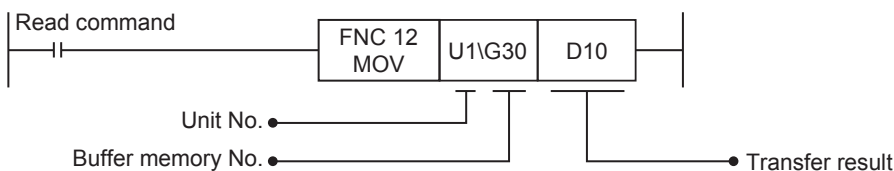
7.1.1 Direct specification of buffer memory

When directly specifying the buffer memory, specify the following device in the source or destination area of the applied instruction as follows:



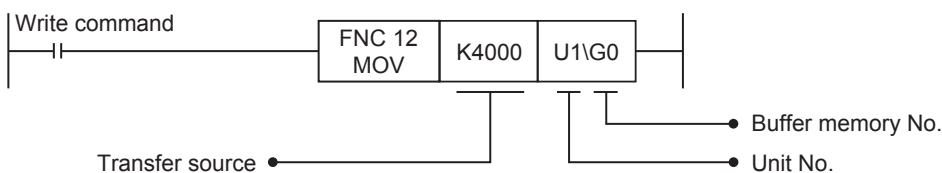
1. Reading out BFM data to PLC (MOV instruction)

If the following program is created, 1 point of data will be read out from the buffer memory BFM#30 of unit No. 1 to data register D10.



2. Writing PLC data into BFM (MOV instruction)

If the following program is created, 1 point of data (K4000) will be written to buffer memory BFM#0 of unit No. 1.

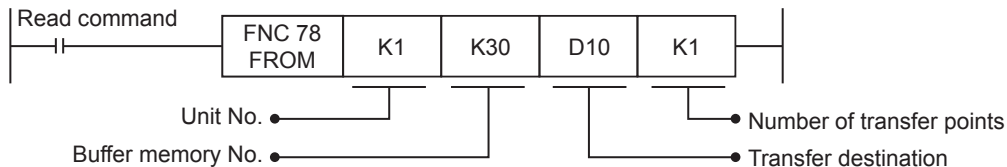


7.1.2 FROM/TO instructions

1. FROM instruction (Reading out BFM data to PLC)

Use the FROM instruction to read the data from the buffer memory.

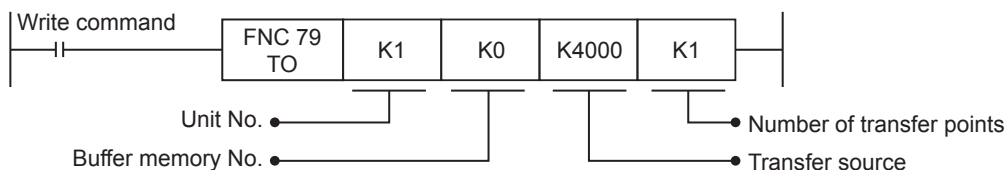
If the following program is created, 1 point of data will be read out from the buffer memory BFM#30 of unit No. 1 to data register D10.



2. TO instruction (Writing PLC data into BFM)

Use the TO instruction to write data to the buffer memory.

If the following program is created, 1 point of data (K4000) will be written to buffer memory BFM#0 of unit No. 1.



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7.2 Buffer Memory List

The table below provides a brief description and reference information for the FX3U-1PG buffer memory.

→ For details on the buffer memory, refer to the Section 7.3 or later.

	BFM No.		Item	Content, Setting range	Default	R/W	Reference
	High order 16bit	Low order 16bit					
Positioning parameter	-	#0	Pulse rate	Number of pulses to rotate the motors once. 1 to 32,767 PLS/REV	K2,000	R/W	Subsection 7.3.1
	#2	#1	Feed rate	Travel distance per revolution of the motor. 1 to 2,147,483,647 (user unit)	K1,000	R/W	Subsection 7.3.2
	-	#3	Operation parameter	Setting of basic conditions such as the unit system	H0000	R/W	Subsection 7.3.3
	#5	#4	Maximum speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K100,000	R/W	Subsection 7.3.4
	-	#6	Bias speed	0 to 32,767 (user unit) Set the value within 0 to 200,000 Hz when converted to pulse data.	K0	R/W	Subsection 7.3.6
	#8	#7	JOG speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K10,000	R/W	Subsection 7.3.6
	#10	#9	Zero return speed (high speed)	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K50,000	R/W	Subsection 7.3.7
	-	#11	Zero return speed (creep)	1 to 32,767 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K1,000	R/W	Subsection 7.3.8
	-	#12	Number of zero-point signal for zero return	Number of zero-point signals for zero return 0 to 32,767	K10	R/W	Subsection 7.3.9
	#14	#13	Zero-point address	Address at zero return completion -2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	K0	R/W	Subsection 7.3.10
	-	#15	Acceleration/ deceleration time	Time between the bias speed and the maximum speed Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms	K100	R/W	Subsection 7.3.11
Control data	-	#16	Starting delay time	Starting delay time 0 to 1,000 ms	K0	R/W	Subsection 7.4.1
	#18	#17	Target address I	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	K0	R/W	Subsection 7.4.2
	#20	#19	Operation speed I	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.*1	K10	R/W	Subsection 7.4.3
	#22	#21	Target address II	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	K0	R/W	Subsection 7.4.4
	#24	#23	Operation speed II	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.*2	K10	R/W	Subsection 7.4.5
	-	#25	Operation command	Operation information such as the positioning operation command	H0000	R/W	Subsection 7.4.6
Monitor data	#27	#26	Current address	-2,147,483,648 to 2,147,483,647 (user unit)	K0	R/W	Subsection 7.5.1
	-	#28	Status information	Status information such as READY	-	R	Subsection 7.5.2
	-	#29	Error code	An error code is stored at the time of the error occurrence.	K0	R	Subsection 7.5.3
	-	#30	Model code	The model code of the FX3U-1PG is stored.	K5,130	R	Subsection 7.5.4

	BFM No.		Item	Content, Setting range	Default	R/W	Reference
	High order 16bit	Low order 16bit					
-	-	#31	Not used	-	-	-	-
Positioning parameter	-	#32	Positioning parameter selection	Positioning parameter type is selected.	H0000	R/W	Subsection 7.3.12
	#34	#33	Pulse rate	Number of pulses to rotate the motors once. 1 to 2,147,483,647 PLS/REV	K2,000	R/W	Subsection 7.3.13
	#36	#35	Feed rate	Travel distance per revolution of the motor. 1 to 2,147,483,647 (user unit)	K1,000	R/W	Subsection 7.3.14
	-	#37	Operation parameter	Setting of basic conditions such as the unit system	H0000	R/W	Subsection 7.3.15
	#39	#38	Maximum speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K100,000	R/W	Subsection 7.3.16
	#41	#40	Bias speed	0 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K0	R/W	Subsection 7.3.17
	#43	#42	JOG speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K10,000	R/W	Subsection 7.3.18
	#45	#44	Zero return speed (high speed)	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K50,000	R/W	Subsection 7.3.19
	#47	#46	Zero return speed (creep)	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	K1,000	R/W	Subsection 7.3.20
	-	#48	Number of zero-point signal for zero return	Number of zero-point signals for zero return 0 to 32,767	K10	R/W	Subsection 7.3.21
	#50	#49	Zero-point address	Address at the zero return completion -2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	K0	R/W	Subsection 7.3.22
	-	#51	Acceleration time	Time from the bias speed to the maximum speed Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms However, the acceleration and deceleration times are the same for approximate S-shaped acceleration/deceleration.	K100	R/W	Subsection 7.3.23
-	#52	Deceleration time	Time from the maximum speed to the bias speed Trapezoidal acceleration/deceleration: 1 to 32,767ms Approximate S-shaped acceleration/deceleration: Same as the acceleration time	K100	R/W	Subsection 7.3.24	
Control data	#54	#53	Target address change value	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	K0	R/W	Subsection 7.4.7
	#56	#55	Operation speed change value	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.*2	K0	R/W	Subsection 7.4.8
	-	#57	Operation command II	Interrupt input via the PLC (BFM)	H0000	R/W	Subsection 7.4.9
Monitor data	#59	#58	Current address (pulse converted value)	-2,147,483,648 to 2,147,483,647 PLS	K0	R/W	Subsection 7.5.5
	#61	#60	Current value of operation speed	0 to 2,147,483,647 (user unit)	K0	R	Subsection 7.5.6
	-	#62	Version information	The version of FX3U-1PG is stored.	-	R	Subsection 7.5.7

R/W : Read or Write
R : Read only

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- *1. In case of external command positioning operation
-2,147,483,647 to -1, 1 to 2,147,483,647 (user unit). Set the value within -200,000 to -1, 1 to 200,000 Hz when converted to pulse data.
In case of variable speed operation
-2,147,483,647 to 2,147,483,647 (user unit). Set the value within -200,000 to 200,000 Hz when converted to pulse data.
- *2. In case of external command positioning operation
-2,147,483,647 to -1, 1 to 2,147,483,647 (user unit). Set the value within -200,000 to -1, 1 to 200,000 Hz when converted to pulse data.

7.3 Positioning Parameters

Set the units and speed used for positioning control.

For the positioning parameter, there are two types: the extension positioning parameter, for which the setting range is extended, and the positioning parameter. The difference between the positioning parameter and the extension positioning parameter is as follows.

- Positioning parameter (BFM#0 to #15)
Same allocation as the BFM of the FX2N-1PG. It is used when operation is executed without changing the FX2N-1PG program.
- Extension positioning parameter (#32 to #52)
Different allocation from the BFM of the FX2N-1PG. It uses the extended set range of the pulse rate, the bias speed, and the creep speed. Or, it is used when setting the acceleration time and the deceleration time individually.

Point

- The positioning parameter becomes valid at operation start-up. Therefore, set before the start-up of the operation.
When the setting is changed during operation or during the remaining distance operation waiting, the change is not reflected to the current operation but from the next operation.
- Setting of the positioning parameter selection (BFM#32) determines whether the positioning parameter is used or the extension positioning parameter is used.

7.3.1 [BFM#0] Pulse rate

Set the number of pulses required to rotate the motor for one turn.

Setting is necessary when the unit system is set to "machine system unit" or "combined system unit."

When "motor system unit" is selected, the setting here will be ignored.

→ For details on the system of units, refer to Subsection 7.3.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#0	Setting range: 1 to 32,767 PLS/REV	R/W	K2,000

Point

- If any electronic gearing is present in the servo amplifier, it is necessary to consider its effect.
The relationship between pulse rate and electronic gearing is shown below.
Pulse rate = Resolution power of encoder (positioning feedback pulses) ÷ Electronic gearing
- When the extension positioning parameter is used, use the pulse rate (BFM#34, #33).

7.3.2 [BFM#2, #1] Feed rate

Set the travel distance of the machine for one turn of the motor.

Setting is necessary when the unit system is set to "machine system unit" or "combined system unit."

When "motor system unit" is selected, the setting here will be ignored.

→ For details on the system of units, refer to Subsection 7.3.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#2	#1	Setting range: 1 to 2,147,483,647 (μm/REV, mdeg/REV, 10 ⁻⁴ inch/REV)	R/W	K1,000

Point

When the extension positioning parameter is used, use the feed rate (BFM#36, #35).

7.3.3 [BFM#3] Operation parameter

Set basic conditions such as the unit system.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#3	Refer to the following.	R/W	H0000

Point

When the extension positioning parameter is used, use the operation parameter (BFM#37).

b1, b0: System of units

Units for positioning control are set as follows.

Bit status		System of units	Position unit	Speed unit	Remarks
b1	b0				
0	0	Motor system	PLS	Hz	The pulse number is used as the standard for the position command and the operation speed.
0	1	Machine system	μm mdeg 10^{-4} inch	cm/min 10deg/min inch/min	μm , mdeg, and 10^{-4} inch is used as the standard for the position command and the speed.
1	0	Combined system	μm mdeg 10^{-4} inch	Hz	Combined units are used, such as the machine system unit for the position command and the motor system unit for the speed command.
1	1				

Conversion of the unit system

The following relationship exists between the motor system unit and the machine system unit, and the pulse conversion is executed automatically.

- Travel distance (PLS) = Travel distance (μm , mdeg, 10^{-4} inch) \times Pulse rate \times Position data multiplier \div Feed rate
- Operation speed (Hz) = Operation speed (cm/min, 10deg/min, inch/min) \times Pulse rate $\times 10^4 \div$ Feed rate $\div 60$
→ **For the command errors, refer to Subsection 6.9.1.**

Point

- When the unit system is set to the machine system unit or the combined system unit, settings of the pulse rate and the feed rate are necessary.
- When the operation speed is executed in the machine system unit, set the value such that its pulse converted equivalent is within the motor system unit (Hz) range or the combined system unit (Hz) range.

Concept of mechanical system of units

When operation parameter BFM#3 (b1, b0) or BFM#37 (b1, b0) (system of units) is set to "(0, 1)", "(1, 0)" or "(1, 1)", the mechanical system of units ("μm", "mdeg", "10⁻⁴ inch") is selected. At this time, there is no positioning parameter to select any one among "μm", "mdeg", "10⁻⁴ inch". However, because all of the positioning parameters (extension positioning parameters) as well as the positioning data and the speed data used in the positioning program adopt the same unit, the same pulse output is acquired without regard to the unit as long as the set value is equivalent.

Setting example

Condition

Setting item	Setting value	Remarks
Pulse rate (BFM#0 or BFM#34, #33)	4,000 [PLS/REV]	
Feed rate (BFM#2, #1 or BFM#36, #35)	100 [μm/REV, mdeg/REV, 10 ⁻¹ minch/REV]	
Position data multiplier [BFM#3 (b5, b4) or BFM#37 (b5, b4)]	0, 0 (b5=0, b4=0)	The travel distance is regarded as "μm", "mdeg" or "10 ⁻⁴ inch".
Electronic gear in servo amplifier (Setting of the servo amplifier side)	1/1	

When you set values in "μm"

In a positioning operation with travel distance of 100 [μm] and operation speed of 6 [cm/min], the following pulse output is given.

$$\begin{aligned} \text{Generated pulse quantity} &= \text{Travel distance} \div \text{Feed rate} \times \text{Pulse rate} \\ &= 100 [\mu\text{m}] \div 100 [\mu\text{m}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 4,000 [\text{PLS}] \end{aligned}$$

$$\begin{aligned} \text{Pulse frequency} &= \text{Operation speed}^{*1} \div \text{Feed rate}^{*1} \times \text{Pulse rate} \\ &= 6 [\text{cm}/\text{min}] \times 10^4 \div 60 \div 100 [\mu\text{m}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 40,000 [\text{Hz}] \end{aligned}$$

*1. The unit is aligned during calculation. 1 cm = 10⁴ μm, 1 min = 60 s.

When you set values in "mdeg"

In a positioning operation with travel distance of 100 [mdeg] and operation speed of 6 [10 deg/min], the following pulse output is given.

$$\begin{aligned} \text{Generated pulse quantity} &= \text{Travel distance} \div \text{Feed rate} \times \text{Pulse rate} \\ &= 100 [\text{mdeg}] \div 100 [\text{mdeg}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 4,000 [\text{PLS}] \end{aligned}$$

$$\begin{aligned} \text{Pulse frequency} &= \text{Operation speed}^{*2} \div \text{Feed rate}^{*2} \times \text{Pulse rate} \\ &= 6 [10\text{deg}/\text{min}] \times 10^4 \div 60 \div 100 [\text{mdeg}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 40,000 [\text{Hz}] \end{aligned}$$

*2. The unit is aligned during calculation. 1 deg = 10³ mdeg, 1 min = 60 s.

When you set values in "10⁻⁴ inch"

In a positioning operation with travel distance of 100 [× 10⁻⁴ inch] and operation speed of 6 [inch/min], the following pulse output is given.

$$\begin{aligned} \text{Generated pulse quantity} &= \text{Travel distance} \div \text{Feed rate} \times \text{Pulse rate} \\ &= 100 [\times 10^{-4} \text{ inch}] \div 100 [\times 10^{-4} \text{ inch}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 4,000 [\text{PLS}] \end{aligned}$$

$$\begin{aligned} \text{Pulse frequency} &= \text{Operation speed}^{*3} \div \text{Feed rate} \times \text{Pulse rate} \\ &= 6 [\text{inch}/\text{min}] \times 10^4 \div 60 \div 100 [\times 10^{-4} \text{ inch}/\text{REV}] \times 4,000 [\text{PLS}/\text{REV}] \\ &= 40,000 [\text{Hz}] \end{aligned}$$

*3. The unit is aligned during calculation. 1 min = 60 s.

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How to use an electronic gear

Some servo motors require pulse trains at 200 kHz or more (in calculation) in order to satisfy the rated rotation speed. For example, the command pulse frequency required to operate the MR-JN Series servo amplifier and HF-KN Series servo motor manufactured by Mitsubishi at the rated rotation speed of 3,000 rev/min can be obtained as follows.

(Suppose that the electronic gear ratio is the initial value "1/1", the number of command input pulses per revolution is the initial value "10,000".)

$$f_0 = \text{FBP} \times 100 \times \frac{N_0}{60} \times \frac{\text{CDV}}{\text{CMX}}$$

$$f_0 = 10,000 \times \frac{3,000}{60} \times 1$$

$$f_0 = 500,000 \text{ [Hz]}$$

f_0 : Command pulse frequency [Hz] (open collector type)
 CMX : Electronic gear (numerator of command pulse magnification)
 CDV : Electronic gear (denominator of command pulse magnification)
 N_0 : Rotation speed of servo motor [rev/min]
 $\text{FBP} \times 100$: Number of command input pulses per revolution [PLS/REV]

However, because the input command pulse in the open collector type servo amplifier and the pulse output from the FX3U-1PG is 200 kHz maximum, operation at 500,000 Hz is impossible.

In such a case, you should change the electronic gear in the servo amplifier.

The electronic gear can be obtained as follows.

$$\frac{\text{CMX}}{\text{CDV}} = \text{FBP} \times 100 \times \frac{N_0}{60} \times \frac{1}{f_0}$$

$$\frac{\text{CMX}}{\text{CDV}} = 10,000 \times \frac{3,000}{60} \times \frac{1}{200,000}$$

$$\frac{\text{CMX}}{\text{CDV}} = \frac{5}{2}$$

f_0 : Command pulse frequency [Hz] (open collector type)
 CMX : Electronic gear (numerator of command pulse magnification)
 CDV : Electronic gear (denominator of command pulse magnification)
 N_0 : Rotation speed of servo motor [rev/min]
 $\text{FBP} \times 100$: Number of command input pulses per revolution [PLS/REV]

The table below shows the setting of major electronic gears and pulse rates obtained by the above calculation.

Rated rotation speed of servo motor	Servo amplifier		Command pulse frequency (200 kHz)	
	Maximum input pulse frequency	Number of command input pulses per revolution	Electronic gear	Pulse rate
3,000 r/min	200 kHz (open collector)	10,000 PLS/REV	5/2	4,000 PLS/REV
		50,000 PLS/REV	25/2	
		131,072 PLS/REV	4,096/125	

b3, b2: Interrupt input setting

The interrupt signals used for interrupt inputs in the interrupt 1-speed positioning operation, external command positioning operation, interrupt stop operation or interrupt 2-speed positioning operation are set.

Bit status		Interrupt input 0	Interrupt input 1
b3	b2		
0	0	DOG	STOP
0	1	DOG	INT1
1	0	INT0	STOP
1	1	INT0	INT1

b5, b4: Position data multiplier

Multiplier for the position data written for the zero-point address (BFM#14, #13), the target address I (BFM#18, #17), the target address II (BFM#22, #21), the current address (BFM#27, #26), and the target address change value (BFM#54, #53).

Bit status		Magnification
b5	b4	
0	0	10 ⁰
0	1	10 ¹
1	0	10 ²
1	1	10 ³

Example of setting: When b5, b4 = (1, 1)

When the target address I (BFM#18, #17) = 123, the actual address or the travel distance becomes as follows.

Motor system of units: 123 × 10³ = 123,000 PLS

Machine system of units, Combined system of units: 123 × 10³ = 123,000 (μm, mdeg, 10⁻⁴ inch)
= 123 (mm, deg, 10⁻¹ inch)

b6: Acceleration/deceleration mode

Set the acceleration/deceleration mode.

b6 = 0: Use trapezoidal acceleration/deceleration.

b6 = 1: Use approximate S-shaped acceleration/deceleration.

b7: Variable speed operation acceleration/deceleration setting

Set whether acceleration/deceleration is set for the variable speed operation.

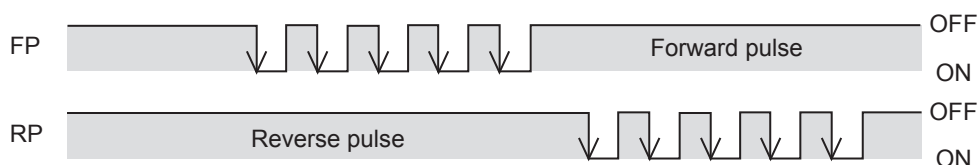
b7 = 0: Variable speed operation without acceleration/deceleration

b7 = 1: Variable speed operation with acceleration/deceleration

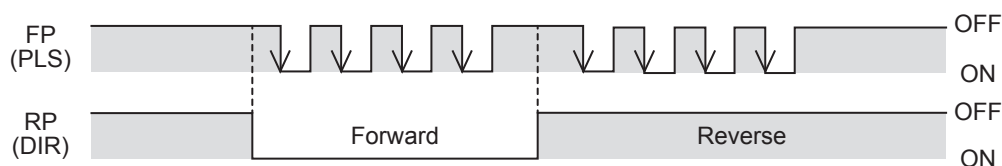
b8: Pulse output format

Set the pulse output format. When it is set, the ON/OFF condition of the pulse output terminal FP/RP changes as follows.

b8 = 0: Forward pulse (FP)/Reverse pulse (RP)



b8 = 1: Pulse (PLS)/Direction (DIR)



b9: Rotation direction

Set the rotating direction. It is used for the initial setting. It is not necessary to change the rotating direction for each actual operation.

b9 = 0: The current address increases with forward pulse (FP).

b9 = 1: The current address decreases with forward pulse (FP).

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b10: Zero return direction

Set the zero return direction.

b10 = 0: At the time of zero return, the operation starts toward the direction in which the current address decreases.

b10 = 1: At the time of zero return, the operation starts toward the direction in which the current address increases.

b11: Limit deceleration mode

Set the operation when the forward limit/reverse limit turns on.

b11 = 0: When the forward limit/reverse limit turns on, the operation immediately stops and outputs the CLR signal.

b11 = 1: When the forward limit/reverse limit turns on, the operation decelerates and stops. The CLR signal is not output.

b12: DOG input polarity

The polarity of the DOG input is set.

b12 = 0: Normally-opened (operates when the DOG input is on)

b12 = 1: Normally-closed (operates when the DOG input is off)

b13: Count start point

Set the count start point for zero-point signal.

b13 = 0: DOG forward end (After DOG forward end detection, the zero-point signal count starts.)

b13 = 1: DOG backward end (After DOG forward end detection and backward end finish, the zero-point signal count starts.)

b14: STOP input polarity

The polarity of the STOP input is set. It is valid only for the input of the FX3U-1PG STOP terminal.

b14 = 0: Normally-opened (operates when the STOP input is ON)

b14 = 1: Normally-closed (operates when the STOP input is OFF)

b15: STOP input mode

The operation for the STOP input is set.

b15 = 0: After deceleration stop by STOP command is executed during operation, the remaining distance operation is executed when the restart command is given.

b15 = 1: After deceleration stop by STOP command is executed during operation, the positioning ends without executing the remaining distance operation.

7.3.4 [BFM#5, #4] Maximum speed

Sets the upper speed limit in each operation.

→ For details on the maximum speed, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#5	#4	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K100,000

Point

- For the JOG speed, zero return speed (high speed), zero return speed (creep), operation speed I, and operation speed II, set the speed same or lower than the maximum speed. When the set speed is higher than the maximum speed, the operation is executed at the maximum speed.
- When the extension positioning parameter is used, use the maximum speed (BFM#39, #38).

7.3.5 [BFM#6] Bias speed

Set the bias speed at the time of startup.

When the FX3U-1PG and the stepping motor are combined and used together, set the speed taking the resonance area and the self-start frequency of the stepping motor into account.

→ For details on the bias speed, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#6	Setting range: 0 to 32,767 (user unit) The value must be within the range from 0 to 200,000 Hz when converted to pulse data.	R/W	K0

Point

- For the bias speed, set the value the same or lower than the maximum speed.
- When the extension positioning parameter is used, use the bias speed (BFM#41, #40).

7.3.6 [BFM#8, #7] JOG speed

Set the speed of the manual forward JOG/reverse JOG operation.

→ For details on the JOG speed, refer to Section 8.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#8	#7	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K10,000

Point

- Set the JOG speed in the range between the bias speed and the maximum speed.
- When the JOG speed is at the maximum speed or higher, the operation is executed at the maximum speed. When the JOG speed is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the extension positioning parameter is used, use the JOG speed (BFM#43, #42).

7.3.7 [BFM#10, #9] Zero return speed (high speed)

Set the high-speed return speed in the mechanical zero return.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#10	#9	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K50,000

Point

- Set the zero return speed (high speed) in the range between the bias speed and the maximum speed.
- When the zero return speed (high speed) is at the maximum speed or higher, the operation is executed at the maximum speed. When the zero return speed (high speed) is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the extension positioning parameter is used, use the zero return speed (high speed) (BFM#45, #44).

7.3.8 [BFM#11] Zero return speed (creep)

In the mechanical zero return, the operation speed after the near point signal (DOG) input is set.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#11	Setting range: 1 to 32,767 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K1,000

Point

- Set the zero return speed (creep) in the range between the bias speed and the maximum speed. However, set the speed at the zero return speed (high speed) or slower.
- When the zero return speed (creep) is at the maximum speed or higher, the operation is executed at the maximum speed. When the zero return speed (creep) is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- To increase the stop accuracy at the zero position, it is recommended to keep the creep speed as low as possible.
- When the extension positioning parameter is used, use the zero return speed (creep) (BFM#47, #46).

7.3.9 [BFM#12] Number of zero-point signal for zero return

Set the zero-point signal count that is used for the mechanical zero return.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#12	Setting range: 0 to 32,767	R/W	K10

Point

- The zero-point signal count is detected on the falling edge.
- When the zero-point signal count is set to 0, the operation immediately stops when the zero-point signal count is started. In this case, the operation immediately stops from the zero return speed (high speed or creep). If there is a possibility to damage the machine due to the immediate stop, be careful with the following points.
 - Set the zero return speed (creep) at a safe speed.
 - Set the zero-point signal count start point at DOG backward end.
 - Design the DOG such that the speed can be reduced to the zero return speed (creep) until the start of the zero-point signal count.
- When the extension positioning parameter is used, use the number of zero-point signal for zero return (BFM#48).

