NAiS

PROGRAMMABLE CONTROLLER

FP SERIES FP1

Hardware

BEFORE BEGINNING

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CHAPTER 1

FEATURES

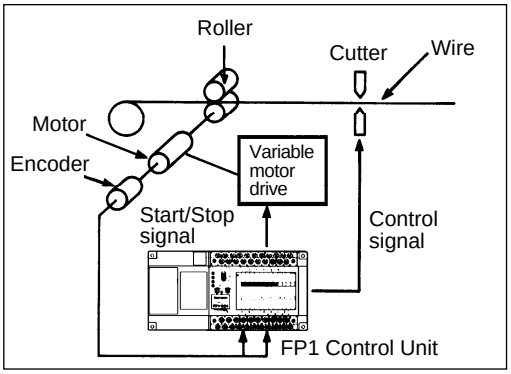
1-1. Features

1. Advanced Control Functions

■ High-speed counter function (all series)

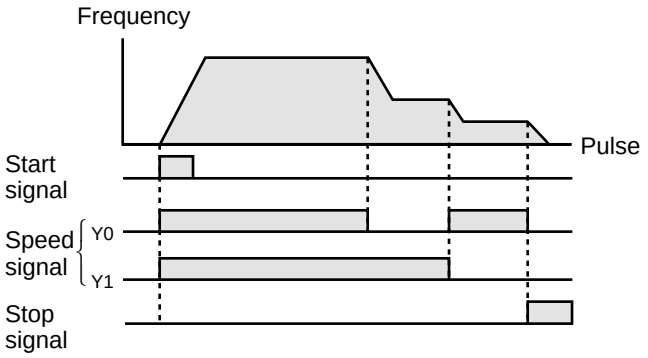
The built-in high-speed counter function supports four modes: two-phase input, UP, DOWN, and UP/DOWN. The FP1 can read the input regardless of the scan time.

Max. counting speed	1-phase: 10 k Hz (when duty cycle ratio 50 %) 2-phase: 5 k Hz
Counting range	–8,388,608 to 8,388,607



• Application: Pattern output function (all series)

This function allows the setting of a maximum of eight output patterns with 15 level settings of the high-speed counter. Can also be applied to multi-stage speed control with use of an inverter.



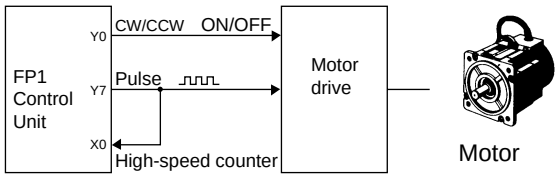
■ Pulse output function (transistor output type)

This function allows the output of a direct pulse (45 Hz to 4.9 k Hz) from the FP1. In combination with a drive, a motor can be controlled. As direct pulse is possible, an additional positioning controller is not necessary. As the C56 and C72 series have two pulse outputs, they also support motor drives with one input for forward and the other input for reverse driving. To prevent incorrect forward/reverse driving, create an interlock circuit outside of the FP1.

• Position control:

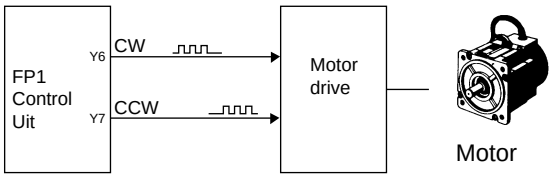
C14, C16, C24, and C40 series

These support drives with one pulse input and one direction switching input. When using a drive with two pulse inputs, a switching circuit based on an external relay is necessary.



C56 and C72 series

These also support drives with two pulse inputs. In addition, it is not necessary to connect the pulse output to the high-speed counter (Y7 to X0).