7.3.10 [BFM#14, #13] Zero-point address

Set the zero-point address when the zero return operation is completed.

When the zero return operation completes, this value is written to the current address.

→ For the zero return operation, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#14	#13	Setting range: -2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS in the converted pulse data.	R/W	K0

Point

- Value is in user units and includes the position data multiplier.
- When the extension positioning parameter is used, use the zero-point address (BFM#50, #49).

7.3.11 [BFM#15] Acceleration/deceleration time

Set the time required to accelerate from the bias speed to the maximum speed (decelerate from the maximum speed to the bias speed).

→ For details on the acceleration/deceleration time, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#15	Setting range: Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms	R/W	K100

Point

When the extension positioning parameter is used, use the acceleration time (BFM#51) and the deceleration time (BFM#52). It is necessary to set the acceleration time (BFM#51) and the deceleration time (BFM#52) individually.

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7.3.12 [BFM#32] Positioning parameter selection

Select whether the positioning parameter (BFM#0 to #15) is used or the extension positioning parameter (BFM#33 to #52) is used.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#32	b0 = OFF (0): Positioning parameter (BFM#0 to #15) is used b0 = ON (1): Extension positioning parameter (BFM#32 to #52) is used b1 to b15: Not used	R/W	H0000

Point

- When the parameter is changed during the operation, the change becomes valid from the next operation.
- Set the positioning parameter to the buffer memory that corresponds to the selected positioning parameter.

7.3.13 [BFM#34, #33] Pulse rate

Set the number of pulses required to rotate the motor for one turn.
Setting is necessary when the unit system is set to "machine system unit" or "combined system unit."
When "motor system unit" is selected, the setting here will be ignored.

→ For details on the system of units, refer to Subsection 7.3.15.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#34	#33	Setting range: 1 to 2,147,483,647 PLS/REV	R/W	K2,000

Point

- If any electronic gearing is present in the servo amplifier, it is necessary to consider its effect.
The relationship between pulse rate and electronic gearing is shown below.
Pulse rate = Resolution power of encoder (positioning feedback pulses) ÷ Electronic gearing
- When the positioning parameter is used, use the pulse rate (BFM#0).

7.3.14 [BFM#36, #35] Feed rate

Set the travel distance of the machine for one turn of the motor.
Setting is necessary when the unit system is set to "machine system unit" or "combined system unit."
When "motor system unit" is selected, the setting here will be ignored.

→ For details on the system of units, refer to Subsection 7.3.15.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#36	#35	Setting range: 1 to 2,147,483,647 (μm/REV, mdeg/REV, 10 ⁻⁴ inch/REV)	R/W	K1,000

Point

When the positioning parameter is used, use the feed rate (BFM#2, #1).

7.3.15 [BFM#37] Operation parameter

Set basic conditions such as the unit system.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#37	Refer to the following.	R/W	H0000

Point

When the positioning parameter is used, use the operation parameter (BFM#3).

b1, b0: System of units

Units for positioning control are set as follows.

Bit status		System of units	Position unit	Speed unit	Remarks
b1	b0				
0	0	Motor system	PLS	Hz	The pulse number is used as the standard for the position command and the operation speed.
0	1	Machine system	μm mdeg 10^{-4} inch	cm/min 10deg/min inch/min	μm , mdeg, and 10^{-4} inch is used as the standard for the position command and the speed.
1	0	Combined system	μm mdeg 10^{-4} inch	Hz	Combined units are used, such as the machine system unit for the position command and the motor system unit for the speed command.
1	1				

Conversion of the unit system

The following relationship exists between the motor system unit and the machine system unit, and the pulse conversion is executed automatically.

- Travel distance (PLS) = Travel distance (μm , mdeg, 10^{-4} inch) \times Pulse rate \times Position data multiplier \div Feed rate
- Operation speed (Hz) = Operation speed (cm/min, 10deg/min, inch/min) \times Pulse rate $\times 10^4 \div$ Feed rate $\div 60$
→ **For the command errors, refer to Subsection 6.9.1.**

Point

- When the unit system is set to the machine system unit or the combined system unit, settings of the pulse rate and the feed rate are necessary.
- When the operation speed is executed in the machine system unit, set the value such that its pulse converted equivalent is within the motor system unit (Hz) range or the combined system unit (Hz) range.

Concept of mechanical system of units and how to use an electronic gear

For concept of mechanical system of units and how to use an electronic gear, refer to Subsection 7.3.3.

b3, b2: Interrupt input setting

The interrupt signals used for interrupt inputs in the interrupt 1-speed positioning operation, external command positioning operation, interrupt stop operation or interrupt 2-speed positioning operation are set.

Bit status		Interrupt input 0	Interrupt input 1
b3	b2		
0	0	DOG	STOP
0	1	DOG	INT1
1	0	INT0	STOP
1	1	INT0	INT1

b5, b4: Position data multiplier

Multiplier for the position data written for the zero-point address (BFM#14, #13), the target address I (BFM#18, #17), the target address II (BFM#22, #21), the current address (BFM#27, #26), and the target address change value (BFM#54, #53).

Bit status		Magnification
b5	b4	
0	0	10^0
0	1	10^1
1	0	10^2
1	1	10^3

Example of setting: When b5, b4 = (1, 1)

When the target address I (BFM#18, #17) = 123, the actual address or the travel distance becomes as follows.

Motor system of units: $123 \times 10^3 = 123,000\text{PLS}$

Machine system of units, Combined system of units: $123 \times 10^3 = 123,000$ (μm , mdeg, 10^{-4} inch)
= 123 (mm, deg, 10^{-1} inch)

b6: Acceleration/deceleration mode

Set the acceleration/deceleration mode.

b6 = 0: Use trapezoidal acceleration/deceleration.

b6 = 1: Use approximate S-shaped acceleration/deceleration.

b7: Variable speed operation acceleration/deceleration setting

Set whether acceleration/deceleration is set for the variable speed operation.

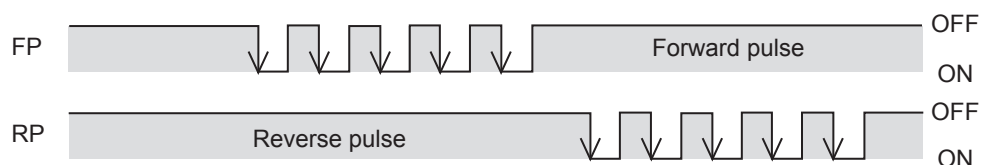
b7 = 0: Variable speed operation without acceleration/deceleration

b7 = 1: Variable speed operation with acceleration/deceleration

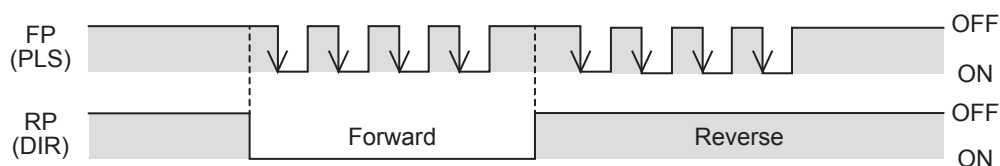
b8: Pulse output format

Set the pulse output format. When it is set, the ON/OFF condition of the pulse output terminal FP/RP changes as follows.

b8 = 0: Forward pulse (FP)/Reverse pulse (RP)



b8 = 1: Pulse (PLS)/Direction (DIR)

**b9: Rotation direction**

Set the rotating direction. It is used for the initial setting. It is not necessary to change the rotating direction for each actual operation.

b9 = 0: The current address increases by with forward pulse (FP).

b9 = 1: The current address decreases by with forward pulse (FP).

b10: Zero return direction

Set the zero return direction.

b10 = 0: At the time of zero return, the operation starts toward the direction in which the current address decreases.

b10 = 1: At the time of zero return, the operation starts toward the direction in which the current address increases.

b11: Limit deceleration mode

Set the operation when the forward limit/reverse limit turns on.

b11 = 0: When the forward limit/reverse limit turns on, the operation immediately stops and outputs the CLR signal.

b11 = 1: When the forward limit/reverse limit turns on, the operation decelerates and stops. The CLR signal is not output.

b12: DOG input polarity

The polarity of the DOG input is set.

b12 = 0: Normally-opened (operates when the DOG input is on)

b12 = 1: Normally-closed (operates when the DOG input is off)

b13: Count start point

Set the count start point for zero-point signal.

b13 = 0: DOG forward end (After DOG forward end detection, the zero-point signal count starts.)

b13 = 1: DOG backward end (After DOG forward end detection and backward end finish, the zero-point signal count starts.)

b14: STOP input polarity

The polarity of the STOP input is set. It is valid only for the input of the FX3U-1PG STOP terminal.

b14 = 0: Normally-opened (operates when the STOP input is ON)

b14 = 1: Normally-closed (operates when the STOP input is OFF)

b15: STOP input mode

The operation for the STOP input is set.

b15 = 0: After deceleration stop by STOP command is executed during operation, the remaining distance operation is executed when the restart command is given.

b15 = 1: After deceleration stop by STOP command is executed during operation, the positioning ends without executing the remaining distance operation.

7.3.16 [BFM#39, #38] Maximum speed

Sets the upper speed limit in each operation.

→ For details on the maximum speed, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#39	#38	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K100,000

Point

- For the JOG speed, zero return speed (high speed), zero return speed (creep), operation speed I, and operation speed II, set the speed same or lower than the maximum speed. When the set speed is higher than the maximum speed, the operation is executed at the maximum speed.
- When the positioning parameter is used, use the maximum speed (BFM#5, #4).

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7.3.17 [BFM#41, #40] Bias speed

Set the bias speed at the time of startup.

When the FX3U-1PG and the stepping motor are combined and used together, set the speed taking the resonance area and the self-start frequency of the stepping motor into account.

→ For details on the bias speed, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#41	#40	Setting range: 0 to 2,147,483,647 (user unit) The value must be within the range from 0 to 200,000 Hz when converted to pulse data.	R/W	K0

Point

- For the bias speed, set the value the same or lower than the maximum speed.
- When the positioning parameter is used, use the bias speed (BFM#6).

7.3.18 [BFM#43, #42] JOG speed

Set the speed of the manual forward JOG/reverse JOG operation.

→ For details on the JOG speed, refer to Section 8.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#43	#42	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K10,000

Point

- Set the JOG speed in the range between the bias speed and the maximum speed.
- When the JOG speed is at the maximum speed or higher, the operation is executed at the maximum speed. When the JOG speed is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the positioning parameter is used, use the JOG speed (BFM#8, #7).

7.3.19 [BFM#45, #44] Zero return speed (high speed)

Set the high-speed return speed in the mechanical zero return.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#45	#44	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K50,000

Point

- Set the zero return speed (high speed) in the range between the bias speed and the maximum speed.
- When the zero return speed (high speed) is at the maximum speed or higher, the operation is executed at the maximum speed. When the zero return speed (high speed) is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- When the positioning parameter is used, use the zero return speed (high speed) (BFM#10, #9).

7.3.20 [BFM#47, #46] Zero return speed (creep)

In the mechanical zero return, the operation speed after the near point signal (DOG) input is set.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#47	#46	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.	R/W	K1,000

Point

- Set the zero return speed (creep) in the range between the bias speed and the maximum speed. However, set the speed at the zero return speed (high speed) or slower.
- When the zero return speed (creep) is at the maximum speed or higher, the operation is executed at the maximum speed. When the zero return speed (creep) is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- To increase the stop accuracy at the zero position, it is recommended to keep the creep speed as low as possible.
- When the positioning parameter is used, use the zero return speed (BFM#11).

7.3.21 [BFM#48] Number of zero-point signal for zero return

Set the zero-point signal count that is used for the mechanical zero return.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#48	Setting range: 0 to 32,767	R/W	K10

Point

- The zero-point signal count is detected at the falling edge.
- When the zero-point signal count is set to 0, the operation immediately stops when the zero-point signal count is started. In this case, the operation immediately stops from the zero return speed (high speed or creep). If there is a possibility to damage the machine due to the immediate stop, be careful with the following points.
 - Set the zero return speed (creep) at a safe speed.
 - Set the zero-point signal count start point at DOG backward end.
 - Design the DOG such that the speed can be reduced to the zero return speed (creep) until the start of the zero-point signal count.
- When the positioning parameter is used, use the number of zero-point signal for zero return (BFM#12).

7.3.22 [BFM#50, #49] Zero-point address

Set the zero-point address when the zero return operation is completed.

When the zero return operation completes, this value is written to the current address.

→ For details on the mechanical zero return, refer to Section 8.3.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#50	#49	Setting range: -2,147,483,648 to 2,147,483,647 (user unit) The value must be within the range from -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	R/W	K0

Point

- Value is in user units and includes the position data multiplier.
- When the positioning parameter is used, use the zero-point address (BFM#14, #13).

7.3.23 [BFM#51] Acceleration time

The time required to accelerate from the bias speed to the maximum speed is set.

→ For details on the acceleration time, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#51	Setting range: Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms However, the acceleration and deceleration times are the same when using approximate S-shaped acceleration/deceleration.	R/W	K100

Point

When the positioning parameter is used, use the acceleration/deceleration time (BFM#15). However, the acceleration time and the deceleration time cannot be set individually.

7.3.24 [BFM#52] Deceleration time

Set the time required from the maximum speed to the bias speed.

→ For details on the deceleration time, refer to Section 6.2.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#52	Setting range: Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: Same as acceleration time	R/W	K100

Point

When the positioning parameter is used, use the acceleration/deceleration time (BFM#15). However, the acceleration time and the deceleration time cannot be set individually.

7.4 Control Data

Set the data for positioning control.

Point

The control data becomes valid when an operation starts. Therefore, set before the start-up of the operation. When the setting is changed during the operation or during the remaining distance operation waiting, the change is not reflected to the current operation but from the next operation. However, setting can be changed during operation for the operation speed I, the target address change value, the operation speed change value, the operation command (b1 to b3), and the operation command II of the variable speed operation.

7.4.1 [BFM#16] Starting delay time

Set the start delay time of the FX3U-1PG.

After the operation command, the operation starts when the time set for the startup delay time has elapsed after the normal startup time^{*1}.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#16	Setting range: 0 to 1,000 ms	R/W	K0

*1. 1 ms or less for the motor system unit, and 2 ms or less for the machine system unit.

Point

The positioning operations that correspond to the starting delay time is as follows.

- 1-speed positioning operation
- Interrupt 1-speed positioning operation
- 2-speed positioning operation
- External command positioning operation
- Variable speed operation
- Interrupt stop operation
- Interrupt 2-speed positioning operation

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7.4.2 [BFM#18, #17] Target address I

Set the target address I (target position or travel distance) of the positioning operation.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#18	#17	Setting range: -2,147,483,648 to 2,147,483,647 (user unit) The value must be within the range from -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	R/W	K0

Point

- Operation will be as follows according to whether relative or absolute addressing is specified in the operation command (BFM#25 b7).
 - With absolute address specified:
By using the current address as a base, the positioning operation to the specified target position is executed.
At this time, the rotation direction is determined by the current address and the target address I.
 - With relative address specified:
By using the current work position as a base, the positioning operation to the specified travel distance is executed.
At this time, the rotation direction is determined according to the target address I sign.
- Value is in user units and includes the position data multiplier.

7.4.3 [BFM#20, #19] Operation speed I

Set the operation speed I of the positioning operation.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#20	#19	Setting range: 1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.*1	R/W	K10

- *1. In case of external command positioning operation
-2,147,483,647 to -1, 1 to 2,147,483,647 (user unit). Set the value within -200,000 to -1, 1 to 200,000 Hz when converted to pulse data.
In case of variable speed operation
-2,147,483,647 to 2,147,483,647 (user unit). Set the value within -200,000 to 200,000 Hz when converted to pulse data.

Point

- Set the operation speed I in the range between the bias speed and the maximum speed.
- In case of the variable speed operation and the external command positioning operation, the rotating direction is determined according to the sign of the operation speed I.
- When the operation speed I is at the maximum speed or higher, the operation is executed at the maximum speed. When the operation speed I is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- The operation speed is not changed even if the operation speed I is changed during the operation. When changing the operation speed during the operation, use the operation speed change function. However, the operation speed can be changed during the variable speed operation.
→ For details of the operation speed change function, refer to Section 6.6.

7.4.4 [BFM#22, #21] Target address II

Set the target address II (target position or travel distance) of the positioning operation. It is used only in the 2-speed positioning operation.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#22	#21	Setting range: -2,147,483,648 to 2,147,483,647 (user unit) The value must be within the range from -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	R/W	K0

Point

- Operation will be as follows according to whether relative or absolute addressing is specified in the operation command (BFM#25 b7).
 - With absolute address specified:
By using the current address as a base, the positioning operation to the specified target position is executed.
At this time, the rotation direction is determined by the target address I and the target address II.
 - With relative address specified:
By using the current work position as a base, the positioning operation to the specified travel distance is executed.
At this time, the rotation direction is determined according to the target address II sign.
- Value is in user units and includes the position data multiplier.

7.4.5 [BFM#24, #23] Operation speed II

Set the operation speed II of the positioning operation.

It is used for the 2-speed positioning operation, the external command positioning operation, and the interrupt 2-speed positioning operation.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#24	#23	Setting range: 1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.*1	R/W	K10

- *1. In case of external command positioning operation
-2,147,483,647 to -1, 1 to 2,147,483,647 (user unit). Set the value within -200,000 to -1, 1 to 200,000 Hz when converted to pulse data.

Point

- Set the operation speed II in the range between the bias speed and the maximum speed.
- When the operation speed II is at the maximum speed or higher, the operation is executed at the maximum speed. When the operation speed II is at the bias speed or lower, the operation is executed at the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.
- The operation speed is not changed even if the operation speed II is changed during the operation. When changing the operation speed during the operation, use the operation speed change function.
→ For details of the operation speed change function, refer to Section 6.6.

7.4.6 [BFM#25] Operation command

A list of operation commands is as shown in the following table.

BFM No.		Bit No.	Item	Description	Detection ^{*1}	Default
High order 16bit	Low order 16bit					
-	#25	b0	Error reset	When it is turned on while an error is output, it resets the error flag, the error code, and the positioning completion flag. (It is valid only when the error is occurring.)	Level	H0000
		b1	STOP	When it is turned on during the positioning operation (including JOG operation and mechanical zero return operation), the operation stops. → For details on the STOP, refer to Section 6.5.	Level	
		b2	Forward limit	When it is turned on while the forward pulse is output, the operation stops. It is used to stop the operation at the forward limit position. → For details on the forward limit, refer to Section 6.4.	Level	
		b3	Reverse limit	When it is turned on while the reverse pulse is output, the operation stops. It is used to stop the operation at the reverse limit position. → For details on the reverse limit, refer to Section 6.4.	Level	
		b4	Forward JOG operation	When it is turned on, the unit outputs pulses in the direction in which in the current address increases. When it is turned off, the unit stops outputting pulses. → For details on the JOG operation, refer to Section 8.2.	Level	
		b5	Reverse JOG operation	When it is turned on, the unit outputs pulses in the direction in which in the current address decreases. When it is turned off, the unit stops outputting pulses. → For details on the JOG operation, refer to Section 8.2.	Level	
		b6	DOG type mechanical zero return operation start	When it is turned on, it starts the DOG type mechanical zero return operation. → For details on the DOG type mechanical zero return operation, refer to Subsection 8.3.2.	Edge	
		b7	Relative/absolute address	It selects the absolute address specification or the relative address specification. OFF: Operates with the absolute address specification ON: Operates with the relative address specification	Level	
		b8	1-speed positioning operation start	When it is turned on, it starts the 1-speed positioning operation. → For details on the 1-speed positioning operation, refer to Section 9.2.	Edge	
		b9	Interrupt 1-speed positioning operation start	When it is turned on, it starts the interrupt 1-speed positioning operation. → For details on the interrupt 1-speed positioning operation, refer to Section 9.3.	Edge	
		b10	2-speed positioning operation start	When it is turned on, it starts the 2-speed positioning operation. → For details on the 2-speed positioning operation, refer to Section 9.4.	Edge	
		b11	External command positioning operation start	When it is turned on, it starts the external command positioning operation. → For details on the external command positioning operation, refer to Section 9.5.	Edge	
b12	Variable speed operation	ON: It starts the variable speed operation. OFF: It stops the variable speed operation. → For details on the variable speed operation, refer to Section 9.6.	Level			

BFM No.		Bit No.	Item	Description	Detection*1	Default
High order 16bit	Low order 16bit					
-	#25	b13	Interrupt stop operation start	When it is turned on, the interrupt stop operation starts. → For details on the interrupt 1-speed positioning operation, refer to Section 9.7.	Edge	H0000
		b14	Interrupt 2-speed positioning operation start	When it is turned on, the interrupt 2-speed positioning operation starts. → For details on the interrupt 2-speed positioning operation, refer to Section 9.8.	Edge	
		b15	Data-set type mechanical zero return operation start	When it is turned on, the data-set type mechanical zero return operation starts. → For details on the data-set type mechanical zero return operation, refer to Subsection 8.3.3.	Edge	

*1. Timing of detection.
 Level detection: activated when the bit is set or cleared.
 Edge detection: activated at OFF-to-ON transition.

Point

- The priority order of each bit becomes as follows. When several bits are turned on, the bit with higher priority becomes valid. However, if several bits of the positioning operations (b6, b8 to b15) turn on, the operation is not executed, and the operation command multiple selection error occurs.

Priority high	Priority low
Error reset (b0) > Forward/reverse limit (b2, b3) > STOP (b1) > Forward JOG/reverse JOG (b4, b5) > Positioning operation (b6, b8 to b15)	

- When another operation command is turned on during operation, the operation command turned on later is ignored, and no error will occur.
- Create the sequence program as each bit (b0, b6, b8 to b11, b13 to b15) of the edge detection always turns off after being turned on. Without turning off each bit, the second or further operations cannot be executed.
- Error reset (b0) is executed only when an error is occurring.
- Do not use the forward limit (b2)/reverse limit (b3) for any purposes other than limiting.
- The positioning operations (b6, b8 to b15) become valid when all bits of the BFM#25 (b0 in the normal status, excluding the b2/b3 and b7 opposite from the operation direction) are turned off and then on.

7.4.7 [BFM#54, #53] Target address change value

Set the target address change value that is used in the target address change function.

→ For details on the target address change function, refer to Section 6.7.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#54	#53	Setting range: -2,147,483,648 to 2,147,483,647 (user unit) The value must be within the range from -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	R/W	K0

Point

Value is in user units and includes the position data multiplier.

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7.4.8 [BFM#56, #55] Operation speed change value

Set the operation speed change value that is used in the operation speed change function.

→ For details on the operation speed change function, refer to Section 6.6.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#56	#55	Setting range: 1 to 2,147,483,647 (user unit) The value must be within the range from 1 to 200,000 Hz when converted to pulse data.*1	R/W	K0

- *1. In case of external command positioning operation
-2,147,483,647 to -1, 1 to 2,147,483,647 (user unit). Set the value within -200,000 to -1, 1 to 200,000 Hz when converted to pulse data.

7.4.9 [BFM#57] Operation command II

A list of operation command II is as shown in the following table.

BFM No.		Bit No.	Item	Description	Detection*1	Default
High order 16bit	Low order 16bit					
-	#57	b0	INT0	The interrupt input is executed via the PLC (BFM). INT0 turns on when b0 = ON.	Edge	H0000
		b1	INT1	The interrupt input is executed via the PLC (BFM). INT1 turns on when b1 = ON.	Edge	
		b2 to b15	-	Not used	-	-

- *1. Timing of detection.
Level detection: activated when the bit is set or cleared.
Edge detection: activated at OFF-to-ON transition.

Point

If INT0 (b0) or INT1 (b1) is on when the positioning operation starts, it automatically turns off.

7.5 Monitor Data

Stores the operation condition of the positioning control. The monitor data are read-only, excluding the current address and the current address (pulse conversion value).

7.5.1 [BFM#27, #26] Current address

Stores the current address data.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#27	#26	-2,147,483,648 to 2,147,483,647 (user unit)	R/W	K0

Point

- The stored address is always an absolute address. However, when the positioning is completed in the interrupt 1-speed positioning or in the interrupt 2-speed positioning operation, the address is the relative address after the interrupt detection.
- The current address can be changed to any specified address during stop. When a value is written in the current address, the current address (pulse conversion value) (BFM#59, #58) is also updated.
- The address change during the positioning operation is invalid.
- Value is in user units and includes the position data multiplier.
- A value read from the servo amplifier by the ABS instruction (FNC155) of the PLC is the pulse conversion value. Write in the current address (pulse conversion value) (BFM#59, #58).

7.5.2 [BFM#28] Status information

The FX3U-1PG condition can be checked in the ON/OFF condition of each bit.

BFM No.		Bit No.	Item	Description	R/W	Default
High order 16bit	Low order 16bit					
-	#28	b0	READY	Turns on when the positioning operation can be executed. <ul style="list-style-type: none"> • Conditions to turn on <ul style="list-style-type: none"> - During the power supply start up - At the completion of positioning - During stop by STOP command during positioning operation - At error reset • Conditions to turn off <ul style="list-style-type: none"> - During the positioning operation - At the time of error occurrence 	R	-
		b1	Forward/Reverse	ON: Turns on during the forward pulse output Stays on even after the forward pulse stops. OFF: Turns off during the reverse pulse output Stays on even after the reverse pulse stops.		
		b2	Zero return completion	Turns on when the zero return completes. <ul style="list-style-type: none"> • Conditions to turn on <ul style="list-style-type: none"> - At the completion of the DOG type mechanical zero return operation - At the completion of the data set type mechanical zero return operation • Conditions to turn off <ul style="list-style-type: none"> - The power is off - When K0 is written to the status information 		
		b3	STOP input ON	ON: STOP input ON OFF: STOP input OFF Same as the ON/OFF condition of the FX3U-1PG STOP terminal.		
		b4	DOG input ON	ON: DOG input ON OFF: DOG input OFF Same as the ON/OFF condition of the FX3U-1PG DOG terminal.		

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BFM No.		Bit No.	Item	Description	R/W	Default
High order 16bit	Low order 16bit					
-	#28	b5	PG0 input ON	ON: PG0 input ON OFF: PG0 input OFF Same as the ON/OFF condition of the FX3U-1PG PG0 terminal.	R	-
		b6	Current value overflow	When the current address (BFM#27, #26 or BFM#59, #58) value exceeds the ± 32 bit data range, it turns on. Turns off when the power is turned off, or when the DOG type mechanical zero return operation or the data-set type mechanical zero return operation is executed.		
		b7	Error flag	Turns on when an error occurs, and the error code number is stored to the error code (BFM#29). Turns off when the power is turned off or when error reset (BFM25 b0) is executed.		
		b8	Positioning completion flag	Turns on when the positioning operation is completed normally. Turns off when the mechanical zero return operation start, positioning operation start (excluding the variable speed operation), or the error reset (only when an error occurred) is executed.		
		b9	1-speed completion flag	Turns on when the 2-speed positioning operation, the external command positioning, or the 1-speed of the interrupt 2-speed positioning operation completes. <ul style="list-style-type: none"> • Conditions to turn on <ul style="list-style-type: none"> - When the 2-speed positioning operation, the external command positioning operation, or the 1-speed of the interrupt 2-speed positioning operation completes. • Conditions to turn off <ul style="list-style-type: none"> - At the completion of positioning - At the time of error occurrence - When the remaining distance operation is cancelled - When the remaining distance operation is not executed (BFM#3 b15 or #37 b15 is ON), and when the operation is decelerated and stopped by the STOP command 		
		b10	Interrupt input 0 ON	ON: Turns on when the interrupt input 0 is detected in an operation mode for which the interrupt input 0 is effective. OFF: Turns off when the next operation is started.		
		b11	Interrupt input 1 ON	ON: Turns on when the interrupt input 1 is detected in an operation mode for which the interrupt input 1 is effective. OFF: Turns off when the next operation is started.		
		b12	Remaining distance operation waiting	Turns on during the remaining distance waiting when the positioning operation (1-speed positioning operation, 2-speed positioning operation, and interrupt stop operation) decelerates and stops by the STOP input. Turns off when the writing operation is executed to the restart command or BFM other than BFM#25.		
		b13 to b15	Not used	-		

Point

- READY (b0) turns off while the error is active, and the start command is not received.
- When K0 is written to the status information, only the zero return execution completion (b2) turns off.

7.5.3 [BFM#29] Error code

An error code is stored at the time of the error occurrence.

→ For the details of the error code, refer to Section 11.2.

BFM No.		Error code	Description	R/W	Default
High order 16bit	Low order 16bit				
-	#29	K0	No error.	R	K0
		K○○1 ^{*1}	Large/small relationship is incorrect.		
		K○○3 ^{*1}	Setting range is incorrect.		
		K○○4 ^{*1}	Setting value overflow error.		
		K5	Operation command multiple selection error.		
		K6	Forward limit/reverse limit error.		
		K7	Watchdog timer error		

*1. ○○ represents the BFM number for which there is an error.

Point

After removing the cause of the error, clear the error code by turning off the power supply or by the error reset (BFM#25 b0).

7.5.4 [BFM#30] FX Series model code

The model code of the FX3U-1PG is stored.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#30	The model code of the FX3U-1PG is K5,130.	R	K5,130

7.5.5 [BFM#59, #58] Current address (pulse converted value)

Stores the current address data in the pulse converted value.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#59	#58	-2,147,483,648 to 2,147,483,647 PLS	R/W	K0

Point

- Stored address is always a pulse conversion value of the absolute address.
- The current address can be changed to any specified address during stop. When a value is written in the current address (pulse conversion value), the current address (BFM#27, #26) is also updated.
- The address change during the positioning operation is invalid.
- A value read from the servo amplifier by the ABS instruction (FNC155) of the PLC is the pulse conversion value. Write in this buffer memory.

7.5.6 [BFM#61, #60] Current value of operation speed

Stores the current operation speed.
Becomes "0" when the operation is at stop.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
#61	#60	0 to 2,147,483,647 (user unit)	R	K0

Point

- In the current operation speed value, the actual operation speed is stored. Because the actual output pulse is stepwise, it is possible that the current operation speed value is different from the operation speed I (BFM#20, #19), the operation speed II (BFM#24, #23), and the operation speed change value (BFM#56, #55) that the user set.
→ For the stepwise of the output pulse, refer to Subsection 6.9.2.
- In the case of machine system units, the current value of the operation speed is as follows.
Current value of operation speed = Actual output frequency × Feed rate × 60 / Pulse rate / 10⁴
When the result is not an integer, the value rounded down is stored as the current value of the operation speed.

7.5.7 [BFM#62] Version information

The version of FX3U-1PG is stored.

BFM No.		Description	R/W	Default
High order 16bit	Low order 16bit			
-	#62	Ver. 1.00 is stored as K100.	R	-

8. Manual Control

This chapter explains manual control.

8.1 Functions Available with Manual Control

Manual operations and available functions are as shown in the following table.

Functions	Operation mode				Reference
	JOG operation	DOG type mechanical zero return operation		Data-set type mechanical zero return operation	
		High speed	Creep		
Extension positioning parameter	✓	✓	✓	✓	Section 7.3
Forward limit/Reverse limit	✓	✓	✓	-	Section 6.4
STOP command	✓	✓	✓	-	Section 6.5
Remaining distance operation	-	-	-	-	Subsection 6.5.2
Approximate S-shaped acceleration/deceleration	✓	-	-	-	Section 6.8
Operation speed change function	✓	✓	-	-	Section 6.6
Target address change function	-	-	-	-	Section 6.7
Starting delay time	-	-	-	-	Subsection 7.4.1

✓ : Applicable

- : Not applicable or not targeted

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8.2 JOG Operation

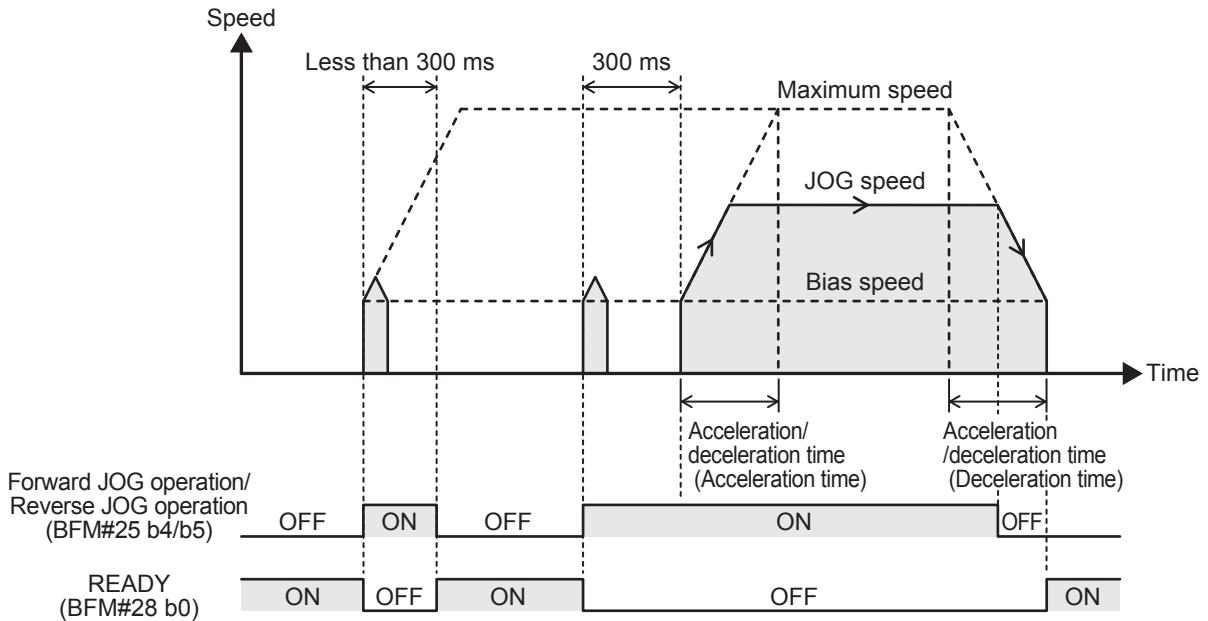
While the forward JOG operation is on, the motor rotates in the current address increasing direction. While the reverse JOG operation is on, the motor rotates in the current address decreasing direction.

→ For details on the STOP command, refer to Section 6.5.

→ For details on the approximate S-shaped acceleration/deceleration, refer to Section 6.8.

1. Operation

- While the forward JOG operation is on, the motor rotates in the current address increasing direction. When the forward JOG operation turns off, the motor decelerates and stops.
- While the reverse JOG operation is on, the motor rotates in the current address decreasing direction. When the reverse JOG operation turns off, the motor decelerates and stops.
- When the ON time of the forward JOG operation/reverse JOG operation is less than 300 ms, the inching operation, which outputs 1 pulse or 1 user unit, is executed.
- When the ON time of the forward JOG operation/reverse JOG operation is 300 ms or longer, the pulse is output continuously.
- When the JOG operation for the reverse direction is executed during the forward JOG operation/reverse JOG operation, the operation decelerates and stops. While the operation is at stop, the READY remains ON. Then, when the forward JOG operation/reverse JOG operation is turned off, the JOG operation resumes.



Point

- When the ON time of the forward JOG operation/reverse JOG operation is less than 300 ms, the following operation is executed.
The FX3U-1PG outputs pulses corresponding to 1 user unit.
However, the FX3U-1PG outputs 1 pulse even if the value "Position data multiplier × Pulse rate" is smaller than the feed rate in the machine system setting or combined system setting and the pulse number required for the travel in 1 user unit is less than 1 pulse.
- When the operation stops at the forward limit/reverse limit, avoiding the limit is possible by the JOG operation to the opposite direction.
- When the forward JOG operation/reverse JOG operation is turned off and the JOG operation is re-turned on during the deceleration, the operation decelerates and stops once, and then accelerates again. When stopped, READY turns on only for an instant.

2. Positioning completion flag

Before and after the JOG operation execution, the positioning completion flag does not change.

3. Speed change during the JOG operation

When changing the JOG speed during the JOG operation, use the operation speed change function. However, the operation speed cannot be changed during the inching operation.

→ For details of the operation speed change function, refer to Section 6.6.

Setting items of JOG operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b6	#37 b6		Acceleration/deceleration mode
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b14	#37 b14		STOP input polarity
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#8, #7	#43, #42	JOG speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#25 b4		Operation command	Forward JOG operation
#25 b5			Reverse JOG operation
#56, #55		Operation speed change value	

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8.3 Mechanical Zero Return Operation

8.3.1 Outline of mechanical zero return operation

1. Types of mechanical zero return operation

The mechanical zero return method for the FX3U-1PG includes the following two variations.

- DOG type mechanical zero return
The position after stopping from the DOG signal with the zero signal of the servo amplifier becomes the zero-point.
→ For details on the DOG type mechanical zero return, refer to Subsection 8.3.2.
- Data-set type mechanical zero return
The position after moving with the JOG operation etc. is defined as the zero-point.
→ For details on the data-set type mechanical zero return, refer to Subsection 8.3.3.

2. Mechanical zero return operation

The mechanical zero return operation varies according to the zero return type. For details, refer to the following.

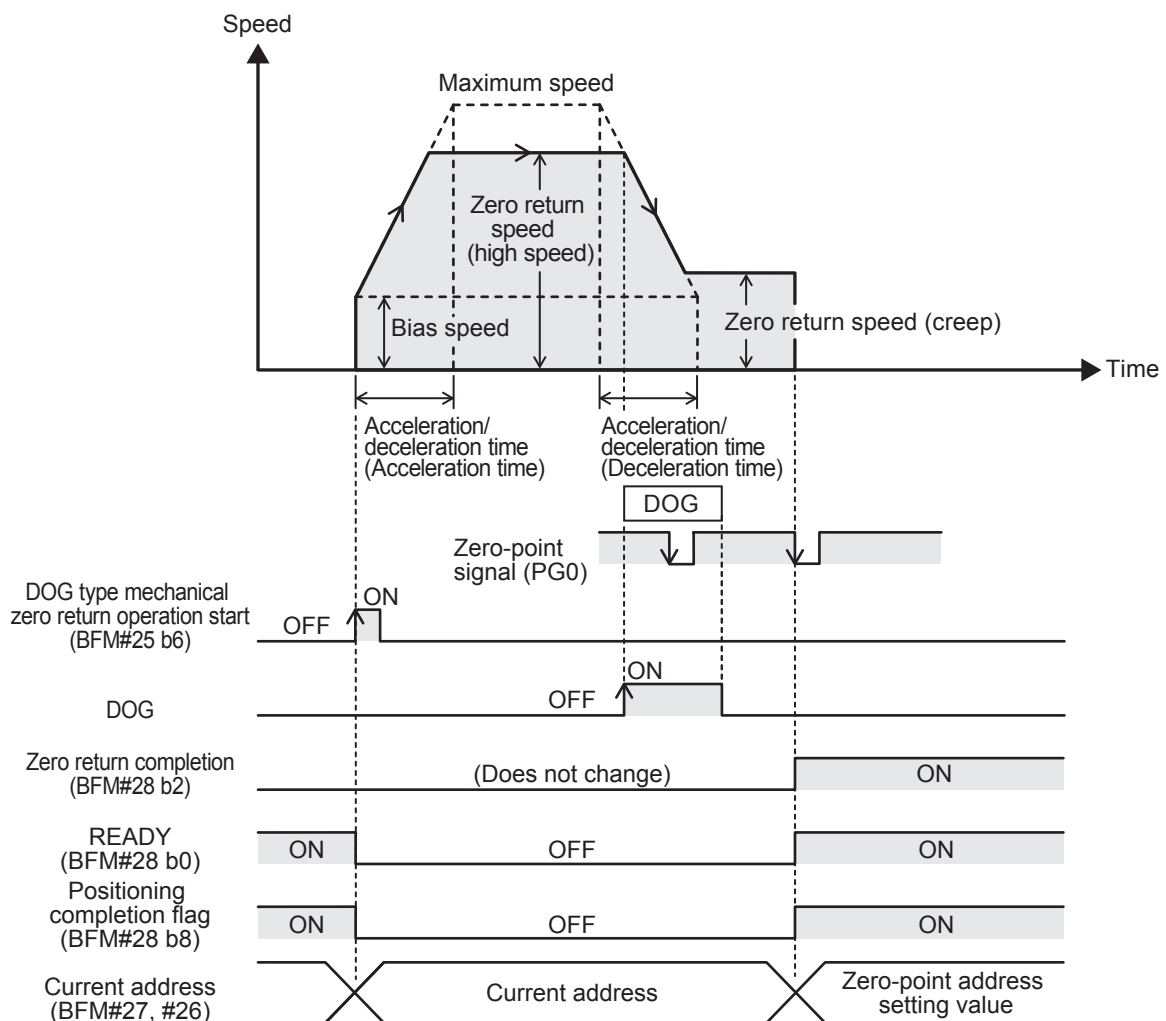
- For details on the DOG type mechanical zero return, refer to Subsection 8.3.2.
- For details on the data-set type mechanical zero return, refer to Subsection 8.3.3.

8.3.2 DOG type mechanical zero return operation

The zero return starts by the DOG type mechanical zero return operation start command. When the DOG search function is used, the DOG type mechanical zero return becomes possible from any position.

1. Operation

- 1) When the DOG type mechanical zero return operation start command of the operation command is turned from off to on, movement in the zero return direction starts at zero return speed (high speed). (The positioning completion flag turns off.)
- 2) When the DOG input turns on, deceleration to the zero return speed (creep) starts.
- 3) When the count start point is passed, the zero-point signal count starts.
- 4) When the count, which is set to the zero return zero-point signal number, is reached, the operation stops. (It outputs the CLR signal.)
- 5) After the zero-return completion, the set value of the zero-point address is written to the current address.
- 6) The positioning completion flag and the zero return completion turn on.



2. Zero return direction

Sets the zero return direction.

When BFM#3 b10/BFM#37 b10 = 0: The operation starts in the current address decreasing direction.

When BFM#3 b10/BFM#37 b10 = 1: The operation starts in the current address increasing direction.

3. DOG input polarity

The polarity of the DOG input is set.

When BFM#3 b12/BFM#37 b12 = 0: Normally-open (Operates when the DOG input is on)

When BFM#3 b12/BFM#37 b12 = 1: Normally-close (Operates when the DOG input is off)

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4. Count start point

Sets the count start point of the zero-point signal.

When BFM#3 b13/BFM#37 b13 = 0: DOG forward end (After detecting the DOG forward end, zero-point signal count starts.)

When BFM#3 b13/BFM#37 b13 = 1: DOG backward end (After detecting the DOG forward end and passing the backward end, zero-point signal count starts.)

Point

- When the DOG forward end
 - Set the number of zero-point signals such that the deceleration completes before the stop position.
- When the DOG backward end
 - Set the DOG length such that the deceleration completes before passing the DOG.

5. Zero return completion

Turns on when the zero return is completed and after the zero-point address is written to the current address.

Turns off when the power is turned off or when K0 is written to the status information. It does not turn off when the zero return operation is started.

6. Positioning completion flag

The positioning completion flag turns off when the DOG type mechanical zero return operation starts.

The positioning completion flag turns on when the zero return operation is completed.

7. Speed change during the zero return operation

When changing the zero return speed (high speed) during the zero return operation, use the operation speed change function. However, zero return speed (creep) cannot be changed.

→ For details of the operation speed change function, refer to Section 6.6.

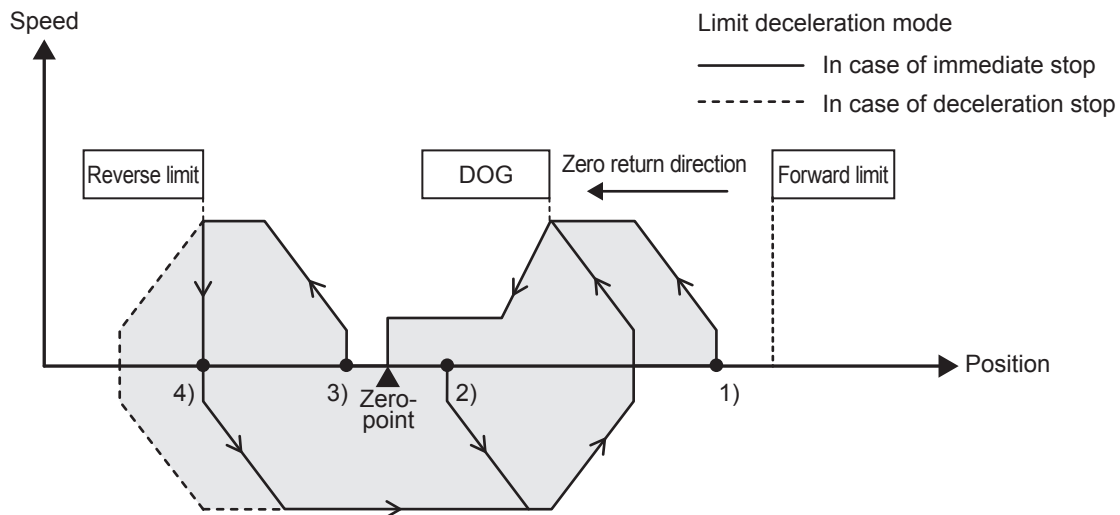
Setting items of the DOG type mechanical zero return operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	
#3 b5, b4	#37 b5, b4		System of units
#3 b8	#37 b8		Position data multiplier
#3 b9	#37 b9		Pulse output format
#3 b10	#37 b10		Rotation direction
#3 b11	#37 b11		Zero return direction
#3 b12	#37 b12		Limit deceleration mode
#3 b13	#37 b13		DOG input polarity
#3 b14	#37 b14		Count start point
#3 b15	#37 b15		STOP input polarity
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#10, #9	#45, #44	Zero return speed (high speed)	
#11	#47, #46	Zero return speed (creep)	
#12	#48	Number of zero-point signal for zero return	
#14, #13	#50, #49	Zero-point address	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#25 b6		Operation command	DOG type mechanical zero return operation start
#28 b2		Status information	Zero return completion
#56, #55		Operation speed change value	

8. DOG search function

When the forward limit/reverse limit is set, zero return operation by DOG search function becomes possible. The zero return operation becomes as follows according to the zero return start position. In addition, operation at the forward limit/reverse limit follows the operation set in the limit deceleration mode (BFM#3 b11 or BFM#37 b11).

DOG search function operation



- 1) When DOG signal is OFF at starting position (before passing the DOG)
 - a) Operates in the zero return direction at the zero return speed (high speed)
 - b) After the DOG detection, deceleration starts to the zero return speed (creep).
 - c) After detection of the zero-point signal count start point, the zero-point signal count starts.
 - d) When the zero-point signal of the specified number (zero-point signal number) is counted, the operation stops.
- 2) When DOG signal is ON at starting position (within the DOG)
 - a) Operates in the direction opposite of the zero return direction at the zero return speed (high speed)
 - b) The operation decelerates and stops when it moves outside of the DOG.
 - c) Operates in the zero return direction at the zero return speed (high speed)
 - d) After the DOG detection, deceleration starts to the zero return speed (creep)
 - e) The operation stops when the zero-point signal of the specified number (zero-point signal number) is counted.
- 3) When DOG signal is OFF at starting position (after passing the DOG)
 - a) Operates in the zero return direction at the zero return speed (high speed)
 - b) The operation immediately stops or decelerates to stop at the reverse limit/forward limit.
 - c) Operates in the direction opposite of the zero return direction at the zero return speed (high speed)
 - d) The operation decelerates and stops when it moves outside of the DOG.
 - e) Operates in the zero return direction at the zero return speed (high speed)
 - f) After the DOG detection, deceleration starts to the zero return speed (creep)
 - g) The operation stops when the zero-point signal of the specified number (zero-point signal number) is counted.
- 4) When the reverse limit/forward limit in the zero return direction is on
 - a) Operates in the direction opposite of the zero return direction at the zero return speed (high speed)
 - b) The operation decelerates and stops when it moves outside of the DOG.
 - c) Operates in the zero return direction at the zero return speed (high speed)
 - d) After the DOG detection, deceleration starts to the zero return speed (creep)
 - e) The operation stops when the zero-point signal of the specified number (zero-point signal number) is counted.

Caution

If the DOG is not detected during the DOG search operations, a forward limit/reverse limit error occurs.

8.3.3 Data-set type mechanical zero return operation

Data-set type mechanical zero return is the zero return method that is used to set the position, which is traveled by the JOG operation etc., as a zero position. Therefore, the work piece does not move when the data-set type mechanical zero return command is turned on.

This zero return method is often used in equipment for which the DOG cannot be used or in the transfer line that does not have a mechanical zero position.

→ For details on the JOG speed, refer to Section 8.2.

1. Operation

- 1) Move the work piece to the position to be set as a zero position, by the JOG operation etc.
- 2) Set the data-set type mechanical zero return operation start from off to on. (It outputs the CLR signal.)
- 3) The set value of the zero-point address is written to the current address.
- 4) The zero return completion turns on.
In case of the data-set type zero return, the positioning completion flag does not turn on.

2. Positioning completion flag

Turns on when the zero return is completed and after the zero-point address is written to the current address. Turns off when the power is turned off or when K0 is written to the status information. It does not turn off when the operation is started.

3. Positioning completion flag

The positioning completion flag turns off when the data-set type mechanical zero return operation starts. The positioning completion flag does not turn on when the zero return operation is completed.

Setting items of the data-set type mechanical zero return operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b5, b4	#37 b5, b4		Position data multiplier
#14, #13	#50, #49	Zero-point address	
#25 b15		Operation command	Data-set type mechanical zero return operation start
#28 b2		Status information	Zero return completion

9. Positioning Control

This chapter explains the control of each positioning operation.

9.1 Functions Available with Each Positioning Operation

Positioning operations and available functions are as shown in the following table.

Function	Operation mode							Reference
	1-speed positioning operation	Interrupt 1-speed positioning operation	2-speed positioning operation	External command positioning operation	Variable speed operation	Interrupt stop operation	Interrupt 2-speed positioning operation	
Extension positioning parameter	✓	✓	✓	✓	✓	✓	✓	Section 7.3
Forward limit/Reverse limit	✓	✓	✓	✓	✓	✓	✓	Section 6.4
STOP command	✓	✓	✓	✓	✓	✓	✓	Section 6.5
Remaining distance operation	✓	-	✓	-	-	✓	-	Subsection 6.5.2
Approximate S-shaped acceleration/deceleration	✓	✓	-	-	-	✓	-	Section 6.8
Operation speed change function	✓	✓	✓	✓	-	✓	✓	Section 6.6
Target address change function	✓	✓	✓	-	-	✓	✓	Section 6.7
Starting delay time	✓	✓	✓	✓	✓	✓	✓	Subsection 7.4.1

✓ : Applicable
- : Not applicable

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9.2 1-speed Positioning Operation

By the 1-speed positioning operation start command, the operation starts at the operation speed I, and the operation decelerates and stops at target address I.

→ For change of the operation speed, refer to Section 6.6.

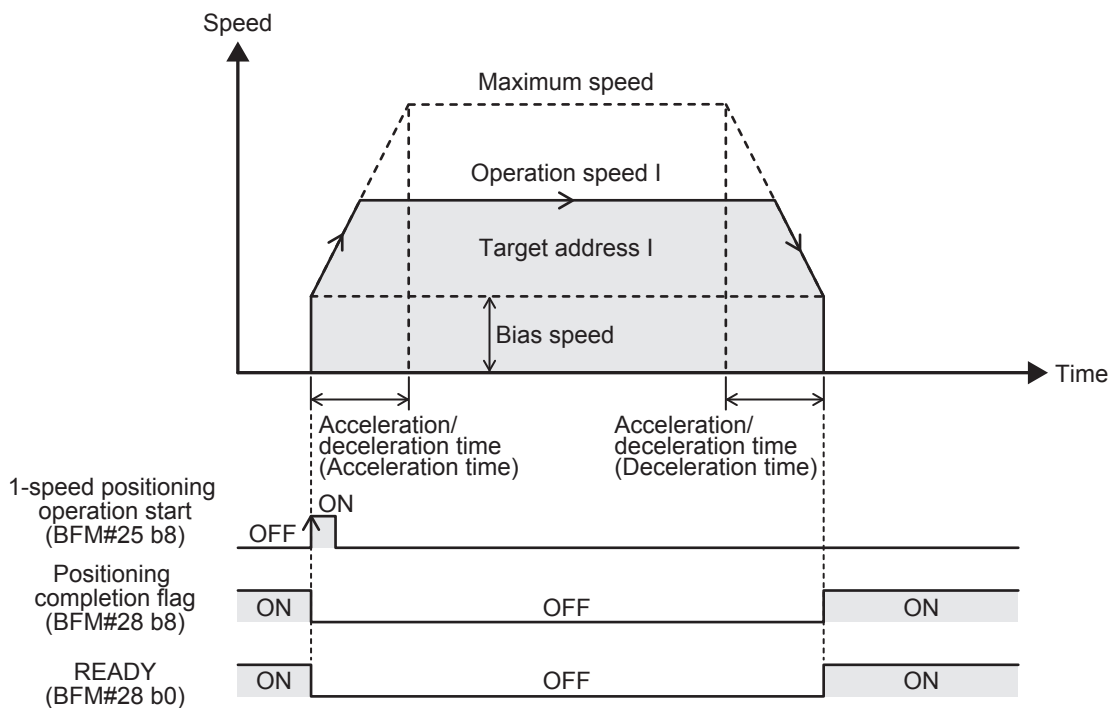
→ For change of the target address, refer to Section 6.7.