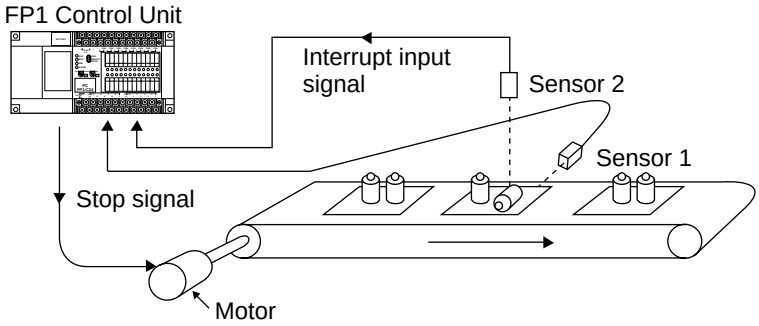


■ Interrupt input function (C24, C40, C56, and C72 series)

This function executes an interrupt program immediately after an external interrupt input (minimum pulse width of 0.2 ms) occurs, regardless of the input timing. It enables high-speed processing at a fixed timing and is not affected by scan time. Therefore, it is useful when performing control which would be disrupted by variations in processing time due to such factors as timing synchronization.

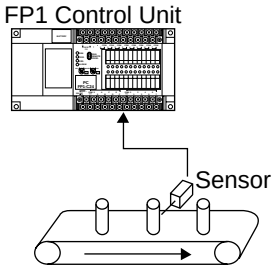
Timing control on a board inspection line

Immediately executes interrupt program when an edge detection signal comes in by interrupt input from Sensor 1. Sensor 2 inspects the part, and if an abnormality is detected, the conveyor stops and the abnormality is reported.



■ Pulse catch input function (all series)

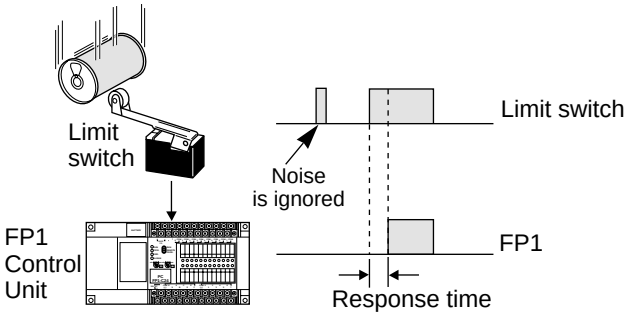
This function catches input pulse signals down to a minimum width of 0.5 ms. It is effective for situations such as when the sensor detects the moving target at a high speed.



■ Adjustable input time filtering function (all series*)

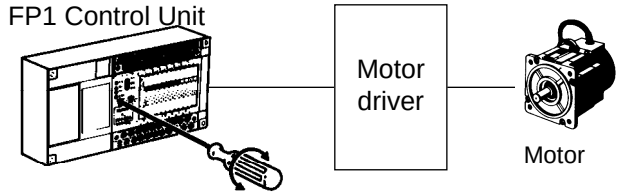
This function allows the input response time (input time constant) to be changed within a range of 1 to 128 ms in accordance with the input device connected. This prevents input errors due to such causes as limit switch chattering noise.

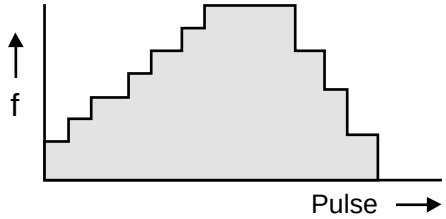
* For E8 and E16 series, input response time is fixed as 2 ms.



■ Manual dial-set register control function (all series)

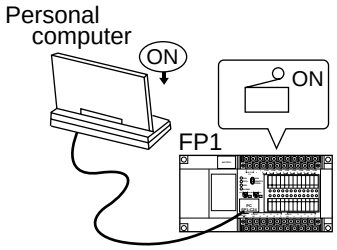
This function makes it possible to change the values of special data registers DT9040 to 9043 within a range of 0 to 255 using the potentiometers on the front face of the Control Unit. Input settings involving analog-type numerical data such as analog timer and pulse output frequency changes can be performed.





■ Forced ON/OFF control function (all series)

This function allows the state of the input and output contacts to be forced ON or OFF with a programming tool (NPST-GR Software, etc.). By forcing the output contact ON or OFF, the connection on the output side can be checked. By forcing the input contact ON or OFF, the program can be checked.



■ Password protection function (all series)

This function forbids reading and writing of the program and system registers. It can be used for program protection and when secrecy is required.