→ For details on the approximate S-shaped acceleration/deceleration, refer to Section 6.8.

→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set the operation speed 1 and target address 1.
- 2) When the 1-speed positioning operation start of the operation command is turned from off to on, the 1-speed positioning operation in operation speed I starts. (The positioning completion flag turns off.)
- 3) The operation decelerates and stops at target address I. The positioning completion flag turns on, and the operation ends.



Point

When the travel amount is 0, the positioning operation is not executed even when the 1-speed positioning operation start is turned on. In addition, the positioning completion flag also does not change. The READY turns off only for an instant.

2. Address specification

Both absolute address and the relative address specification is possible.

With absolute address specified: Specifies the distance from the address 0.

With relative address specified: Specifies a travel distance from the current address.

3. Rotation direction

- With absolute address specified:
 - The rotation direction is determined according to the relationship between the current address and the target address I.
 - Current address < Target address I: Forward
 - Current address > Target address I: Reverse
- With relative address specified:
 - The rotation direction is determined by the sign (positive/negative) of the target address I.
 - Target address I > 0: Forward
 - Target address I < 0: Reverse

4. Positioning completion flag

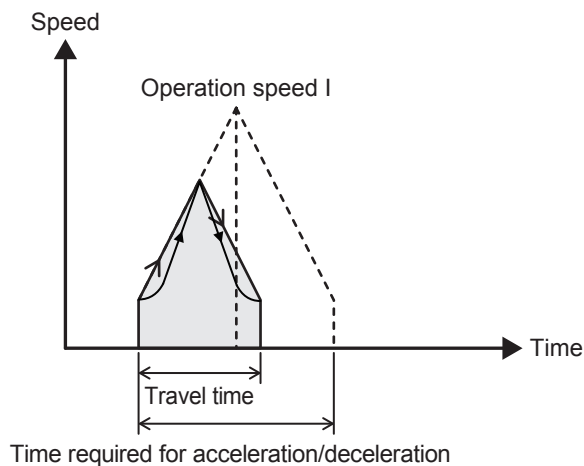
The positioning completion flag turns off when the operation starts.
The positioning completion flag turns on when the operation reaches the target address.

Setting items of the 1-speed positioning operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b6	#37 b6		Acceleration/deceleration mode
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b14	#37 b14		STOP input polarity
#3 b15	#37 b15		STOP input mode
#5, #4	#39, #38		Maximum speed
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#18, #17		Target address I	
#20, #19		Operation speed I	
#25 b8		Operation command	1-speed positioning operation start
#54, #53		Target address change value	
#56, #55		Operation speed change value	

Caution of the 1-speed positioning operation

- Operation when the travel amount to the target position is small
When the time required for the travel amount (target address I) is shorter than the time required for the acceleration/deceleration, the actual operation speed does not reach operation speed I.



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9.3 Interrupt 1-speed Positioning Operation

By the interrupt 1-speed positioning start command, the operation starts with operation speed I. After detecting the rise/fall edge of the interrupt input 0, the operation decelerates and stops at the target address I.

→ For change of the operation speed, refer to Section 6.6.

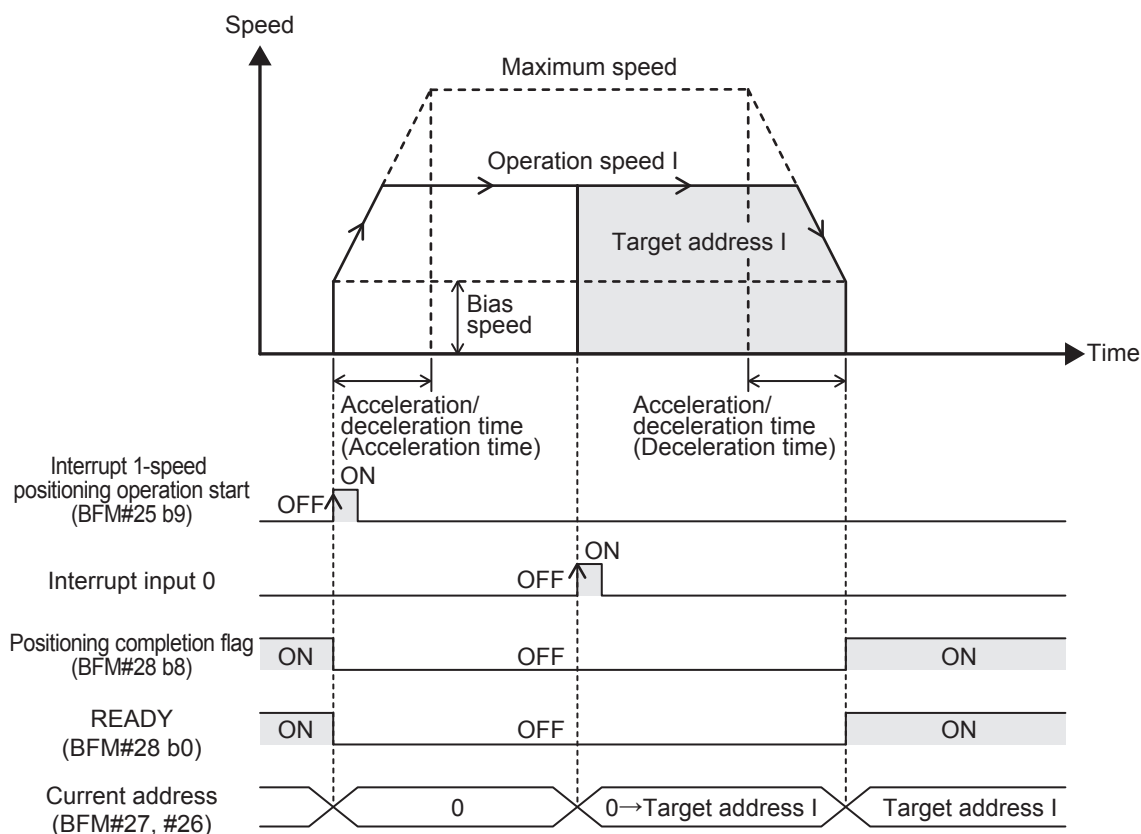
→ For change of the target address, refer to Section 6.7.

→ For details on the approximate S-shaped acceleration/deceleration, refer to Section 6.8.

→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set operation speed 1 and target address 1.
- 2) When the interrupt 1-speed positioning operation start of the operation command is turned from off to on, the interrupt 1-speed positioning operation in the operation speed I starts. (The positioning completion flag turns off.)
- 3) When the interrupt input 0 is detected, the traveling is executed for the distance set to target address I in the operation speed I, and decelerates and stops. The positioning completion flag turns on and the operation ends.



Point

- The current address is cleared by the interrupt 1-speed positioning operation start command. After detecting the interrupt input 0, the current address starts changing.
- When the travel amount is 0, the positioning operation is not executed even when the interrupt 1-speed positioning operation start is turned on. In addition, the positioning completion flag also does not change. The READY turns off only for an instant.

2. Address specification

Address specification is handled as a relative address (the travel amount is specified by using the distance from the current address.

(Even when the absolute address is specified, relative address specification is used.)

3. Rotation direction

The operation direction is determined by the sign (positive/negative) of the target address I.
 When the target address I sign is positive: Forward
 When the target address I sign is negative: Reverse

4. Positioning completion flag

The positioning completion flag turns off when the operation starts.
 The positioning completion flag turns on when the operation reaches to the target address I.

5. Interrupt input 0

The contents of the interrupt input 0 and the detection edge change as follows by the interrupt input setting and the DOG input polarity setting.

Interrupt input setting (BFM#3 b3, b2 or BFM#37 b3, b2)	DOG input polarity (BFM#3 b12 or BFM#37 b12)	Interrupt input 0	Detection edge
(0, 1) or (0, 0)	0	DOG	Rising edge
(0, 1) or (0, 0)	1	DOG	Falling edge
(1, 1) or (1, 0)	-	INT0	Rising edge

Point

- When interrupt input 0 is on at the start of the positioning operation and the rising edge is the detection edge, interrupt input 0 becomes valid when the signal turns OFF and then ON again.
- When interrupt input 0 is off at the start of the positioning operation and the falling edge is the detection edge, interrupt input 0 becomes valid when the signal turns ON and then OFF again.

Setting items of the interrupt 1-speed positioning operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b3, b2	#37 b3, b2		Interrupt input setting
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b6	#37 b6		Acceleration/deceleration mode
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b12	#37 b12		DOG input polarity
#3 b14	#37 b14		STOP input polarity
#3 b15	#37 b15		STOP input mode
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#18, #17		Target address I	
#20, #19		Operation speed I	
#25 b9		Operation command	Interrupt 1-speed positioning operation start
#54, #53		Target address change value	
#56, #55		Operation speed change value	
#57 b0		Operation command II	INT0

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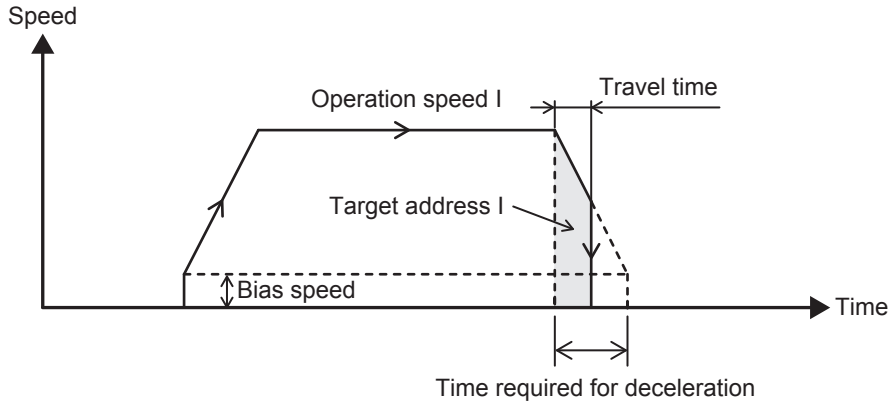
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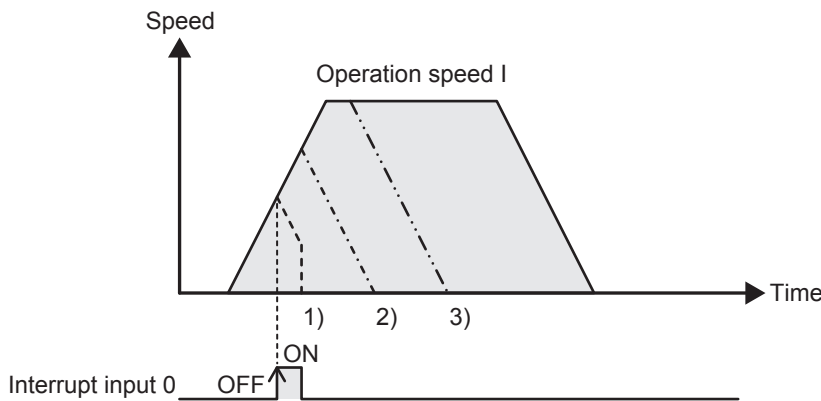
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Caution of the interrupt 1-speed positioning operation

- Operation when the travel amount to the target position is small
When the time required for the travel amount (target address I) is shorter than the time required for deceleration, the operation immediately stops when the operation reaches target address I. In addition, when the travel amount is smaller than $(\text{operation speed}/1,000) \times 3$ pulse, variation occurs in the detection of the interrupt input.
 - During operation at 1 kHz or higher: Within 3 ms
 - During operation at less than 1 kHz: Within 3 pulses



- Operation when the interrupt input 0 is detected during the acceleration
 - 1) When the target address I < the number of pulses required for deceleration from the current speed
As soon as the interrupt input 0 turns on, the deceleration immediately starts. When the operation reaches to the target address I, it immediately stops.
 - 2) When the number of pulses required for deceleration from the current speed ≤ target address I < pulse number required for acceleration/deceleration from the current speed
The acceleration is executed up to the position where the remaining pulse number = pulse number required for deceleration, and then the operation decelerates and stops.
 - 3) When the pulse number required for acceleration/deceleration from the current speed ≤ the target address I
The operation accelerates to the operation speed I and then decelerates and stops.



- Operation when the interrupt input 0 is not detected
The operation continues until the interrupt input 0 is detected.

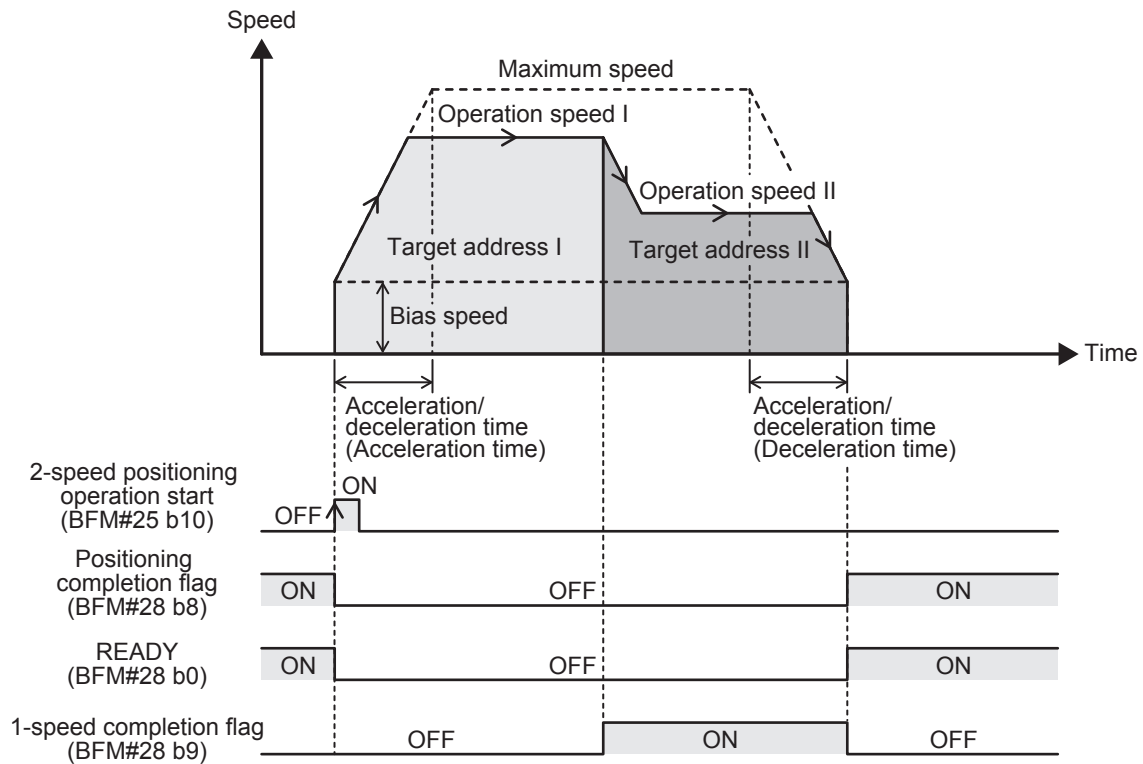
9.4 2-speed Positioning Operation

By the 2-speed positioning operation start command, the operation starts with the operation speed I. It moves to target address I, changes the speed to operation speed II, and travels to the target address II, and decelerates and stops.

- For change of the operation speed, refer to Section 6.6.
- For change of the target address, refer to Section 6.7.
- For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set the operation speed I, operation speed II, target address I, and target address II.
- 2) When the 2-speed positioning operation start of the operation command is turned from off to on, the 2-speed positioning operation in the operation speed I starts. (The positioning completion flag turns off.)
- 3) The speed changes to the operation speed II at the target address I. (The 1-speed completion flag turns on.)
- 4) The operation decelerates and stops at the target address II and turns on the positioning completion flag and ends the operation.



Point

When the travel amount is 0, the positioning operation is not executed even when the 2-speed positioning operation start is turned on. In addition, the positioning completion flag also does not change. The READY turns off only for an instant.

2. Address specification

Both absolute address and the relative address specification is possible.

With absolute address specified: Specifies the distance from the address 0.

With relative address specified: Specifies the travel distance from the current address.

3. Rotation direction

- With the specified absolute address:
 - The rotation direction is determined according to the relationship between the current address, the target address I, and the target address II.
 - Current address < Target address I, Target address I < Target address II: Forward
 - Current address > Target address I, Target address I > Target address II: Reverse

- With the specified relative address:
The rotation direction is determined by the sign (positive/negative) of the target address I and the target address II.
 - Target address I, Target address II > 0: Forward
 - Target address I, Target address II < 0: Reverse

Caution

An abrupt change in the rotation direction may cause damage to the machine. It may also cause an error through motor overload.

If the operation in a different direction requires stop time, use the 1-speed positioning operation.

Point

When the traveling direction to the target address I and target address II is not the same as shown below, the motor decelerates and stops at the target address I, and then starts rotation in the reverse direction within 1 ms in the case of forward pulse/reverse pulse output or within 2 ms in the case of pulse/direction output.

- With the specified absolute address: When the relationship between "the current address and the target address I" and "the target address I and the target address II" is different
- With the specified relative address: When the target address I and the target address II signs (positive/negative) are different

4. 1-speed completion flag

- Conditions to turn on
 - When the operation reaches target address I
 - When the operation exceeds target address I during deceleration by an error or by STOP
- Conditions to turn off
 - When the positioning completes
 - When the operation stops by an error
 - When the operation stops by the STOP command (only when the remaining distance operation is invalid)
 - When the remaining distance operation is cancelled (only when the remaining distance operation is valid)

5. Positioning completion flag

The positioning completion flag turns off when the operation starts.

The positioning completion flag turns on when the operation reaches target address II.

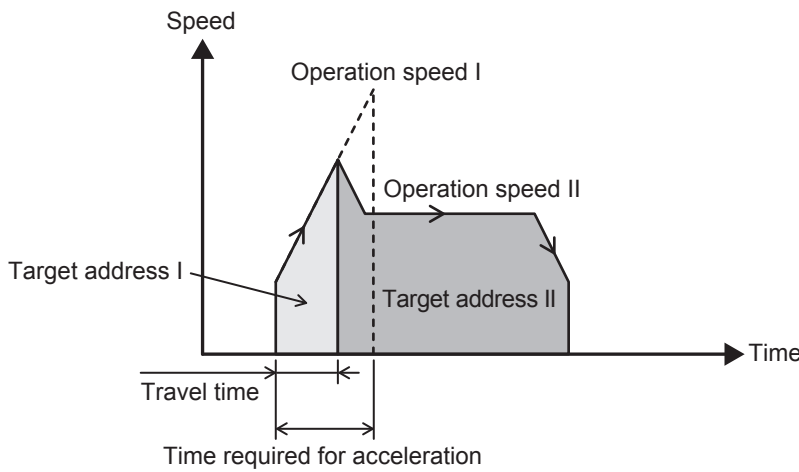
Setting items of the 2-speed positioning operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	
#3 b5, b4	#37 b5, b4		System of units
#3 b8	#37 b8		Position data multiplier
#3 b9	#37 b9		Pulse output format
#3 b11	#37 b11		Rotation direction
#3 b14	#37 b14		Limit deceleration mode
#3 b15	#37 b15		STOP input polarity
			STOP input mode
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#18, #17		Target address I	
#20, #19		Operation speed I	

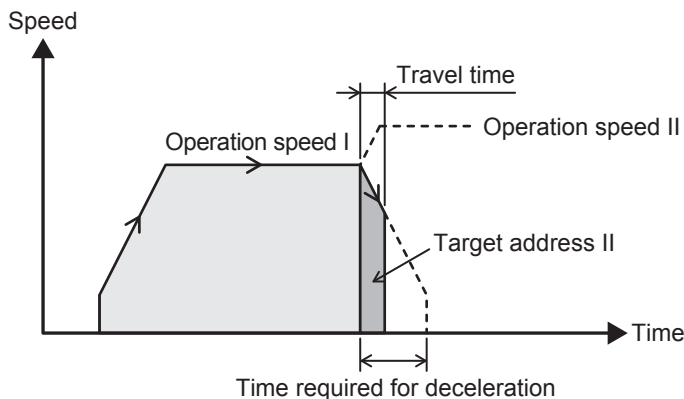
BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#22, #21		Target address II	
#24, #23		Operation speed II	
#25 b10		Operation command	2-speed positioning operation start
#54, #53		Target address change value	
#56, #55		Operation speed change value	

Caution of the 2-speed positioning operation

- Operation when the 1-speed travel amount is small
 - When the time required to accelerate to the operation speed I < the travel time to target address I
The operation accelerates until reaching target address I

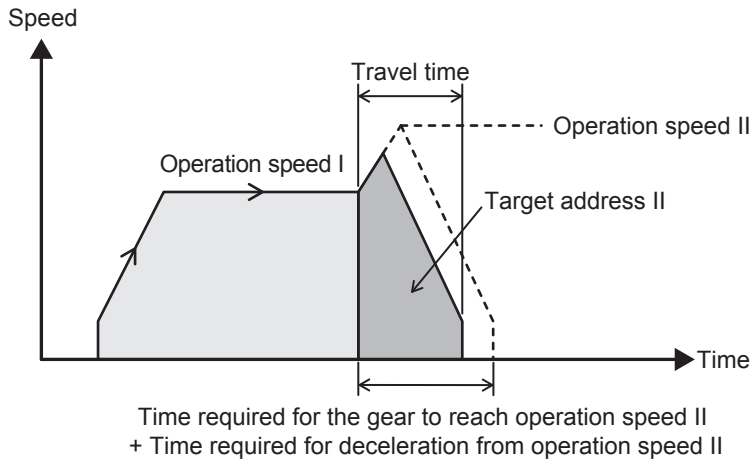


- When the 1-speed travel amount is 0
When the 1-speed travel amount is 0, the operation starts with operation speed II and decelerates and stops at the target address II. The 1-speed completion flag turns on at the startup of the operation and turns off when the positioning completes.
- Operation when the 2-speed travel amount is small
 - When the time required to decelerate from operation speed I > the travel time to target address II
The deceleration starts after the 1-speed completion and stops when target address II is reached.



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- When the time required to decelerate from operation speed I < the travel time to target address II < time required to change the speed to operation speed II + time required to decelerate from the operation speed II
The deceleration starts before reaching operation speed II

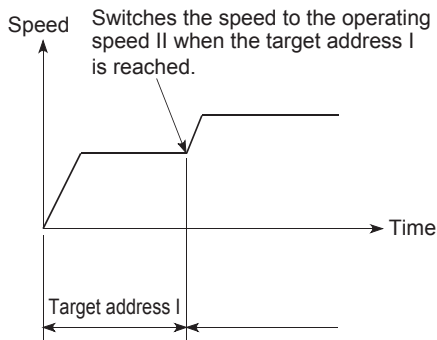


- When the 2-speed travel amount is 0
When the 2-speed travel amount is 0, the operation starts with operation speed I and decelerates and stops at the target address I. The 1-speed completion flag does not turn on, and the positioning completion flag turns on when the positioning completes.
- Caution when the target address change function and the operation speed change function are used.
When a value is set to the target address change value (BFM#54, #53) or operation speed change value (BFM#56, #55) within the time shown below just before the speed changes from the 1-speed to the 2-speed, the travel amount at the 2-speed may change.
 - During operation at 1 kHz or higher: within 3 ms
 - During operation at less than 1 kHz: within 3 pulses

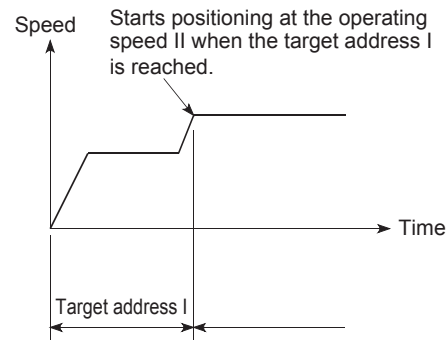
6. Speed switching

Speed switching is classified into “standard switching” and “front-load switching”. In the FX3U-1PG, the speed is switched by standard switching. (Refer to the figure below.)

<Operation by standard switching>



<Operation by front-load switching>



9.5 External Command Positioning Operation

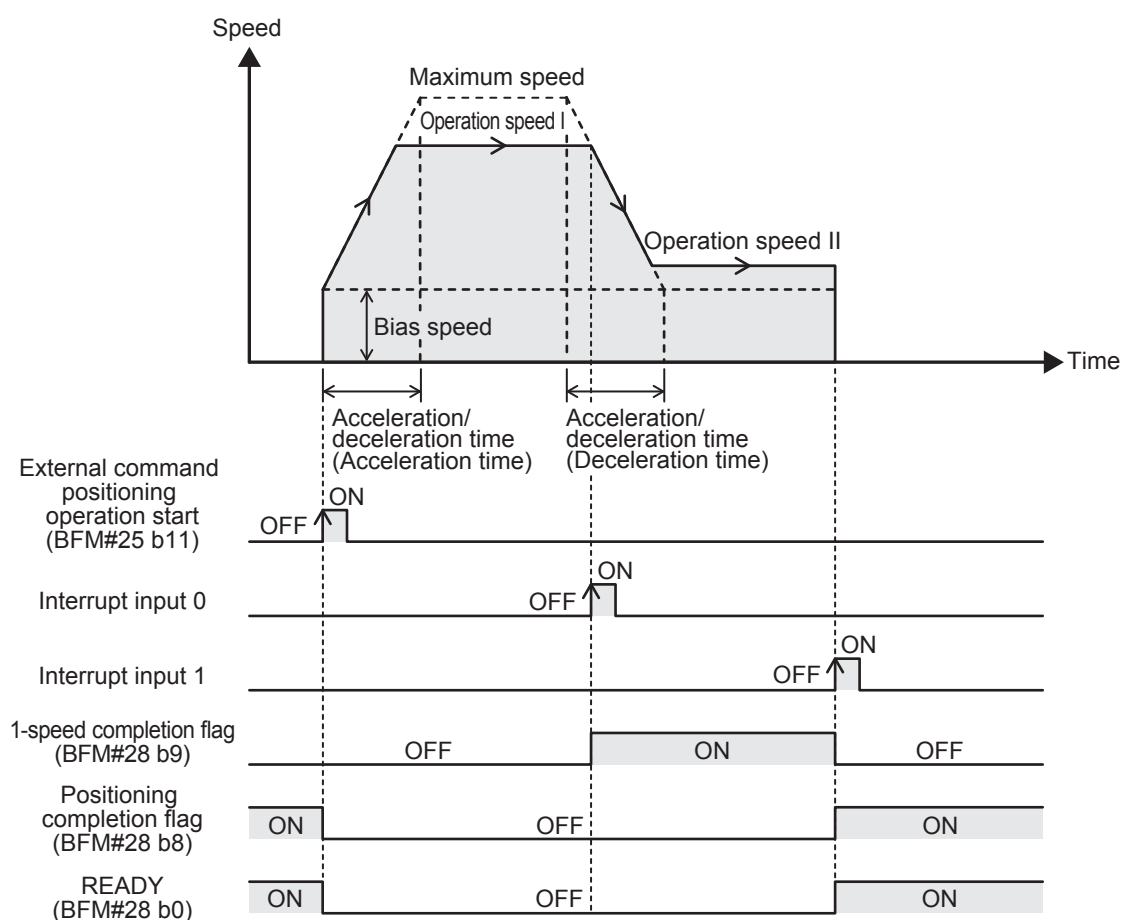
By the external command positioning operation start command, the operation starts with operation speed I, detects the rise/fall edge of interrupt input 0, and changes the speed to operation speed II. Then, the rise/fall edge of the interrupt input 1 is detected and stops immediately.