■ Constant length scan setting function (all series)

The duration of one scan is fixed by setting it to units of 2.5 ms, eliminating variation in the scan time.

■ Clock/Calendar control function (C24C, C40C, C56C, and C72C types)

By means of year, month, day, hour, minute, second, and day of the week settings, this function makes it possible to change temporal elements of control. It can be used for temporal control of such items as lighting, air conditioning, and equipment.

2. Communication Functions

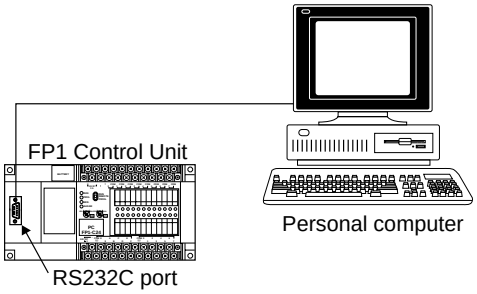
■ Computer link function (MEWTOCOL)

This function allows the reading and writing of FP1 contact information and data register content from a host computer. It can be used for such applications as data collection and the monitoring of operating conditions.

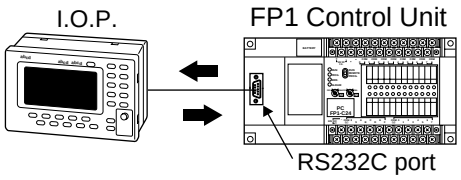
Communication between one computer and one FP1 Control Unit

• Using RS232C port (C24C, C40C, C56C, and C72C types)

The RS232C port can be used for direct connection to a personal computer, allowing the easy performance of a 1:1 computer link.

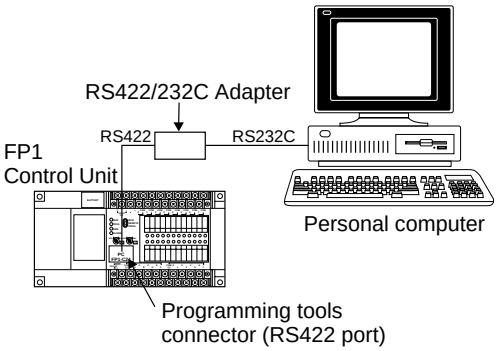


When connected to an I.O.P. using the computer link function, the I.O.P.'s data can be read as the FP1's internal relay or data register data. This can be used for such operations as production control.



• Using programming tools connector (RS422 port) (all series)

The RS422 port can also be used for a 1:1 computer link by connecting it through an RS422/232C Adapter.

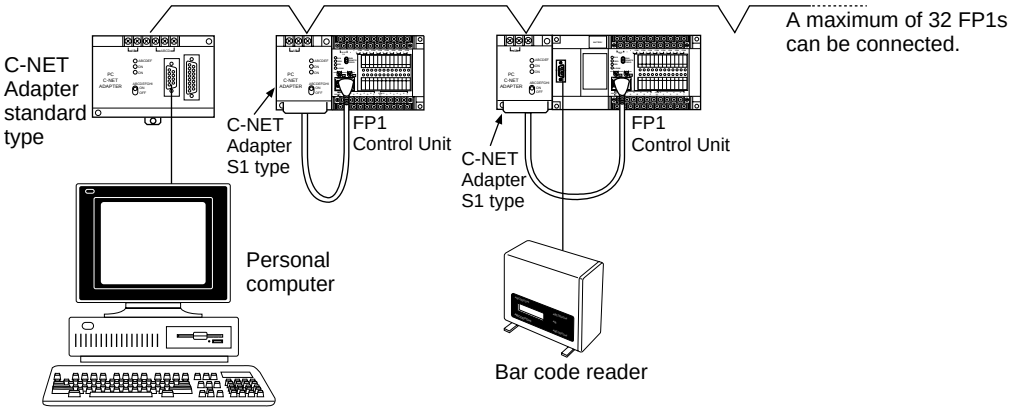


Note:

When using control units equipped with RS232C port (C24C, C40C, C56C, and C72C types), various combinations can be created by making a computer link through the RS422 port and connecting another device to the RS232C port.