→ For change of the operation speed, refer to Section 6.6.

→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set operation speed I and operation speed II.
- 2) When the operation command to start external command positioning operation is turned from off to on, the external command positioning operation starts with operation speed I. (The positioning completion flag turns off.)
- 3) When interrupt input 0 is detected, the speed changes to operation speed II.
- 4) When interrupt input 1 is detected, the operation immediately stops, and the operation completes by turning on the positioning completion flag.



Point

When the interrupt input 1 is detected before the interrupt input 0 is detected, the operation immediately stops.

2. Rotation direction

The rotating direction is determined by the sign (positive/negative) of the operation speed I.

- Operation speed I > 0: Forward
- Operation speed I < 0: Reverse

Point

When the signs (positive/negative) of the operation speed I and the operation speed II are different, the 2-speed is operated with the bias speed. However, if the bias speed is 0, the operation is executed at 1 Hz.

3. 1-speed completion flag

- Conditions to turn on
 - When interrupt input 0 is detected
- Conditions to turn off
 - When the positioning completes
 - When the operation stops by an error
 - When the operation stops by the STOP command

4. Positioning completion flag

The positioning completion flag turns off when the operation starts.

The positioning completion flag turns on when interrupt input 1 is detected and the operation is stopped.

5. Interrupt input 0, Interrupt input 1

The contents of the interrupt input 0, the interrupt input 1, and the detection edge change as follows depending on the interrupt input setting, DOG input polarity, and the STOP input polarity setting.

Interrupt input setting (BFM#3 b3, b2 or BFM#37 b3, b2)	DOG input polarity (BFM#3 b12 or BFM#37 b12)	STOP input polarity (BFM#3 b14 or BFM#37 b14)	Interrupt input 0: Detection edge	Interrupt input 1: Detection edge
(0, 0)	0	0	DOG: Rising edge	STOP (Terminal): Rising edge
(0, 0)	0	1	DOG: Rising edge	STOP (Terminal): Falling edge
(0, 0)	1	0	DOG: Falling edge	STOP (Terminal): Rising edge
(0, 0)	1	1	DOG: Falling edge	STOP (Terminal): Falling edge
(0, 1)	0	-	DOG: Rising edge	INT1: Rising edge
(0, 1)	1	-	DOG: Falling edge	INT1: Rising edge
(1, 0)	-	0	INT0: Rising edge	STOP (Terminal): Rising edge
(1, 0)	-	1	INT0: Rising edge	STOP (Terminal): Falling edge
(1, 1)	-	-	INT0: Rising edge	INT1: Rising edge

Point

- When interrupt input 0 and interrupt input 1 are on at the start of the positioning operation and the rising edge is the detection edge, interrupt input 0 and interrupt input 1 become valid when their signals turns OFF and then ON again, respectively.
- When interrupt input 0 and interrupt input 1 are off at the start of the positioning operation and the falling edge is the detection edge, interrupt input 0 and interrupt input 1 become valid when their signals turns ON and then OFF again, respectively.

Setting items of the external command positioning operation

BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b3, b2	#37 b3, b2		Interrupt input setting
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b12	#37 b12		DOG input polarity
#3 b14	#37 b14		STOP input polarity
#3 b15	#37 b15		STOP input mode
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#20, #19		Operation speed I	
#24, #23		Operation speed II	
#25 b11		Operation command	External command positioning operation start
#56, #55		Operation speed change value	
#57 b0		Operation command II	INT0
#57 b1			INT1

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9.6 Variable Speed Operation

By the variable speed operation command, the operation starts with operation speed I. When operation speed I is changed during the operation, the operation is executed with the changed speed.

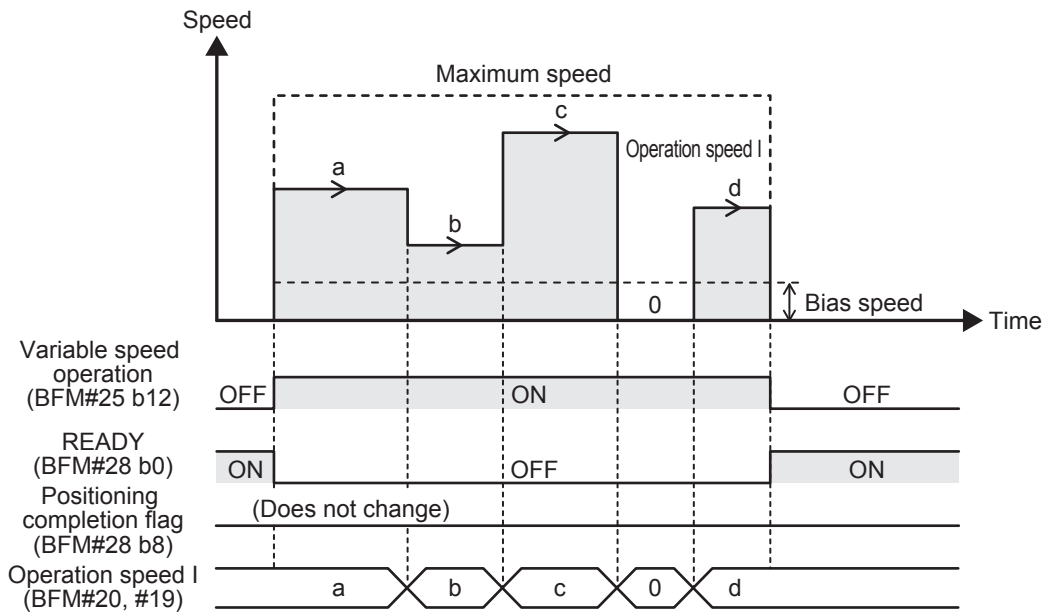
When the variable speed operation command is turned off, the operation immediately stops or decelerates and stops. For the variable speed operation, select "without acceleration/deceleration" and "with acceleration/deceleration" by the variable speed operation acceleration/deceleration setting (BFM#3 b7 or BFM#37 b7).

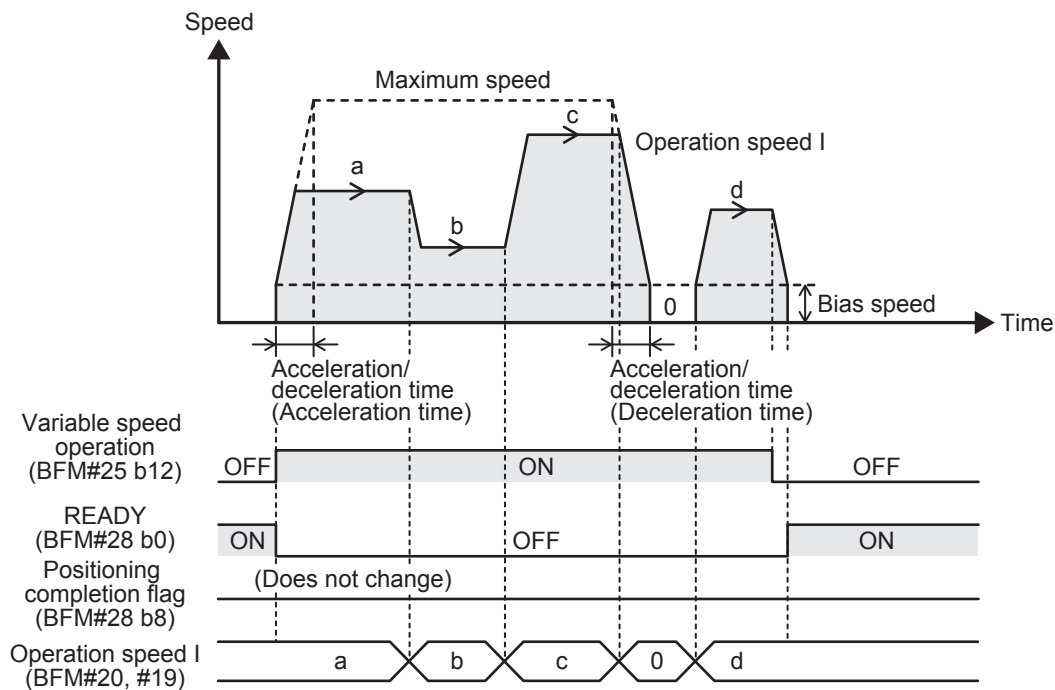
→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set operation speed I to any value other than 0.
- 2) When the variable speed operation command of the operation command is turned on, the variable speed operation starts.
- 3) When the variable speed operation command of the operation command is turned off, the variable speed operation stops. (Without acceleration/deceleration: immediately stops, With acceleration/deceleration: decelerates and stops)

Without acceleration/deceleration (when BFM#3 b7 or BFM#37 b7 is off)



With acceleration/deceleration (when BFM#3 b7 or BFM#37 b7 is on)**Point**

- Operation speed I does not change in the following cases
 - During deceleration by the deceleration command (STOP, forward limit, reverse limit)
 - During deceleration stop by operation command OFF
- When the variable speed operation command (with acceleration/deceleration) is turned off and the operation command is turned on again during deceleration, the operation decelerates and stops once and then accelerates again. After the deceleration and stop, READY turns on for an instant. Take note that READY ON may possibly be detected depending on the timing.
- When operation speed I is started with 0, the pulse output is not executed, but READY turns OFF.

2. Rotation direction

The rotating direction is determined by the sign (positive/negative) of operation speed I.

- Operation speed I > 0: Forward
- Operation speed I < 0: Reverse
- When operation speed I = 0, or the absolute value of operation speed I < bias speed: Stop

Caution

An abrupt change in the rotation direction may cause damage to the machine. It may also cause an error through motor overload.

To change the rotation direction, set operation speed I value to 0, and wait for the motor to stop completely after stop.

If operation speed I value changes from positive to negative (e.g. 100 → -100), the work piece will stop, and start reverse operation.

Point

When the sign (positive or negative) of the operation speed I is changed during the operation, the motor immediately stops or decelerates and stops, and then starts rotation in the reverse direction within 1 ms in the case of forward pulse/reverse pulse output or within 2 ms in the case of pulse/direction output.

3. Acceleration/deceleration speed setting of the variable speed operation

- When the acceleration/deceleration speed setting of the variable speed operation is off: Variable speed operation without acceleration/deceleration
- When the acceleration/deceleration speed setting of the variable speed operation is on: Variable speed operation with the acceleration/deceleration

4. Positioning completion flag

Before and after the variable speed operation, the positioning completion flag does not change.

5. Response time

When operation speed I is changed, the time required to change the speed becomes as follows.

- During operation at 1 kHz or higher: Within 3 ms
- During operation at less than 1 kHz: Within 3 pulses

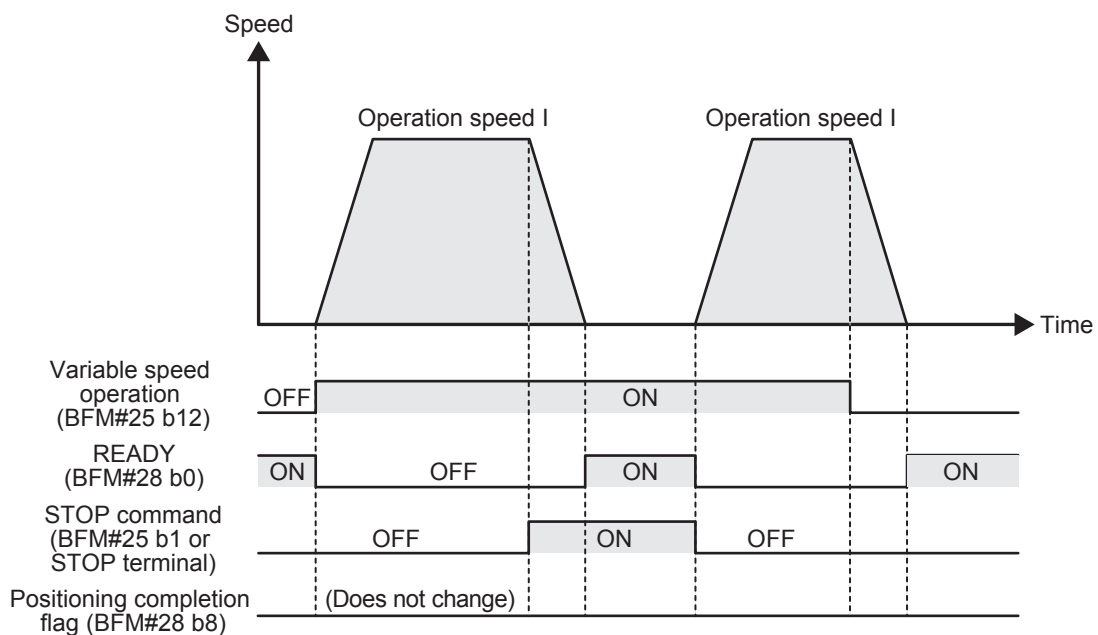
Setting items of the variable speed operation

BFM No.		Setting items
Positioning parameter	Extension positioning parameter	
#0	#34, #33	Pulse rate
#2, #1	#36, #35	Feed rate
#3 b1, b0	#37 b1, b0	Operation parameter
#3 b5, b4	#37 b5, b4	
#3 b7	#37 b7	
#3 b8	#37 b8	
#3 b9	#37 b9	
#3 b11	#37 b11	
#3 b14	#37 b14	
#3 b15	#37 b15	
#5, #4	#39, #38	Maximum speed
#6	#41, #40	Bias speed
#15	-	Acceleration/deceleration time
-	#51	Acceleration time
-	#52	Deceleration time
#16		Starting delay time
#20, #19		Operation speed I
#25 b12		Operation command
		Variable speed operation

Caution of the variable speed operation

- Operation when the STOP command is set to ON during the variable speed operation
The motor stops when the STOP command is set to ON during the variable speed operation, and restarts the operation when the STOP command is set to OFF.

Example when acceleration/deceleration is provided



9.7 Interrupt Stop Operation

By the interrupt stop operation start command, the operation starts with operation speed I. After detecting the rise/fall edge of interrupt input 0, the operation decelerates and stops. In addition, when interrupt input 0 is not detected, the operation decelerates and stops at the target address I.

→ For change of the operation speed, refer to Section 6.6.

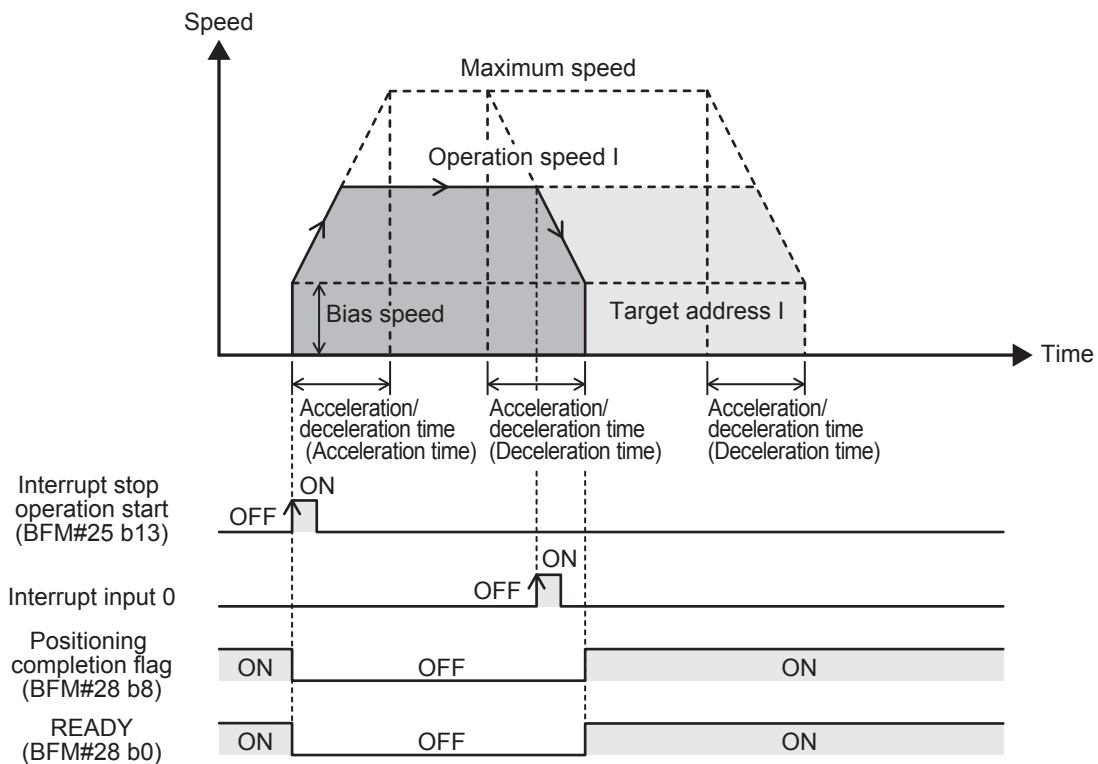
→ For change of the target address, refer to Section 6.7.

→ For details on the approximate S-shaped acceleration/deceleration, refer to Section 6.8.

→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) It sets the operation speed I and the target address I.
- 2) When the interrupt stop operation start of the operation command is turned from off to on, the interruption stop operation starts with operation speed I. (The positioning completion flag turns off.)
- 3) When interrupt input 0 is detected, the operation decelerates and stops. Turn on the positioning completion flag to end the operation.



Point

When the travel amount is 0, the positioning operation is not executed even when the interrupt stop operation start is turned on. In addition, the positioning completion flag also does not change. The READY turns off only for an instant.

2. Address specification

Both absolute address and the relative address can be specified.

With absolute address specified: Specifies the distance from address 0.

With relative address specified: Specifies the travel amount from the current address.

3. Rotation direction

- With specified absolute address:
 - The rotating direction is determined according to the relationship between the current address and target address I.
 - Current address < Target address I: Forward
 - Current address > Target address I: Reverse

- With specified relative address:
The rotating direction is determined by the sign (positive/negative) of target address I.
 - Target address I > 0: Forward
 - Target address I < 0: Reverse

4. Positioning completion flag

The positioning completion flag turns off when the operation starts.
After the interrupt input 0 is detected, and the operation decelerates and stops, the positioning completion flag turns on.
When the interrupt input 0 is not detected, after the operation reaches to the target address I, the positioning completion flag turns on.

5. Interrupt input 0

The contents of the interrupt input 0 and the detection edge change as follows depending on the interrupt input setting and the DOG input polarity setting.

Interrupt input setting (BFM#3 b3, b2 or BFM#37 b3, b2)	DOG input polarity (BFM#3 b12 or BFM#37 b12)	Interrupt input 0	Detection edge
(0, 1) or (0, 0)	0	DOG	Rising edge
(0, 1) or (0, 0)	1	DOG	Falling edge
(1, 1) or (1, 0)	-	INT0	Rising edge

Point

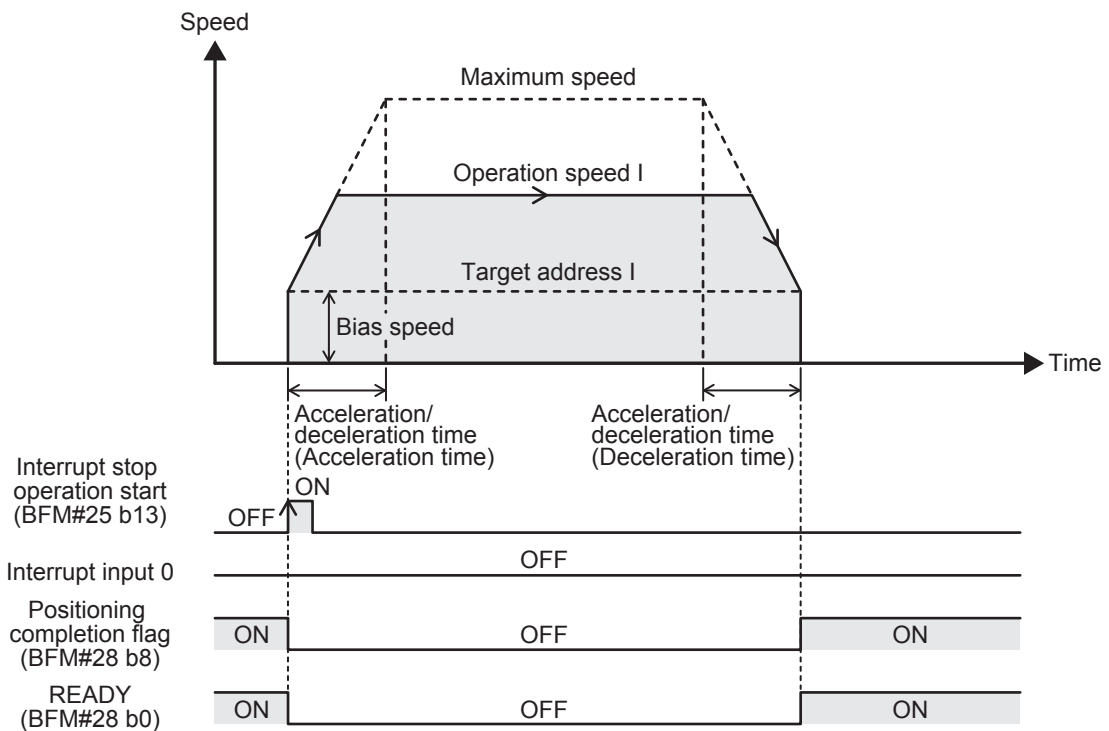
- When interrupt input 0 is on at the start of the positioning operation and the rising edge is the detection edge, interrupt input 0 becomes effective when the signal turns OFF and then ON again.
- When interrupt input 0 is off at the start of the positioning operation and the falling edge is the detection edge, interrupt input 0 becomes effective when the signal turns ON and then OFF again.

Setting items for the interrupt stop operation

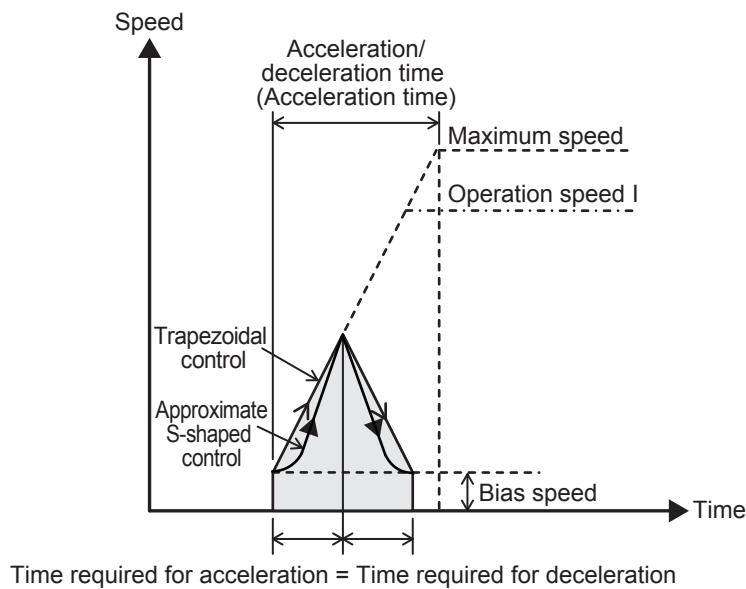
BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b3, b2	#37 b3, b2		Interrupt input setting
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b6	#37 b6		Acceleration/deceleration mode
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b12	#37 b12		DOG input polarity
#3 b14	#37 b14		STOP input polarity
#3 b15	#37 b15		STOP input mode
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#20, #19		Operation speed I	
#25 b13		Operation command	Interrupt stop operation start
#54, #53		Target address change value	
#56, #55		Operation speed change value	
#57 b0		Operation command II	INT0

Caution of the interrupt stop positioning operation

- Operation when interrupt input 0 is not detected
When interrupt input 0 is not detected, the positioning completion flag turns on after the operation reaches the target address I.



- Operation when interrupt input 0 is detected during acceleration
The following operation is executed when interrupt input 0 is detected during acceleration.



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9.8 Interrupt 2-speed Positioning Operation

By the interrupt 2-speed positioning start command, the operation starts with operation speed I. After detecting the rise/fall edge of interrupt input 0, the operation speed changes to operation speed II. Then, after the rise/fall edge of interrupt input 1 is detected, the operation decelerates and stops at target address I.

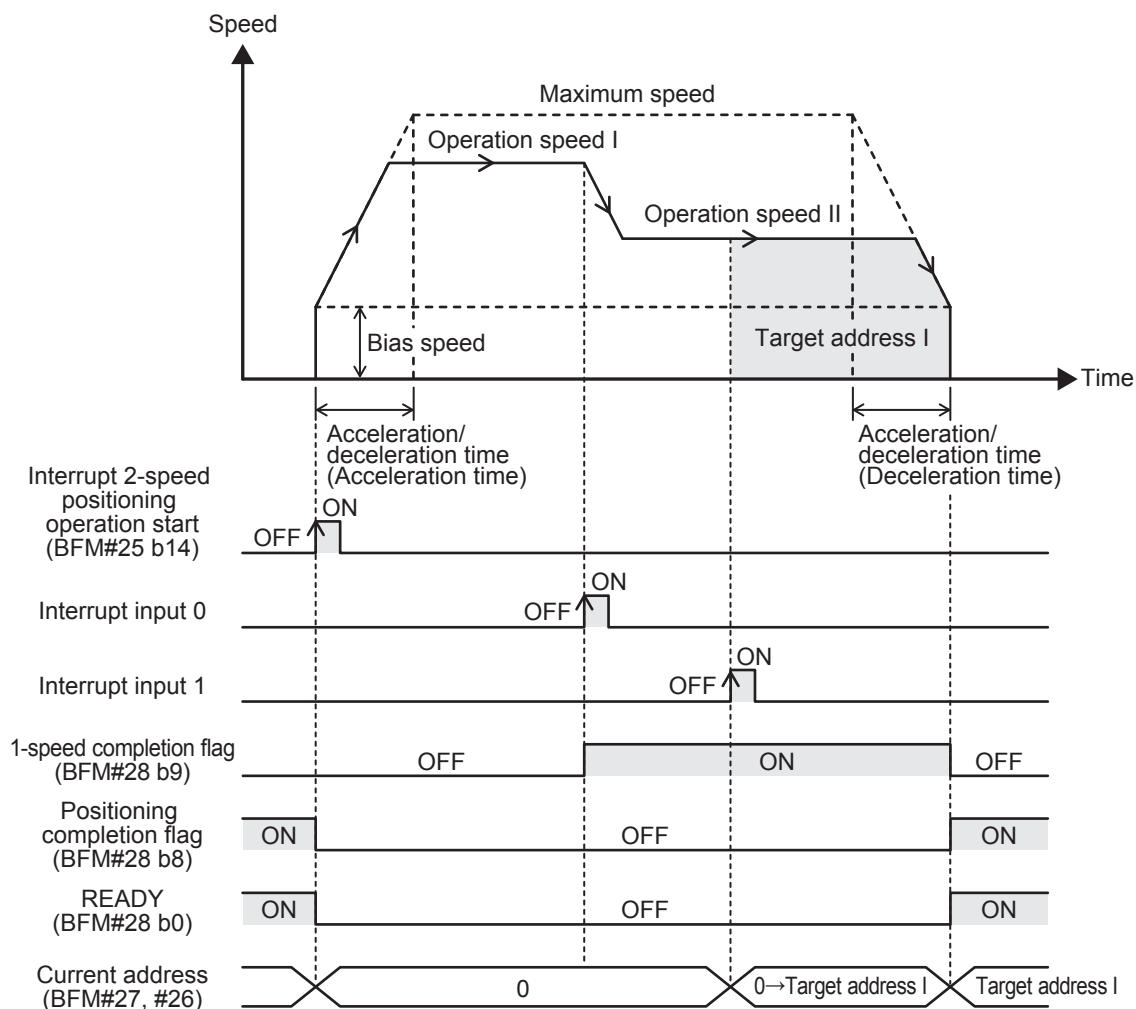
→ For change of the operation speed, refer to Section 6.6.

→ For change of the target address, refer to Section 6.7.

→ For details on the STOP command, refer to Section 6.5.

1. Operation

- 1) Set operation speed I, operation speed II, and target address I.
- 2) When the interrupt 2-speed positioning operation start of the operation command is turned from off to on, the interrupt 2-speed positioning operation in operation speed I starts. (The positioning completion flag turns off).
- 3) When interrupt input 0 is detected, the speed changes to operation speed II.
- 4) When interrupt input 1 is detected, traveling is executed for the amount set to the target address I with operation speed II, and the operation completes by turning on the positioning completion flag.



Point

- When interrupt input 1 is detected before interrupt input 0 is detected, interrupt input 1 is ignored.
- The current address is cleared by interrupt 2-speed positioning operation start command. After detecting interrupt input 1, the current address starts changing.
- When the travel amount is 0, the positioning operation is not executed even when the interrupt 2-speed positioning operation start is turned on. In addition, the positioning completion flag also does not change. READY turns off only instantaneously.

2. Address specification

Is handled as a relative address (the travel amount is specified by using the distance from the current address.)

(Even when an absolute address is specified, it is treated as a relative address.)

3. Rotation direction

The operation direction is determined by the sign (positive/negative) of target address I.

When the target address I sign is positive: Forward

When the target address I sign is negative: Reverse

4. 1-speed completion flag

- Conditions to turn on
 - When interrupt input 0 is detected
- Conditions to turn off
 - When the positioning completes
 - When the operation stops by an error
 - When the operation stops by the STOP command

5. Positioning completion flag

The positioning completion flag turns off when the operation starts.

When the interrupt input 1 is detected, and the operation reaches to the target address I, the positioning completion flag turns on.

6. Interrupt input 0, Interrupt input 1

The contents of the interrupt input 0, the interrupt input 1, and the detection edge change as follows depending on the interrupt input setting, the DOG input polarity, and the STOP input polarity settings.

Interrupt input setting (BFM#3 b3, b2 or BFM#37 b3, b2)	DOG input polarity (BFM#3 b12 or BFM#37 b12)	STOP input polarity (BFM#3 b14 or BFM#37 b14)	Interrupt input 0: Detection edge	Interrupt input 1: Detection edge
(0, 0)	0	0	DOG: Rising edge	STOP (Terminal): Rising edge
(0, 0)	0	1	DOG: Rising edge	STOP (Terminal): Falling edge
(0, 0)	1	0	DOG: Falling edge	STOP (Terminal): Rising edge
(0, 0)	1	1	DOG: Falling edge	STOP (Terminal): Falling edge
(0, 1)	0	-	DOG: Rising edge	INT1: Rising edge
(0, 1)	1	-	DOG: Falling edge	INT1: Rising edge
(1, 0)	-	0	INT0: Rising edge	STOP (Terminal): Rising edge
(1, 0)	-	1	INT0: Rising edge	STOP (Terminal): Falling edge
(1, 1)	-	-	INT0: Rising edge	INT1: Rising edge

Point

- When interrupt input 0 and interrupt input 1 are on at the start of the positioning operation and the rising edge is the detection edge, interrupt input 0 and interrupt input 1 become valid when their signals turn OFF and then ON again, respectively.
- When interrupt input 0 and interrupt input 1 are off at the start of the positioning operation and the falling edge is the detection edge, interrupt input 0 and interrupt input 1 become valid when their signals turn ON and then OFF again, respectively.

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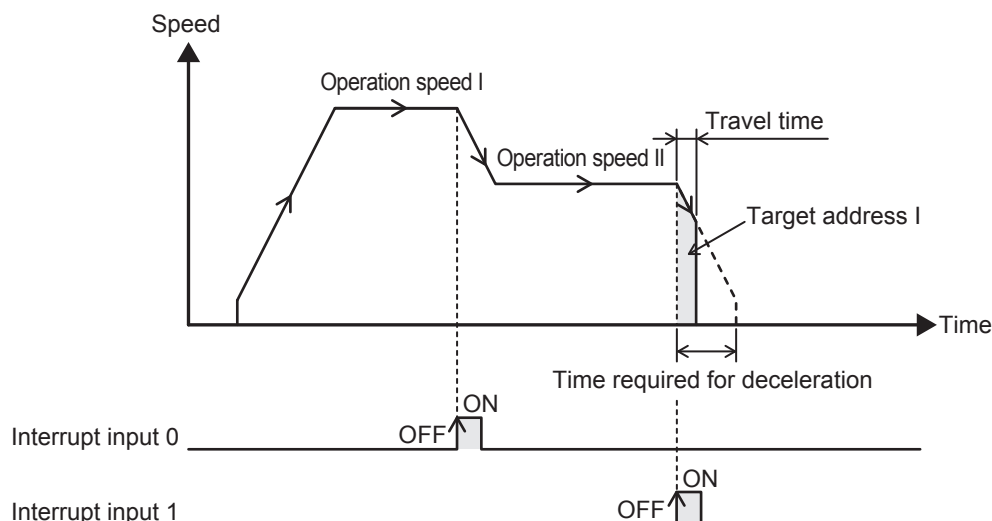
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Setting items of the interrupt 2-speed positioning operation


BFM No.		Setting items	
Positioning parameter	Extension positioning parameter		
#0	#34, #33	Pulse rate	
#2, #1	#36, #35	Feed rate	
#3 b1, b0	#37 b1, b0	Operation parameter	System of units
#3 b3, b2	#37 b3, b2		Interrupt input setting
#3 b5, b4	#37 b5, b4		Position data multiplier
#3 b8	#37 b8		Pulse output format
#3 b9	#37 b9		Rotation direction
#3 b11	#37 b11		Limit deceleration mode
#3 b12	#37 b12		DOG input polarity
#3 b14	#37 b14		STOP input polarity
#3 b15	#37 b15		STOP input mode
#5, #4	#39, #38	Maximum speed	
#6	#41, #40	Bias speed	
#15	-	Acceleration/deceleration time	
-	#51	Acceleration time	
-	#52	Deceleration time	
#16		Starting delay time	
#20, #19		Operation speed I	
#22, #21		Target address II	
#24, #23		Operation speed II	
#25 b14		Operation command	Interrupt 2-speed positioning operation start
#56, #55		Operation speed change value	
#57 b0		Operation command II	INT0
#57 b1			INT1


Caution of the interrupt 2-speed positioning operation

- Operation when the travel amount to the target position is small
When the time required for the travel amount (target address I) is shorter than the time required for deceleration, the operation immediately stops when the operation reaches the target address I. In addition, when the travel amount is smaller than $(\text{operation speed}/1,000) \times 3$ pulse, variation occurs in the detection of the interrupt input.
 - During operation at 1 kHz or higher: Within 3 ms
 - During operation at less than 1 kHz: Within 3 pulses



10. Program Example

STARTUP AND MAINTENANCE PRECAUTIONS	 WARNING
<ul style="list-style-type: none"> • Do not touch any terminal while the PLC's power is on. Doing so may cause electric shock or malfunctions. • Before cleaning or retightening terminals, cut off all phases of the power supply externally. Failure to do so may cause electric shock. • Before modifying or disrupting the program in operation or running the PLC, carefully read through this manual and the associated manuals and ensure the safety of the operation. An operation error may damage the machinery or cause accidents. 	

STARTUP AND MAINTENANCE PRECAUTIONS	 CAUTION
<ul style="list-style-type: none"> • Do not disassemble or modify the PLC. Doing so may cause fire, equipment failures, or malfunctions. For repair, contact your local Mitsubishi Electric representative. • Turn off the power to the PLC before connecting or disconnecting any extension cable. Failure to do so may cause equipment failures or malfunctions. • Turn off the power to the PLC before attaching or detaching the following devices. Failure to do so may cause equipment failures or malfunctions. <ul style="list-style-type: none"> - Peripheral devices, display modules, expansion boards and special adapters - I/O extension units/blocks, FX Series terminal block and the special function units/blocks - Battery and memory cassette 	

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10.1 Assignments

10.1.1 I/O assignments

PLC

Device No.	Name	Remarks
X000	Error reset	
X001	STOP	
X002	Forward limit	Use external wiring with NC contacts.
X003	Reverse limit	Use external wiring with NC contacts.
X004	Forward JOG operation	
X005	Reverse JOG operation	
X006	DOG type mechanical zero return operation start	
X007	1-speed positioning operation start	
Y000	Stand by display	

FX3U-1PG

Terminal name	Description	Remarks
DOG	DOG input of DOG type mechanical zero return	
STOP	Deceleration stop input	
PG0	Zero point signal is input form the servo amplifier	
FP	Forward pulses output	
RP	Reverse pulses output	
CLR	CLR signal is being output	

10.1.2 Device assignments

Device No.	Name	Remarks
M0	Error reset	
M1	STOP	
M2	Forward limit	
M3	Reverse limit	
M4	Forward JOG operation	
M5	Reverse JOG operation	
M6	DOG type mechanical zero return operation start	
M7	Relative/absolute address	Relative address specification
M8	1-speed positioning operation start	
M9	Interrupt 1-speed positioning operation start	Always OFF
M10	2-speed positioning operation start	Always OFF
M11	External command positioning operation start	Always OFF
M12	Variable speed operation	Always OFF
M13	Interrupt stop operation start	Always OFF
M14	Interrupt 2-speed positioning operation start	Always OFF
M15	Data-set type mechanical zero return operation start	Always OFF
M20	READY	
M28	Positioning completion flag	
D11, D10	Current address	
D21, D20	Current address (pulse converted value)	
D31, D30	Current value of operation speed	

10.1.3 Buffer memory assignments

BFM No.	Name	Setting value	Remarks
#0	Pulse rate	K8,192	PLS/REV
#2, #1	Feed rate	K1,000	μm/REV
#3 b1, b0	Operation parameter	H2032	b1=1, b0=0: Combined system
#3 b3, b2			b3=0, b2=0: Not used
#3 b5, b4			b5=1, b4=1:10 ³
#3 b6			b6=0: Trapezoidal acceleration/deceleration
#3 b7			b7=0: Not used
#3 b8			b8=0: Forward pulse/Reverse pulse
#3 b9			b9=0: Current address increases
#3 b10			b10=0: Current address decreases
#3 b11			b11=0: Immediately stop
#3 b12			b12=0: NO contacts
#3 b13			b13=1: DOG backward end
#3 b14			b14=0: NO contacts
#3 b15			b15=0: Remaining distance operation
#5, #4			Maximum speed
#6	Bias speed	K0	
#8, #7	JOG speed	K10,000	
#10, #9	Zero return speed (high speed)	K10,000	
#11	Zero return speed (creep)	K1,500	
#12	Number of zero-point signal for zero return	K3	
#14, #13	Zero-point address	K0	
#15	Acceleration/deceleration time	K100	
#16	Starting delay time	K0	
#18, #17	Target address I	K1,000	
#20, #19	Operation speed I	K200,000	
#25	Operation command	M15 to M0	Refer to Subsection 10.1.2.
#28	Status information	M35 to M20	Refer to Subsection 10.1.2.
#32	Positioning parameter selection	K0	Use the positioning parameter

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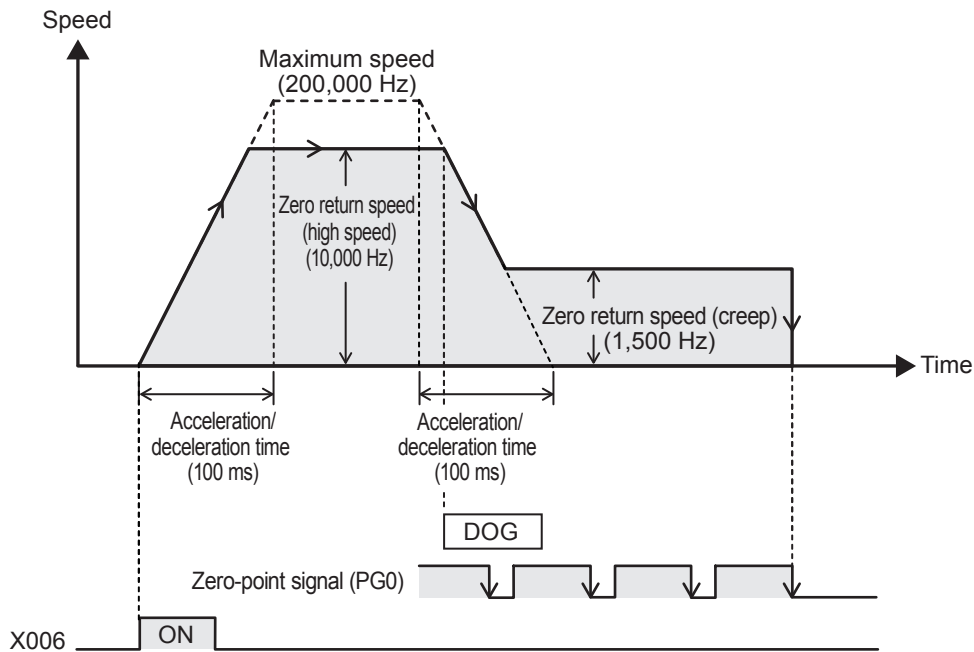
Program Example

10.2 Explanation of Operation

The motor executes reciprocating movements using the 1-speed positioning operation. The motor can execute also the DOG type mechanical zero return operation and JOG operation. Do not put the load on the motor for safety reasons when you confirm the operation according to this program example.

10.2.1 DOG type mechanical zero return operation

- 1) When X006 (DOG type mechanical zero return operation start) in the PLC main unit is set to ON, the motor starts the DOG type mechanical zero return operation in the current value decreasing direction.
- 2) When the DOG input turns ON, the motor decelerates to the zero return speed (creep).
- 3) When the zero-point signal is input for 3 counts after the DOG input turns OFF again, the motor stops, the zero-point address "0" is written to the current address, and the CLR signal is output.

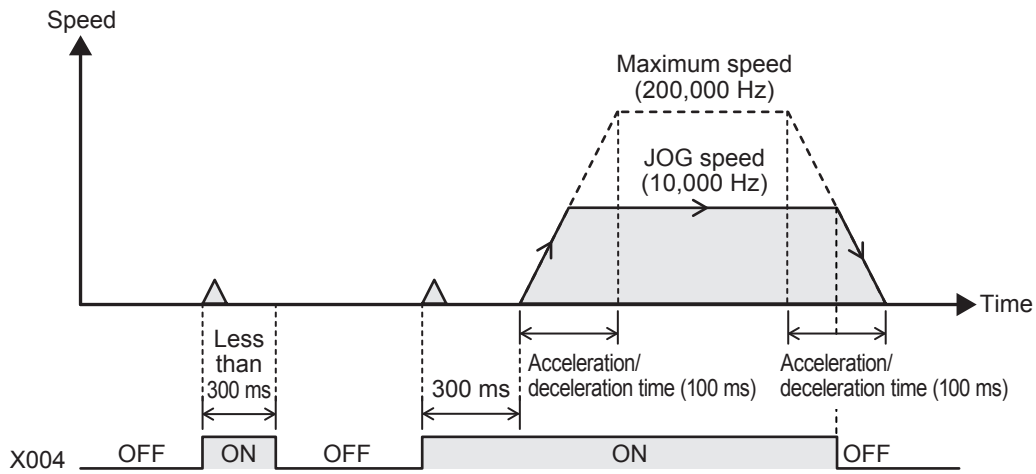


Remarks

The DOG search function can be used depending on the start position of the DOG type mechanical zero return operation.

10.2.2 JOG operation

When X004 (Forward JOG operation) in the PLC main unit is set to ON, the motor executes the JOG operation in the current value increasing direction.

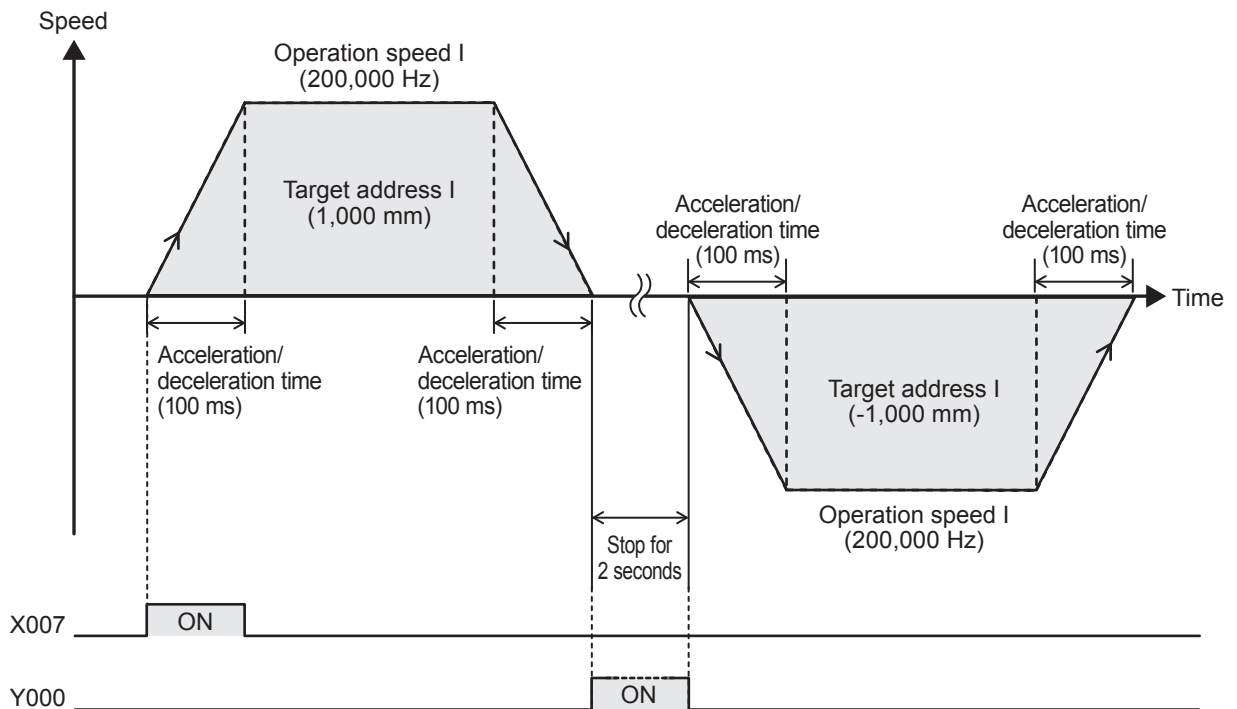


Remarks

When X005 (Reverse JOG operation) in the PLC main unit is set to ON, the work starts moving in the reverse direction at the same speed as above.

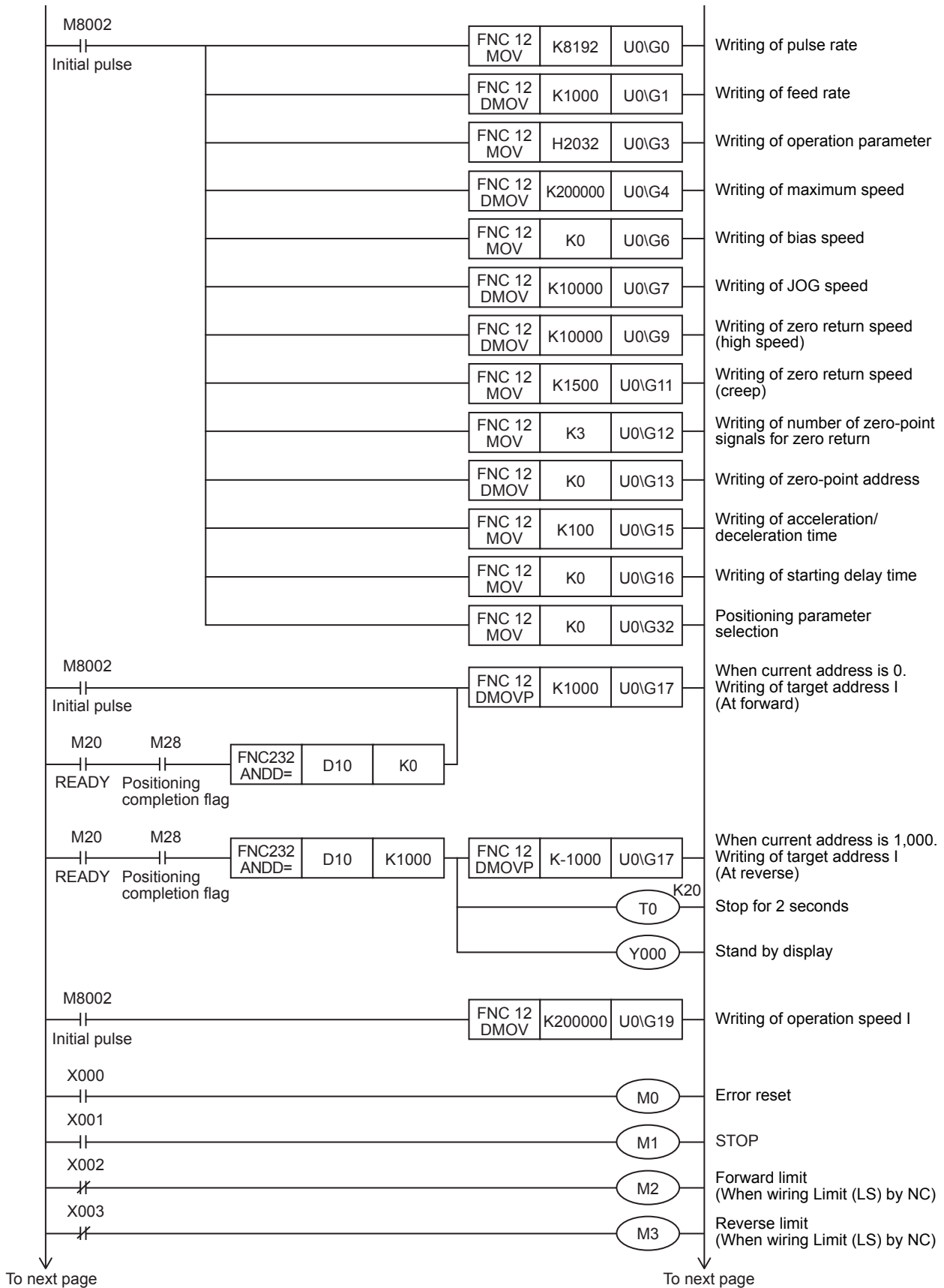
10.2.3 1-speed positioning operation

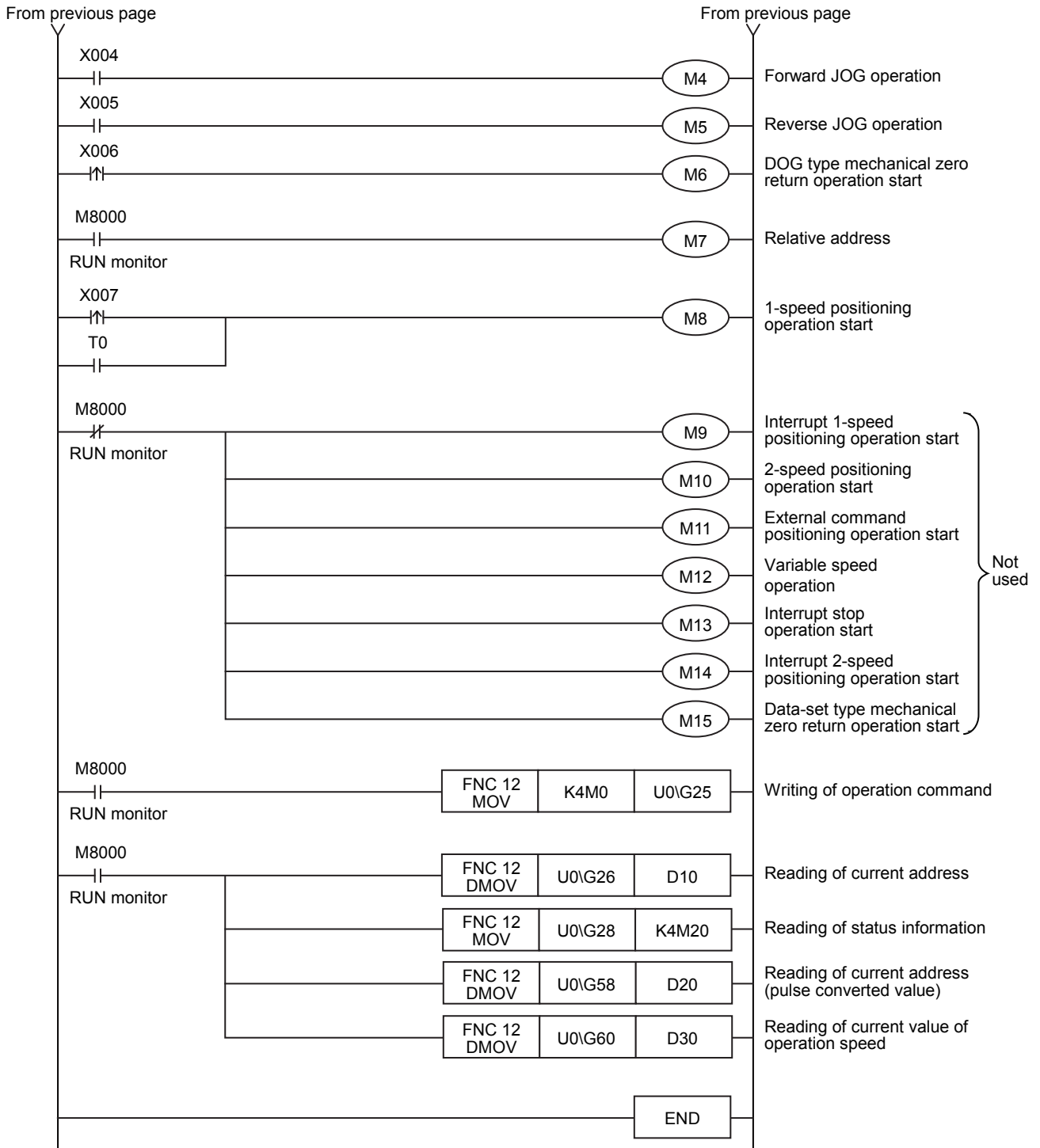
- 1) When X007 (1-speed positioning operation start) is set to ON, the motor moves 1,000 mm in the forward direction, and stops for 2 seconds. At this time, "Y000" is output as the waiting indication.
- 2) After that, the motor moves 1,000 mm in the reverse direction, and finishes the operation.