Communication between one computer and 32 FP1 Control Units

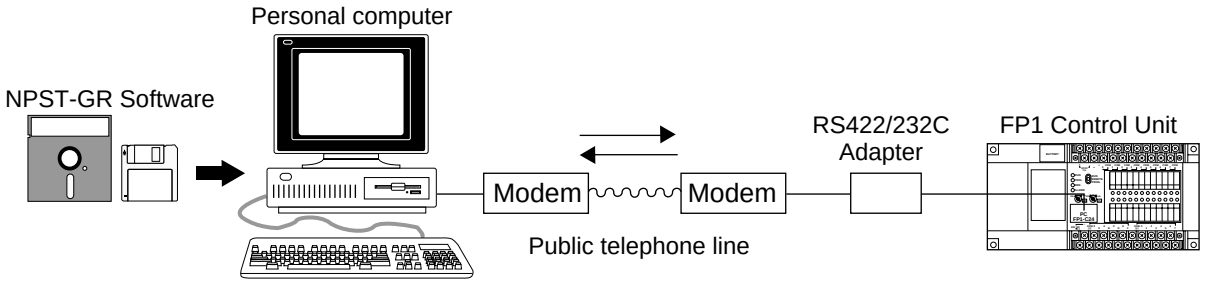
Using a C-NET Adapter, a maximum of 32 FP1 units can be connected with one personal computer. If a bar code reader is connected via the RS232C port, this system can be used for collection of various production control information.



• Refer to C-NET LINK UNIT Technical Manual for details about computer link function.

■ Modem communication (C24, C40, C56, and C72 series)

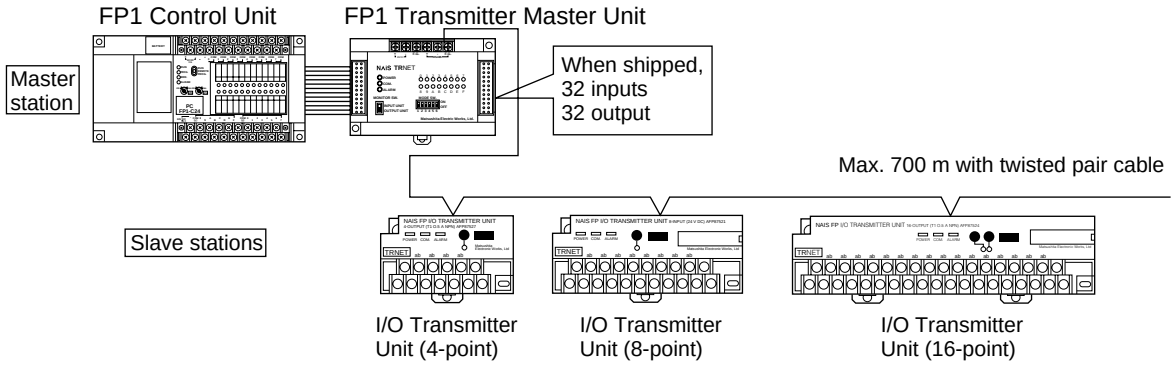
Using a modem, data transfer and long-distance communication between a personal computer and an FP1 unit can be performed. This can be done even when using NPST-GR Software. Select a cable in accordance with the specifications of the modem used.



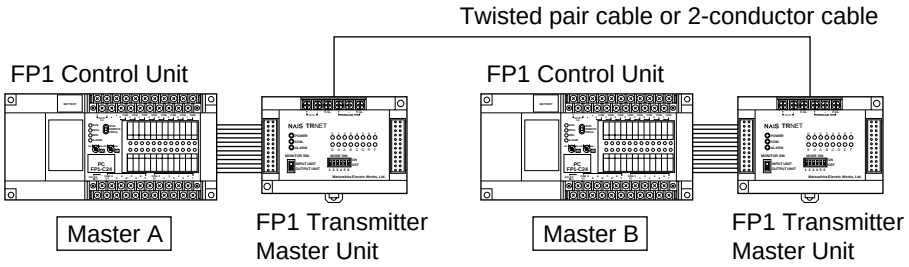
■ MEWNET-TR (Remote I/O Control) system

I/O information can be exchanged between a master and several slave stations at a remote site. A maximum of 80 inputs and 64 outputs can be controlled by 2 master units (C24, C40, C56 and C72 series) one transmitter master unit supports a total communication distance of 700 m using twisted pair cable. Master to master communication is also available.

• Master-slave communication

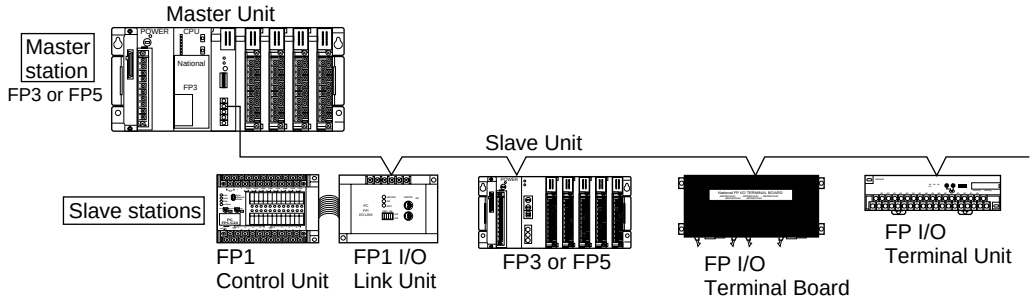


• Master-master communication



■ MEWNET-F (Remote I/O Control) system

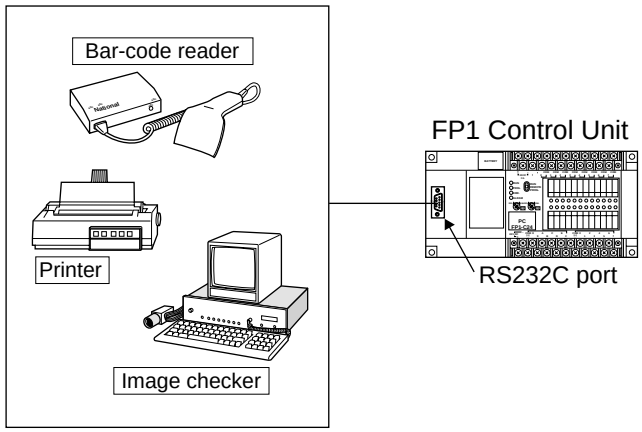
Using a FP1 I/O link unit, this function allows the exchange of I/O information with the host FP series programmable controller through a two-conductor cable.



• Refer to REMOTE I/O SYSTEM Technical Manual for details about I/O link function (remote I/O control function).

■ General communication using RS232C port (C24C, C40C, C56C, and C72C types)

This function allows data input and output when connected to a device having an RS232C port. Data reading from a bar code reader, data output to a printer, and bilateral data exchange with the image checker are all possible.



1-2. Table of FP1 Units

1. Control Units

Series		Description					
		Built-in memory	I/O point	Operating voltage	Input type	Output type	Part number
C14	Standard types	EEPROM	14 Input: 8 Output: 6	24 V DC	Sink/source	Relay	AFP12313B
						Transistor (NPN open collector)	AFP12343B
						Transistor (PNP open collector)	AFP12353B
				100 V to 240 V AC	Sink/source	Relay	AFP12317B
						Transistor (NPN open collector)	AFP12347B
						Transistor (PNP open collector)	AFP12357B
C16	Standard types	EEPROM	16 Input: 8 Output: 8	24 V DC	Sink/source	Relay	AFP12113B
						Transistor (NPN open collector)	AFP12143B
						Transistor (PNP open collector)	AFP12153B
					Source	Relay	AFP12112B
						Transistor (NPN open collector)	AFP12142B
				100 V to 240 V AC	Sink/source	Relay	AFP12117B
						Transistor (NPN open collector)	AFP12147B
						Transistor (PNP open collector)	AFP12157B
					Source	Relay	AFP12116B
						Transistor (NPN open collector)	AFP12146B
C24	Standard types	RAM	24 Input: 16 Output: 8	24 V DC	Sink/source	Relay	AFP12213B
						Transistor (NPN open collector)	AFP12243B
						Transistor (PNP open collector)	AFP12253B
					Source	Relay	AFP12212B
						Transistor (NPN open collector)	AFP12242B
				100 V to 240 V AC	Sink/source	Relay	AFP12217B
						Transistor (NPN open collector)	AFP12247B
						Transistor (PNP open collector)	AFP12257B
					Source	Relay	AFP12216B
						Transistor (NPN open collector)	AFP12246B
	C24C types (with RS232C port and Clock/ Calender function)	RAM	24 Input: 16 Output: 8	24 V DC	Sink/source	Relay	AFP12213CB
						Transistor (NPN open collector)	AFP12243CB
						Transistor (PNP open collector)	AFP12253CB
					Source	Relay	AFP12212CB
						Transistor (NPN open collector)	AFP12242CB
				100 V to 240 V AC	Sink/source	Relay	AFP12217CB
						Transistor (NPN open collector)	AFP12247CB
						Transistor (PNP open collector)	AFP12257CB
					Source	Relay	AFP12216CB
						Transistor (NPN open collector)	AFP12246CB