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10.3 Sequence Program





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11. Troubleshooting

When a fault occurs, check the power supply voltage, the PLC main unit and the FX3U-1PG for loose terminal screws, and examine the connectors for a defective contact.

STARTUP AND MAINTENANCE PRECAUTIONS



WARNING

- Do not touch any terminal while the PLC's power is on.
Doing so may cause electric shock or malfunctions.
- Before cleaning or retightening terminals, cut off all phases of the power supply externally.
Failure to do so may cause electric shock.
- Before modifying or disrupting the program in operation or running the PLC, carefully read through this manual and the associated manuals and ensure the safety of the operation.
An operation error may damage the machinery or cause accidents.

STARTUP AND MAINTENANCE PRECAUTIONS



CAUTION

- Do not disassemble or modify the PLC.
Doing so may cause fire, equipment failures, or malfunctions.
For repair, contact your local Mitsubishi Electric representative.
- Turn off the power to the PLC before connecting or disconnecting any extension cable.
Failure to do so may cause equipment failures or malfunctions.
- Turn off the power to the PLC before attaching or detaching the following devices.
Failure to do so may cause equipment failures or malfunctions.
 - Peripheral devices, display modules, expansion boards and special adapters
 - I/O extension units/blocks, FX Series terminal block and the special function units/blocks
 - Battery and memory cassette

11.1 LED Diagnostics

LED display	State	Content of Error	Corrective action
POWER	OFF	5 V DC is not supplied via the extension cable from PLC.	<ul style="list-style-type: none"> • Correctly connect the extension cable. • Properly supply the power of the PLC. • When the service power supply of the PLC main unit is used, make sure that the supply capacity is not exceeded.
	ON	5 V DC is supplied via the extension cable from PLC.	The power supply is normal.
STOP	OFF	When the stop command is not input to the STOP terminal.	When the LED does not turn on even when the STOP command is input, check the input wires.
DOG	OFF	When DOG input is not entered.	When the LED does not turn on even when the DOG is input, check the input wires.
PG0	OFF	When zero point signal is not entered.	When the LED does not turn on even when the zero-point signal is input, check the input wires.
FP	OFF	Forward pulse or pulse train interrupted.	When the LED does not turn on or blink even when each positioning operation is executed, check the following items.
RP	OFF	Reverse pulse or directional output interrupted.	<ul style="list-style-type: none"> • Confirm that the positioning operation is executed in the program of the PLC. • When the STOP command or the forward limit/reverse limit command is input, the pulse output is not executed.
CLR	OFF	CLR signal is not output.	<ul style="list-style-type: none"> • When the LED does not turn on when the zero return completes, confirm that the zero return operation is executed in the program of the PLC. • When the LED does not turn on even when the forward limit/reverse limit is on, confirm that the limit deceleration mode (BFM#3 b11 or BFM#37 b11) is off in the program of the PLC.
	ON	CLR signal is output.	When the deviation counter is not cleared at the servo amplifier side even when the CLR signal is output, check the output wire.
ERR	OFF	Normal operation.	No error.
	Flicker	Error occurred.	An error occurred at FX3U-1PG. Check the error code (BFM#29) and take appropriate measures.
	ON	CPU error occurred.	If the FX3U-1PG does not fix the problem when powered ON again, consult your local Mitsubishi Electric representative.

11.2 Error Codes

When an error occurs, the error contents can be checked by the error code (BFM#29).

After removing the error cause, clear the error code by turning off the power supply or by error reset (BFM#25 b0).

Error code	Error Content	Error corrective action
K0	No error.	-
K○○1*1	Speed relationship is incorrect. When the high speed < the bias speed or the zero return speed (high speed) < the creep speed is set and the operation is started, this error is output.	Set the maximum speed > the bias speed or the zero return speed (high speed) > the creep speed and execute error reset.
K○○3*1	Setting range is incorrect. When a value beyond the setting range is set to the positioning parameter and the operation is started, this error is output.	Change the positioning parameter set value to a value within the set range and execute error reset.
K○○4*1	Setting value overflow error. When the converted pulse value of the travel distance exceeds ±32 bits (at the start of operation or while the target address is changed), this error is output.	Set the travel amount to a value within ±32 bit and execute error reset.
K5	Operation command multiple selection error. When several operation commands are simultaneously on in b6, b8 to b15 of BFM#25, this error is output.	Change the sequence program so that only one operation command turns on, and execute error reset.
K6	Forward limit/reverse limit error. When the forward limit (BFM#25 b2) or the reverse limit (BFM#25 b3) turn on, this error is output.	When the forward limit/reverse limit turns off, this error is reset. Move away from the forward limit/reverse limit by using the JOG operation.
K7	Watchdog timer error.	If the error remains even when the power is turned from OFF to ON, consult your local Mitsubishi Electric representative.

*1. ○○ represents the BFM number for which there is an error.

11.3 Diagnostics on the PLC Main Unit

The following describes some of the PLC errors from the LED lights on the PLC.

For details related to the PLC main unit wiring, special auxiliary relays, and special data registers, refer to the following respective manuals.

→ Refer to FX3u Hardware Edition.

→ Refer to FX3uc Hardware Edition.

11.3.1 POWER (POW) LED [ON/Flicker/OFF]

The table below describes details for the LED statuses.

LED Status	PLC Status	Error corrective action
ON	Power of the specified voltage is being supplied to the power supply terminal.	The power supply is normal.
Flicker	One of the following causes may have occurred. <ul style="list-style-type: none"> Power and current of the specified voltage is not being supplied to the power supply terminal. Incorrect external wiring. Internal errors in the PLC. 	<ul style="list-style-type: none"> Check the supply voltage. After disconnecting cables other than the power cable, turn the power ON again, and check for changes in the state. If no improvement is obtained, consult your local Mitsubishi Electric representative.
OFF	One of the following causes may have occurred. <ul style="list-style-type: none"> The power supply is OFF. Incorrect external wiring. Power of the specified voltage is not being supplied to the power supply terminal. The power cable is broken. 	<ul style="list-style-type: none"> If the power is not OFF, check the power supply and the power supply route. If power is being supplied correctly, consult your local Mitsubishi Electric representative. After disconnecting cables other than the power cable, turn the power ON again, and check for changes in the state. If no improvement is obtained, consult your local Mitsubishi Electric representative.

11.3.2 BATT (BAT) LED [ON/OFF]

The table below describes details for the LED statuses.

LED Status	PLC Status	Error corrective action
ON	The battery voltage is low.	Immediately replace the battery.
OFF	The battery voltage is higher than the value with D8006.	Normal.

11.3.3 ERROR (ERR) LED [ON/Flicker/OFF]

The table below describes details for the LED statuses.

LED Status	PLC Status	Error corrective action
ON	A watchdog timer error may have occurred, or the hardware of the PLC may be damaged.	<ol style="list-style-type: none"> 1) Stop the PLC, and turn the power ON again. If the ERROR (ERR) LED goes out, a watchdog timer error may have occurred. Adopt any of the following measures: <ul style="list-style-type: none"> - Review the program. Set the maximum value (D8012) lower than the watchdog timer value. - Check that the input used for input interrupt or pulse catch is not being abnormally turned ON and OFF in one scan. - Check that the frequency of the pulse (duty 50%) input to the high-speed counter is not exceeding the specified range. - Add WDT instructions. Add some WDT instructions to the program, and reset the watchdog timer several times in one scan. - Change the watchdog timer value. Change the watchdog timer setting (D8000) in the program so that the setting is larger than the maximum value of the scan time (D8012). 2) Remove the PLC and supply the power to it from another power source. If the ERROR (ERR) LED goes out, noise may have affected the PLC. Adopt the following measures: <ul style="list-style-type: none"> - Check the ground wiring, and re-examine the wiring route and installation location. - Fit a noise filter onto the power supply line. 3) If the ERROR (ERR) LED does not go out even after measures in 1) and 2) are adopted, consult your local Mitsubishi Electric representative.
Flicker	One of the following errors has occurred on the PLC: <ul style="list-style-type: none"> • Parameter error • Syntax error • Ladder error 	Perform PLC diagnosis and program check with the programming tool.
OFF	No errors to stop the PLC have occurred.	If the operations of the PLC are abnormal, perform PLC diagnosis and program check with the programming tool. An I/O error, parallel link/communication error, or operation error may have occurred.

Appendix A: Version Information

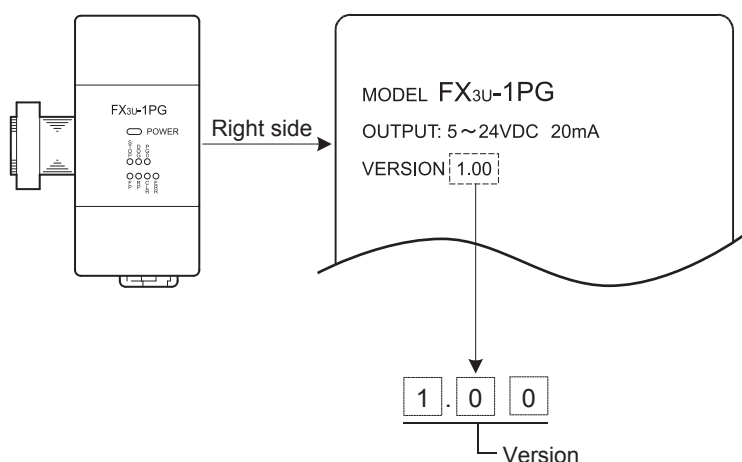
Appendix A-1 Version Information

Appendix A-1-1 Version check method

The version of FX3U-1PG can be checked by the following method.

1. Checking the nameplate

The version of the FX3U-1PG is shown as "VERSION" indicated on the label adhered to the right side of the product.



2. Checking the buffer memory (BFM)

In the FX3U-1PG, users can obtain the FX3U-1PG version information by monitoring BFM#62 (decimal number).

Appendix A-1-2 Version upgrade history

The table below lists the version upgrade history of the FX3U-1PG.

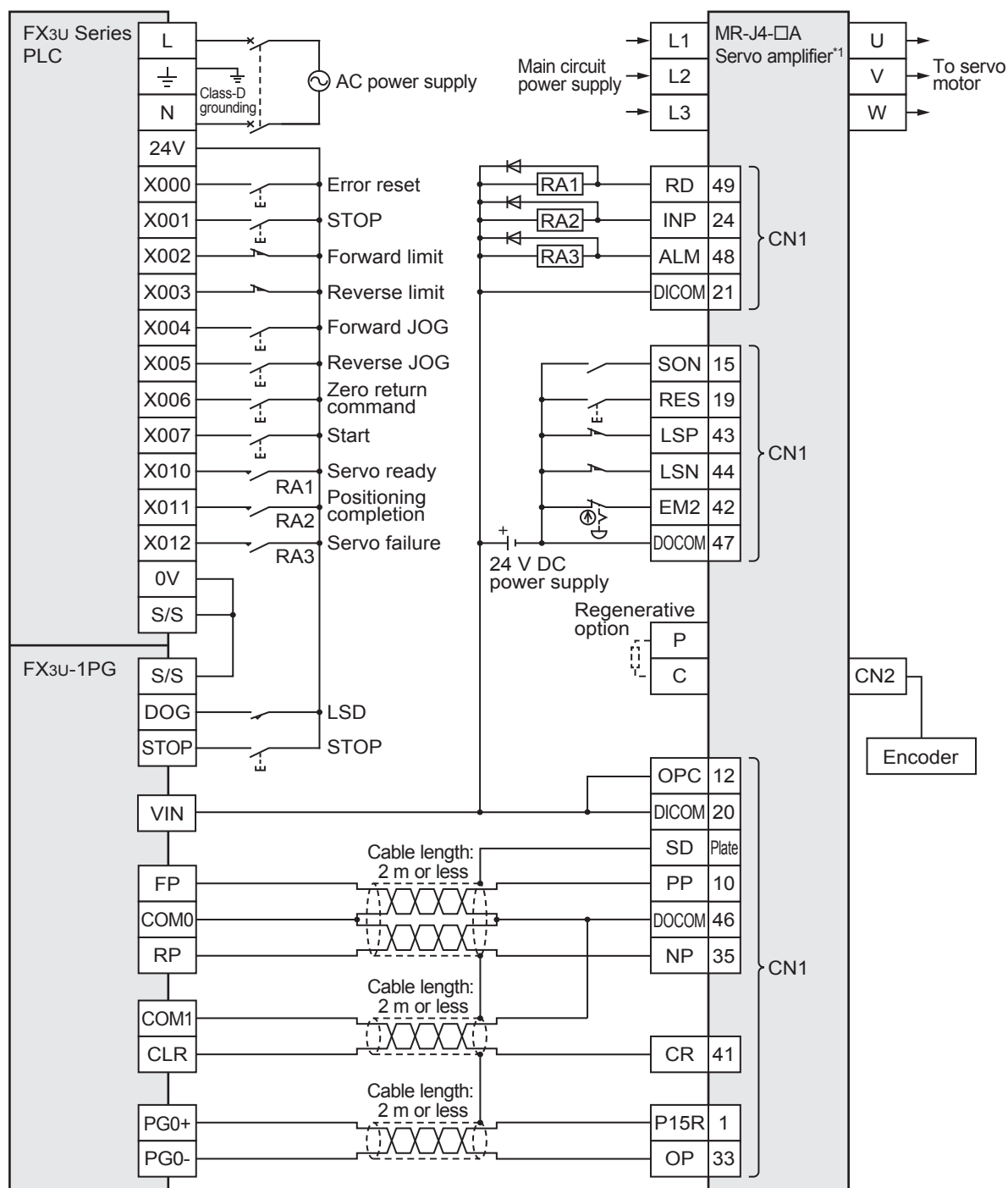
Version	Contents of version upgrade
Ver. 1.00	First product

Appendix B: Example Connection

This chapter explains FX3U-1PG connected to a FX3U Series PLC (AC power supply type), and examples of connection with the servo amplifier and stepping motor driver.

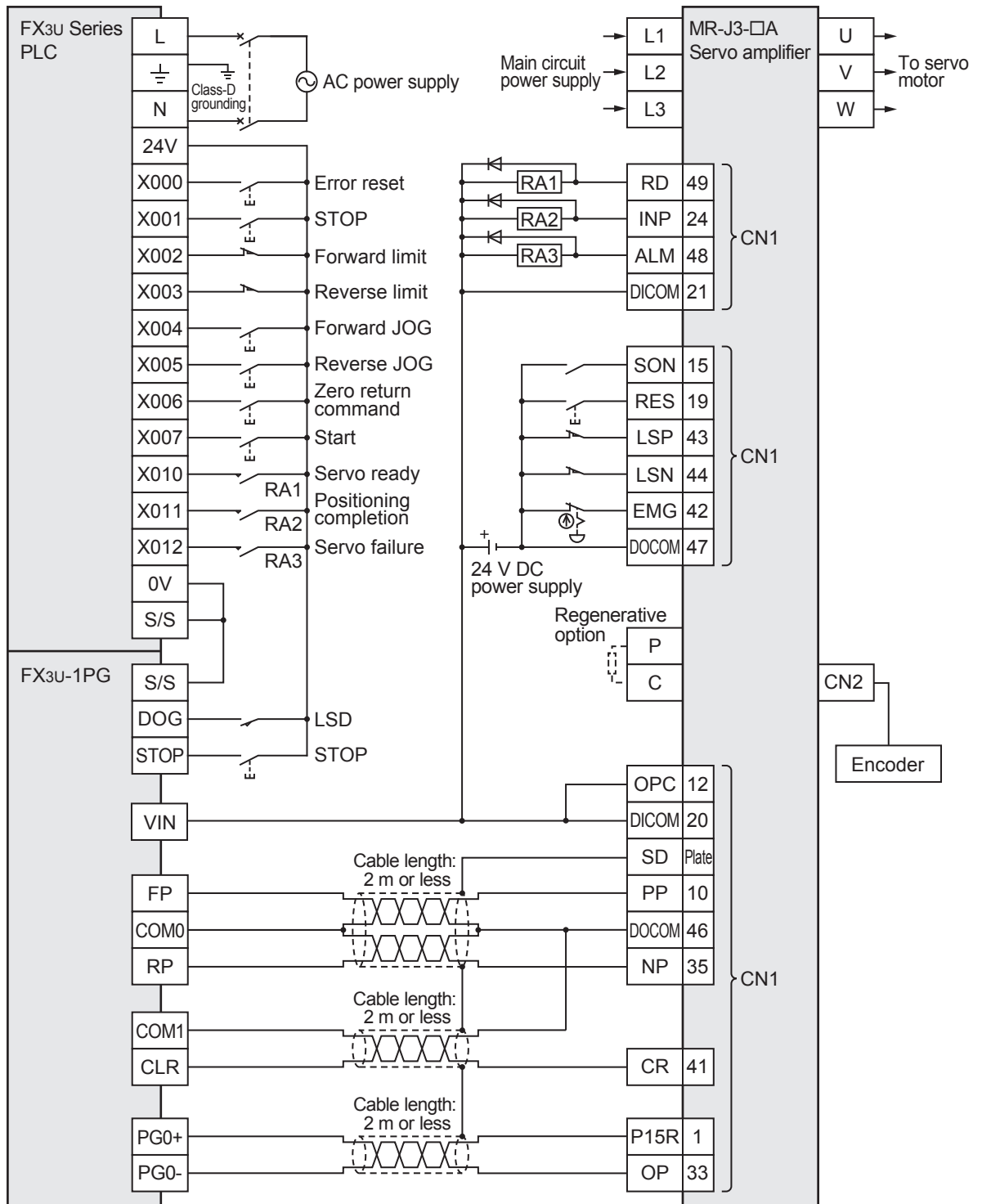
For details of other PLC, servo amplifier and stepping motor driver, refer to the manual of each product.

Appendix B-1 Example of Connection with MR-J4-[]A Servo Amplifier

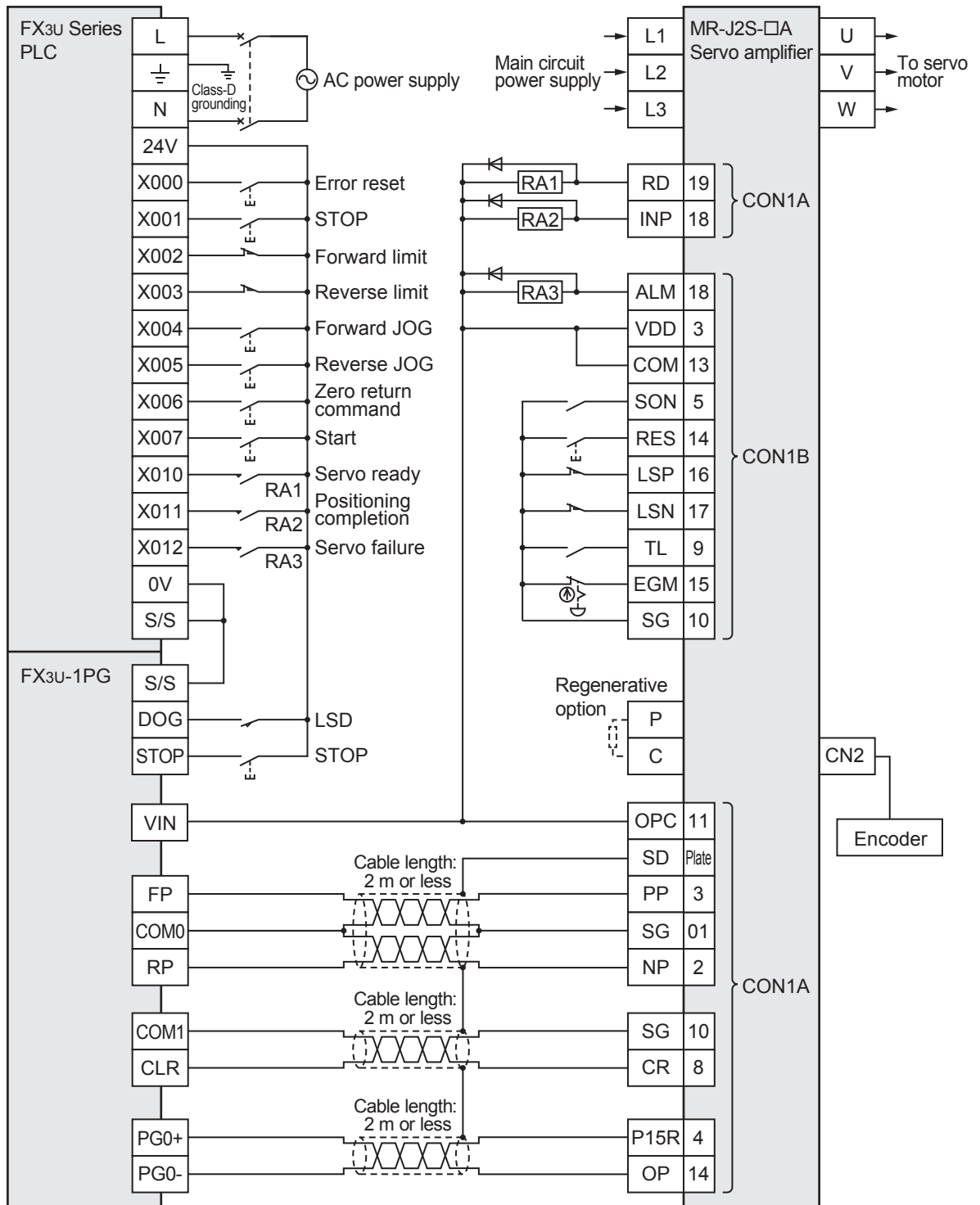


1. Set the command pulse input form of the servo amplifier (PA13) MR-J4-□A to "021" (negative logic, command input pulse train filter: 500 kpps or less).
 In "**", set "0" when the pulse output type of FX3U-1PG is "Forward/reverse pulse train", and set "1" when it is "Pulse train + Direction".

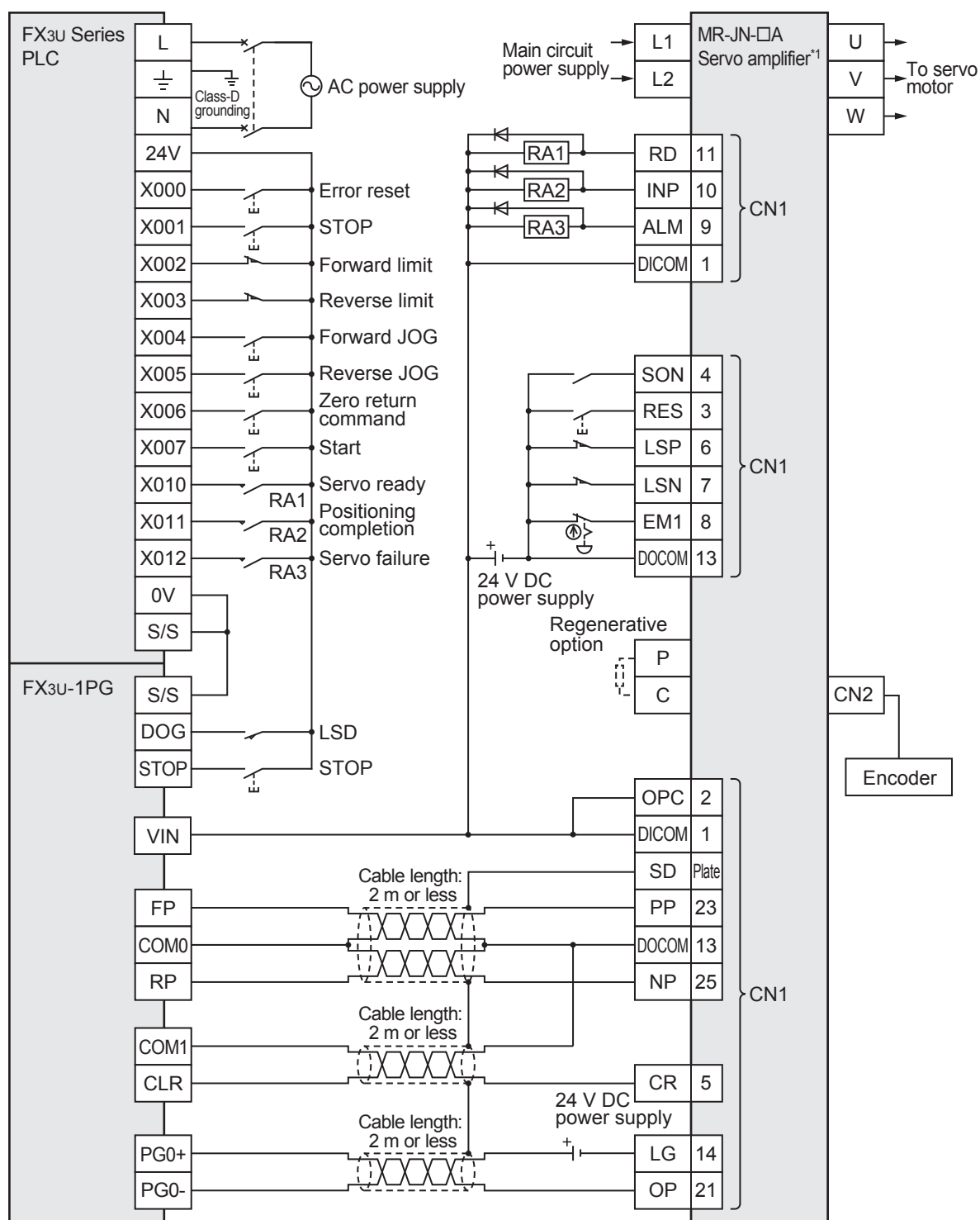
Appendix B-2 Example of Connection with MR-J3-[]A Servo Amplifier



Appendix B-3 Example of Connection with MR-J2S-[]A Servo Amplifier



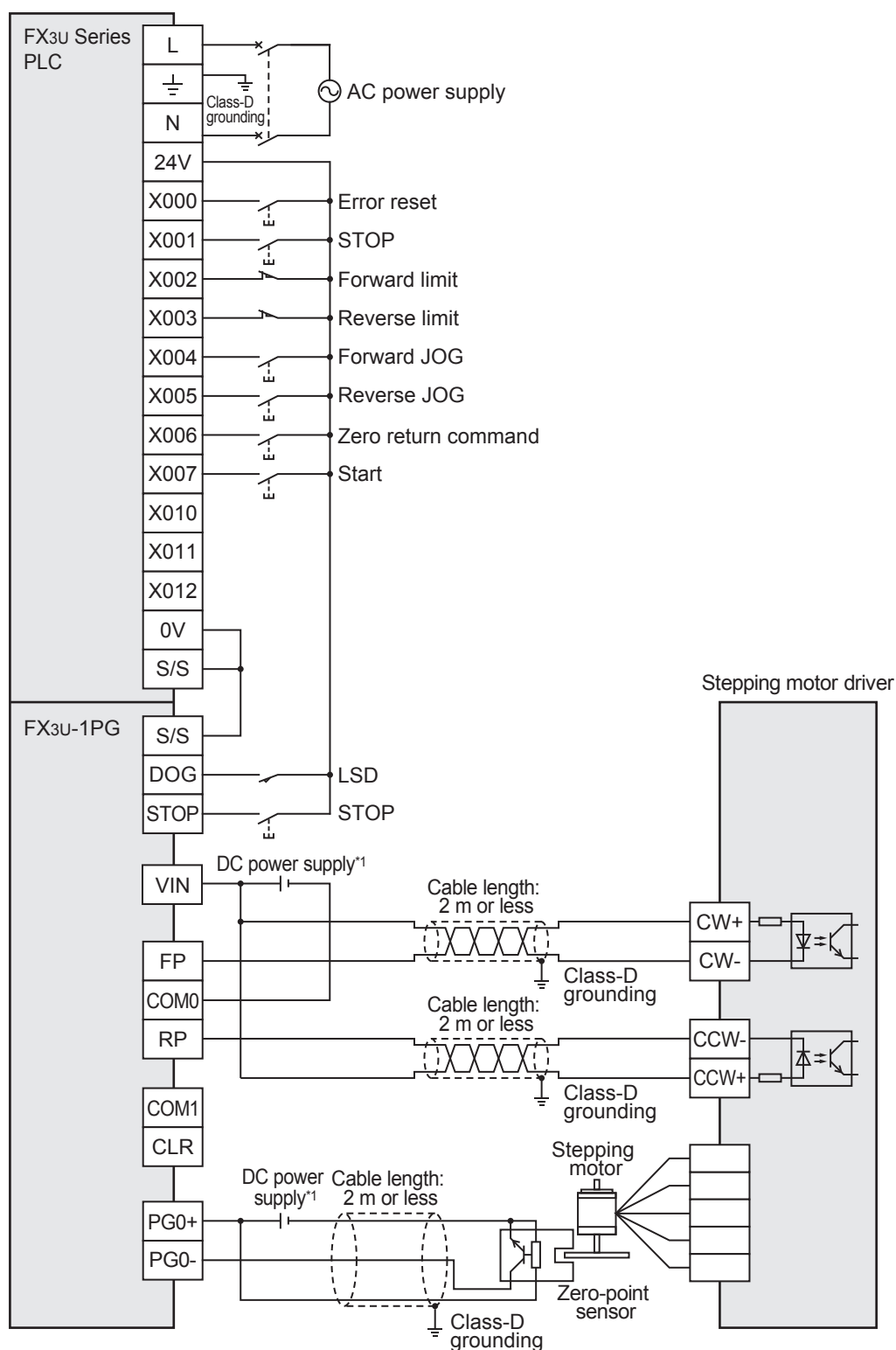
Appendix B-4 Example of Connection with MR-JN-[]A Servo Amplifier



- *1. Set the command pulse input form of the servo amplifier (PA13) MR-JN-[]A to "21*" (negative logic, command input pulse train filter: 200 kpps or less). In "*", set "0" when the pulse output type of FX3U-1PG is "Forward/reverse pulse train", and set "1" when it is "Pulse train + Direction".

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Appendix B-5 Example of Connection with Stepping Motor Driver



*1. The I/O specification of the FX3U-1PG is 5 to 24 V DC. However, confirm the voltage range and circuit configuration of the stepping motor driver before wiring.

For the voltage range and circuit configuration of the FX3U-1PG, refer to the following.

→ For the voltage range, refer to Section 2.4 and 2.5.

→ For the circuit configuration, refer to Section 5.1 and 5.2.

Appendix C: Differences with FX2N-1PG

This appendix describes the differences between the FX3U-1PG and the FX2N-1PG. The following are differences between the FX3U-1PG and the FX2N-1PG. Be careful when replacing the FX2N-1PG with the FX3U-1PG. Change the system or sequence program as needed.

Appendix C-1 Differences of Specification

Differences in specification between FX3U-1PG and FX2N-1PG are shown in the following table.

Item		FX3U-1PG	FX2N-1PG
Applicable PLC		FX3U/FX3UC PLC	FX2N/FX2NC/FX3U/FX3UC PLC
Number of connectable units to the main unit		FX3U PLC: Up to 8 blocks can be extended. FX3UC PLC: Up to 6 blocks can be extended.	FX2N PLC: Up to 8 blocks can be extended. FX2NC PLC: Up to 4 blocks can be extended. FX3U PLC: Up to 8 blocks can be extended. FX3UC (D, DS, DSS) PLC: Up to 8 blocks can be extended. FX3UC-32MT-LT(-2) PLC: Up to 7 blocks can be extended.
Positioning	Range	-2,147,483,648 to 2,147,483,647 (user unit)	-999,999 to 999,999 (user unit)
	Output frequency	1 Hz to 200 kHz The output pulse frequency (f) of FX3U-1PG is stepwise as follows. $f = 24 \times 10^6 / n$ (Hz) Where, n: Integer in range of 120 to 24,000,000	10 Hz to 100 kHz The output pulse frequency (f) of FX2N-1PG is stepwise as follows. $f = 1 \times 10^6 / 0.25n$ (Hz) Where, n: Integer in range of 40 to 400,000
	Acceleration /deceleration time	Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms	Trapezoidal acceleration/deceleration: 50 to 5,000 ms
	Starting time	Motor system: 1 ms or less Machine system: 2 ms or less	1st time: 500 ms or less 2nd time and later: Approximately 10 ms
Drive power supply	Inner control 5 V DC Current consumption 150 mA (Power is supplied through the extension cable from the PLC.)	5 V DC Current consumption 55 mA (Power is supplied through the extension cable from the PLC.)	

Appendix C-2 Differences of Buffer Memory

BFM No.		Item	Setting range	
High order 16bit	Low order 16bit		FX3U-1PG	FX2N-1PG
-	#0	Pulse rate	1 to 32,767 PLS/REV	
#2	#1	Feed rate	1 to 2,147,483,647 (user unit)	1 to 999,999 (user unit)
-	#3	Operation parameter	b1, b0: System of units	
			b3, b2: Interrupt input setting	
			b3, b2: Not used	
			b5, b4: Position data multiplier	
			b6: Acceleration/deceleration mode	
			b6: Not used	
			b7: Variable speed operation acceleration/deceleration setting	
			b7: Not used	
			b8: Pulse output format	
			b9: Rotation direction	
			b10: Zero return direction	
			b11: Limit deceleration mode	
			b11: Not used	
			b12: DOG input polarity	
b13: Count start point				
b14: STOP input polarity				
b15: STOP input mode				
#5	#4	Maximum speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 153,000 (user unit) Set the value within 10 to 100,000 Hz when converted to pulse data.
-	#6	Bias speed	0 to 32,767 (user unit) Set the value within 0 to 200,000 Hz when converted to pulse data.	0 to 15,300 (user unit) Set the value within 0 to 10,000 Hz when converted to pulse data.
#8	#7	JOG speed	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 153,000 (user unit) Set the value within 10 to 100,000 Hz when converted to pulse data.
#10	#9	Zero return speed (high speed)	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 153,000 (user unit) Set the value within 10 to 100,000 Hz when converted to pulse data.
-	#11	Zero return speed (creep)	1 to 32,767 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 15,300 (user unit) Set the value within 0 to 10,000 Hz when converted to pulse data.
-	#12	Number of zero-point signal for zero return	0 to 32,767	
#14	#13	Zero-point address	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	-999,999 to 999,999 (user unit) Set the value within -999,999 to 999,999 PLS when converted to pulse data.
-	#15	Acceleration/deceleration time	Trapezoidal acceleration/deceleration: 1 to 32,767 ms Approximate S-shaped acceleration/deceleration: 1 to 5,000 ms	Trapezoidal acceleration/deceleration: 50 to 5,000 ms
-	#16	Starting delay time	0 to 1,000 ms	Not used
#18	#17	Target address I	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	-999,999 to 999,999 (user unit) Set the value within -999,999 to 999,999 PLS when converted to pulse data.
#20	#19	Operation speed I	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 153,000 (user unit) Set the value within 10 to 100,000 Hz when converted to pulse data.
#22	#21	Target address II	-2,147,483,648 to 2,147,483,647 (user unit) Set the value within -2,147,483,648 to 2,147,483,647 PLS when converted to pulse data.	-999,999 to 999,999 (user unit) Set the value within -999,999 to 999,999 PLS when converted to pulse data.

BFM No.		Item	Setting range	
High order 16bit	Low order 16bit		FX3U-1PG	FX2N-1PG
#24	#23	Operation speed II	1 to 2,147,483,647 (user unit) Set the value within 1 to 200,000 Hz when converted to pulse data.	1 to 153,000 (user unit) Set the value within 10 to 100,000 Hz when converted to pulse data.
-	#25	Operation command	b0: Error reset b1: STOP b2: Reverse limit b3: Reverse limit b4: Forward JOG operation b5: Reverse JOG operation b6: DOG type mechanical zero return operation start b7: Relative/absolute address b8: 1-speed positioning operation start b9: Interrupt 1-speed positioning operation start b10: 2-speed positioning operation start b11: External command positioning operation start b12: Variable speed operation b13: Interrupt stop operation start b14: Interrupt 2-speed positioning operation start b15: Data-set type mechanical zero return operation start	
			b13: Not used	b13: Not used
			b14: Not used	b14: Not used
			b15: Not used	b15: Not used
#27	#26	Current address	-2,147,483,648 to 2,147,483,647 (user unit)	
-	#28	Status information	b0: READY b1: Forward/Reverse b2: Zero return completion b3: STOP input ON b4: DOG input ON b5: PG0 input ON b6: Current value overflow b7: Error flag b8: Positioning completion flag b9: 1-speed completion flag b10: Interrupt input 0 ON b11: Interrupt input 1 ON b12: Remaining distance operation waiting b13 to b15: Not used	
			b9: Not used	b9: Not used
			b10: Not used	b10: Not used
			b11: Not used	b11: Not used
			b12: Not used	b12: Not used
-	#29	Error code	An error code is stored at the time of the error occurrence.	
-	#30	Model code	K5,130	K5,110
-	#31	Not used	Not used	
Buffer memories BFM#32 and later are new in the FX3U-1PG. Refer to Section 7.2 for the contents of buffer memories BFM#32 and later.			Not used	

11 Troubleshooting

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Appendix C-3 Differences in Operation

Appendix C-3-1 Differences in properties common to all operation modes

Differences in properties common to all operation modes of FX3U-1PG and FX2N-1PG are shown in the following table.

Change point		FX3U-1PG	FX2N-1PG	Replacement point
Output frequency		<p>The output pulse frequency (f) of FX3U-1PG is stepwise as follows. $f = 24 \times 10^6 / n$ (Hz) Where, n: Integer in range of 120 to 24,000,000 Example: When the operation speed I is set to "99,000 Hz" $99,000 = 24 \times 10^6 / n$ $n = 24 \times 10^6 / 99,000$ $= 242.4$ (Rounded off) ≈ 242 When the "n = 242" Output pulse frequency $f = 24 \times 10^6 / 242$ $= 99,174$ Hz</p>	<p>The output pulse frequency (f) of FX2N-1PG is stepwise as follows. $f = 1 \times 10^6 / 0.25n$ (Hz) Where, n: Integer in range of 40 to 400,000 Example: When the operation speed I is set to "99,000 Hz" $99,000 = 1 \times 10^6 / 0.25n$ $n = 1 \times 10^6 / 0.25 / 99,000$ $= 40.4$ (Rounded off) ≈ 40 When the "n = 40" Output pulse frequency $f = 4 \times 10^6 / 40$ $= 100,000$ Hz</p>	<p>The actual output frequency may be different even if the same operation speed I is set as shown in the example on the left because the stepwise property of the output frequency is different. Confirm that no problem is expected in the system. Change the sequence program as needed. The frequency which can be output from the FX2N-1PG can be output also from the FX3U-1PG. Accordingly, by setting the actual output frequency of the FX2N-1PG in the FX3U-1PG, the motor can operate at the same speed using the FX3U-1PG.</p>
Starting time		<p>Motor system: 1 ms or less Machine system: 2 ms or less</p>	<p>1st time: 500 ms or less 2nd time and later: Approximately 10 ms</p>	<p>Confirm that that the difference in the starting time causes no problem in the system. Change the sequence program, such as setting up starting delay time (BFM#16) if needed.</p>
Operation when the PLC mode changes from RUN to STOP		<p>Continues the positioning operation.</p>	<p>The motor decelerates and stops. However, the motor continues the operation if the FROM/TO instruction, etc. is being executed by the BFM monitoring function, etc.</p>	<p>When the positioning operation is stopped by the PLC mode change from RUN to STOP, change the sequence program so that the positioning operation is stopped by the STOP signal (BFM#25 b1 or STOP terminal).</p>
Operation command (BFM#25)	STOP detection (BFM#25 b1)	<p>Level detection. It is necessary to keep the STOP signal ON for 1 ms or more.</p>	<p>Edge detection.</p>	<p>When the STOP is set to "OFF → ON → OFF" in less than 1 ms, change the sequence program so that the STOP remains ON for 1 ms or more.</p>
Forward limit/ Reverse limit (forward pulse stop or reverse pulse stop)	Operation when the forward limit or reverse limit (forward pulse stop or reverse pulse stop) is detected in the operation direction	<p>The operation varies as follows depending on the setting of the limit deceleration mode (BFM#3 b11 or BFM#37 b11):</p> <ul style="list-style-type: none"> When the limit deceleration mode (b11) is OFF The motor stops immediately, and the FX3U-1PG outputs the CLR signal. When the limit deceleration mode (b11) is ON The motor decelerates and stops, and the FX3U-1PG does not output the CLR signal. <p>In either mode, the forward limit/ reverse limit error (Error code: K6) occurs after the motor stops.</p>	<p>The motor stops immediately, and the FX2N-1PG outputs the CLR signal. No error occurs.</p>	<p>In a sequence program that detects errors and then performs a specified action, confirm that no problem is expected when the forward limit/ reverse limit error occurs. Change the sequence program as needed.</p>

Appendix C-3-2 Differences in individual operation modes

Differences in individual operation modes of FX3U-1PG and FX2N-1PG are shown in the following table.

JOG operation

Change point	FX3U-1PG	FX2N-1PG	Replacement point
Inching travel amount	The FX3U-1PG outputs pulses corresponding to 1 user unit. However, the FX3U-1PG outputs 1 pulse even if the value "Position data multiplier x Pulse rate" is smaller than the feed rate in the machine system setting or combined system setting and the pulse number required for the travel in 1 user unit is less than 1 pulse.	The FX2N-1PG outputs 1 pulse.	Confirm that no problem is expected in the system when the travel amount generated by 1 inching operation is large if the pulse number corresponding to 1 user unit is larger than 1 pulse. Change the sequence program as needed.

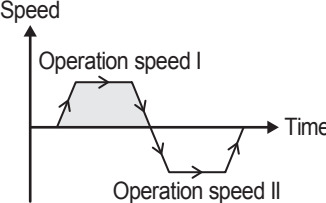
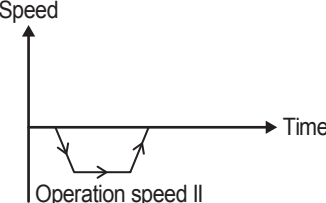
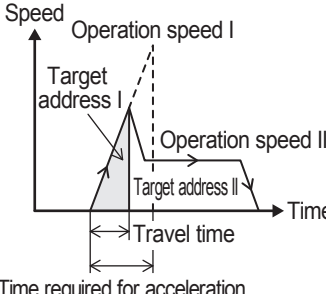
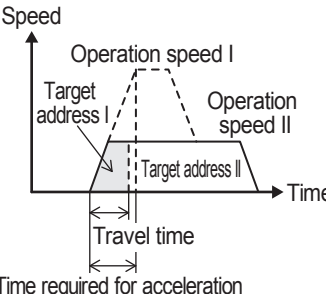
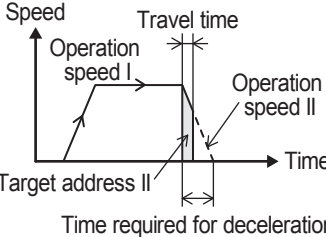
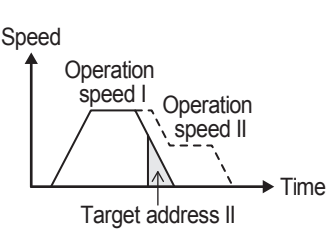
DOG type mechanical zero return operation

Change point	FX3U-1PG	FX2N-1PG	Replacement point
DOG search operation when the forward limit/reverse limit is ON	The motor starts the DOG search operation even when the direction of the forward limit or reverse limit in the ON status is the same as the zero return direction.	The motor does not perform the operation when the direction of the forward pulse stop (forward limit) or reverse pulse stop (reverse limit) in the ON status is the same as the zero return direction.	Confirm that no problem is expected in the system when an error occurs at the forward limit or reverse limit, the zero return operation is executed from the corresponding limit position, and the motor reverses the operation direction. Change the sequence program as needed.
Operation when the DOG cannot be detected	The motor stops at the forward limit (or reverse limit) and the forward limit/reverse limit error occurs if the DOG cannot be detected while the motor starts the zero return operation, reverses the operation direction at the reverse limit (or forward limit) and then reaches the forward limit (or reverse limit).	The motor stops at the forward limit (or reverse limit) but no error occurs if the DOG cannot be detected while the motor starts the zero return operation, reverses the operation direction at the reverse limit (or forward limit) and then reaches the forward limit (or reverse limit).	Confirm that no problem is expected in the system when an error occurs at the forward limit or reverse limit, the zero return operation is executed from the corresponding limit position, and the motor reverses the operation direction. Change the sequence program as needed.

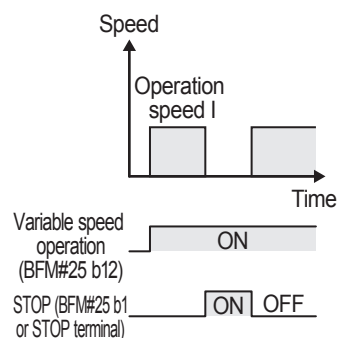
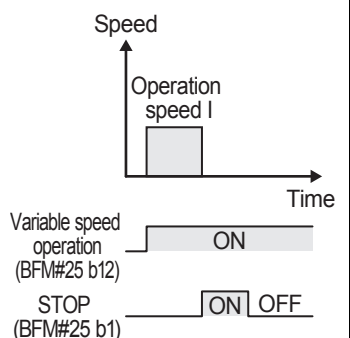
Interrupt 1-speed positioning operation

Change point	FX3U-1PG	FX2N-1PG	Replacement point
Operation when the travel amount is small (When the time required to perform deceleration from the operation speed I is longer than the travel time)	<p>The motor decelerates when the interrupt input is detected, and stops at the target address I.</p>	<p>The motor does not accelerate until the operation speed I is reached, and performs acceleration only until it reaches a speed so as to achieve "Travel amount during deceleration = Target address I".</p>	<p>Confirm that no problem is expected in the system when the operation speed is different or when the travel amount is small and the motor stops immediately. Change the sequence program as needed so that the motor operation using the FX3U-1PG becomes the same motor operation using the FX2N-1PG by reducing the operation speed I.</p>

2-speed positioning operation

Change point	FX3U-1PG	FX2N-1PG	Replacement point
<p>When the operation direction is different between the 1-speed and the 2-speed</p>	<p>The motor reaches the target address I at the operation speed I, reverses the operation direction, and then reaches the target address II at the operation speed II.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a positive speed ramp to 'Operation speed I', reaches 'Target address I', then reverses to a negative speed ramp to 'Operation speed II', reaching 'Target address II'.</p>	<p>The motor reaches the target address II at the operation speed II from the beginning.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a negative speed ramp to 'Operation speed II', reaching 'Target address II'.</p>	<p>Confirm that no problem is expected in the system when the motor reverses the operation direction if the operation direction is different between the 1-speed and the 2-speed. 1-speed positioning operation can be substituted for operation of the FX2N-1PG. Change the sequence program as needed.</p>
<p>Operation when the travel amount at the 1-speed is small (When the time required to perform acceleration until the operation speed I is longer than the travel time until the target address I)</p>	<p>The motor performs acceleration until it reaches the target address I.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a positive speed ramp to 'Operation speed I', reaching 'Target address I' before 'Operation speed II' is reached. 'Target address II' is reached later.</p>	<p>The motor starts with operation speed II from the beginning.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a positive speed ramp to 'Operation speed I', reaching 'Target address I' before 'Operation speed II' is reached. 'Target address II' is reached later.</p>	<p>Confirm that speed acceleration until the operation speed I causes no problem in the system. 1-speed positioning operation can be substituted for operation of the FX2N-1PG. Change the sequence program as needed.</p>
<p>Operation when the travel amount at the 2-speed is small (When the time required to perform deceleration from the operation speed I is longer than the travel time until the target address II)</p>	<p>The motor starts deceleration at the end of the 1-speed, and stops immediately when it reaches the target address II.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a positive speed ramp to 'Operation speed I', then decelerates to 'Operation speed II' before reaching 'Target address II'.</p>	<p>The motor starts deceleration before it reaches the target address I, and stops when it reaches the target address II.</p>  <p>The graph shows speed on the y-axis and time on the x-axis. It starts with a positive speed ramp to 'Operation speed I', then decelerates to 'Operation speed II' before reaching 'Target address II'.</p>	<p>Confirm that immediate stop causes no problem in the system. 1-speed positioning operation can be substituted for operation of the FX2N-1PG. Change the sequence program as needed.</p>

Variable speed operation

Change point	FX3U-1PG	FX2N-1PG	Replacement point
Operation when the operation speed I starts at a speed lower than the bias speed	The FX3U-1PG does not output pulses. The READY flag (BFM#28 b0) turns OFF.	The motor operates at the bias speed. (The motor operates at 10 Hz if the bias speed is set to "0".)	Change the sequence program so that the operation speed I at the beginning is set to the bias speed.
Operation when the operation speed I is changed to a speed lower than the bias speed	The FX3U-1PG stops the pulse output. The READY flag (BFM #28 b0) remains OFF.	The motor operates at the bias speed. (The motor operates at 10 Hz if the bias speed is set to "0".)	Change the sequence program so that the operation speed I is changed to the bias speed.
Operation when the STOP is set from ON to OFF while the operation command remains ON	The motor restarts the operation when the STOP signal is set to OFF. 	The motor does not restart the operation even if the STOP signal is set to OFF. 	Confirm that no problem is expected in the system when the operation is restarted by setting the STOP signal to OFF. Change the sequence program as needed so that the motor is stopped by the STOP signal, the operation command is set to OFF, and then the STOP signal is set to OFF.

MEMO

Warranty

Please confirm the following product warranty details before using this product.

1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the sales representative or Mitsubishi Service Company. However, if repairs are required onsite at domestic or overseas location, expenses to send an engineer will be solely at the customer's discretion. Mitsubishi shall not be held responsible for any re-commissioning, maintenance, or testing on-site that involves replacement of the failed module.

[Gratis Warranty Term]

The gratis warranty term of the product shall be for one year after the date of purchase or delivery to a designated place. Note that after manufacture and shipment from Mitsubishi, the maximum distribution period shall be six (6) months, and the longest gratis warranty term after manufacturing shall be eighteen (18) months. The gratis warranty term of repair parts shall not exceed the gratis warranty term before repairs.

[Gratis Warranty Range]

- 1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.
- 2) Even within the gratis warranty term, repairs shall be charged for in the following cases.
 - a) Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.
 - b) Failure caused by unapproved modifications, etc., to the product by the user.
 - c) When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.
 - d) Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.
 - e) Relay failure or output contact failure caused by usage beyond the specified Life of contact (cycles).
 - f) Failure caused by external irresistible forces such as fires or abnormal voltages, and failure caused by force majeure such as earthquakes, lightning, wind and water damage.
 - g) Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.
 - h) Any other failure found not to be the responsibility of Mitsubishi or that admitted not to be so by the user.

2. Onerous repair term after discontinuation of production

- 1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued.
Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.
- 2) Product supply (including repair parts) is not available after production is discontinued.

3. Overseas service

Overseas, repairs shall be accepted by Mitsubishi's local overseas FA Center. Note that the repair conditions at each FA Center may differ.

4. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation of damages caused by any cause found not to be the responsibility of Mitsubishi, loss in opportunity, lost profits incurred to the user or third person by Failures of Mitsubishi products, special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products, replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Changes in product specifications

The specifications given in the catalogs, manuals or technical documents are subject to change without prior notice.

6. Product application

- 1) In using the Mitsubishi MELSEC programmable logic controller, the usage conditions shall be that the application will not lead to a major accident even if any problem or fault should occur in the programmable logic controller device, and that backup and fail-safe functions are systematically provided outside of the device for any problem or fault.
- 2) The Mitsubishi programmable logic controller has been designed and manufactured for applications in general industries, etc. Thus, applications in which the public could be affected such as in nuclear power plants and other power plants operated by respective power companies, and applications in which a special quality assurance system is required, such as for Railway companies or Public service purposes shall be excluded from the programmable logic controller applications.
In addition, applications in which human life or property that could be greatly affected, such as in aircraft, medical applications, incineration and fuel devices, manned transportation, equipment for recreation and amusement, and safety devices, shall also be excluded from the programmable logic controller range of applications.
However, in certain cases, some applications may be possible, providing the user consults their local Mitsubishi representative outlining the special requirements of the project, and providing that all parties concerned agree to the special circumstances, solely at the users discretion.

Revised History

Date	Revision	Description
9/2012	A	First Edition
4/2015	B	<ul style="list-style-type: none">• The description of speed switching in the 2-speed positioning operation is added.• Errors are corrected.

FX3U-1PG

USER'S MANUAL

mitsubishi electric corporation

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MODEL	FX3U-1PG-U-E
MODEL CODE	09R629