Series		Description					
		Built-in memory	**I/O point**	**Operating voltage**	**Input type**	**Output type**	**Part number**
C40	Standard types	RAM	40 Input: 24 Output: 16	24 V DC	Sink/source	Relay	AFP12413B
						Transistor (NPN open collector)	AFP12443B
						Transistor (PNP open collector)	AFP12453B
					Source	Relay	AFP12412B
						Transistor (NPN open collector)	AFP12442B
				100 V to 240 V AC	Sink/source	Relay	AFP12417B
						Transistor (NPN open collector)	AFP12447B
						Transistor (PNP open collector)	AFP12457B
					Source	Relay	AFP12416B
						Transistor (NPN open collector)	AFP12446B
	C40C types (with RS232C port and Clock/ Calender function)	RAM	40 Input: 24 Output: 16	24 V DC	Sink/source	Relay	AFP12413CB
						Transistor (NPN open collector)	AFP12443CB
						Transistor (PNP open collector)	AFP12453CB
					Source	Relay	AFP12412CB
						Transistor (NPN open collector)	AFP12442CB
				100 V to 240 V AC	Sink/source	Relay	AFP12417CB
						Transistor (NPN open collector)	AFP12447CB
						Transistor (PNP open collector)	AFP12457CB
					Source	Relay	AFP12416CB
						Transistor (NPN open collector)	AFP12446CB
C56	Standard types	RAM	56 Input: 32 Output: 24	24 V DC	Sink/source	Relay	AFP12513B
						Transistor (NPN open collector)	AFP12543B
						Transistor (PNP open collector)	AFP12553B
				100 V to 240 V AC	Sink/source	Relay	AFP12517B
						Transistor (NPN open collector)	AFP12547B
						Transistor (PNP open collector)	AFP12557B
	C56C types (with RS232C port and Clock/ Calender function)	RAM	56 Input: 32 Output: 24	24 V DC	Sink/source	Relay	AFP12513CB
						Transistor (NPN open collector)	AFP12543CB
						Transistor (PNP open collector)	AFP12553CB
				100 V to 240 V AC	Sink/source	Relay	AFP12517CB
						Transistor (NPN open collector)	AFP12547CB
						Transistor (PNP open collector)	AFP12557CB
C72	Standard types	RAM	72 Input: 40 Output: 32	24 V DC	Sink/source	Relay	AFP12713B
						Transistor (NPN open collector)	AFP12743B
						Transistor (PNP open collector)	AFP12753B
				100 V to 240 V AC	Sink/source	Relay	AFP12717B
						Transistor (NPN open collector)	AFP12747B
						Transistor (PNP open collector)	AFP12757B
	C72C types (with RS232C port and Clock/ Calender function)	RAM	72 Input: 40 Output: 32	24 V DC	Sink/source	Relay	AFP12713CB
						Transistor (NPN open collector)	AFP12743CB
						Transistor (PNP open collector)	AFP12753CB
				100 V to 240 V AC	Sink/source	Relay	AFP12717CB
						Transistor (NPN open collector)	AFP12747CB
						Transistor (PNP open collector)	AFP12757CB

2. Expansion Units

Series	Description				
	I/O point	Operating voltage	Input type	Output type	Part number
E8	8 Input: 8	———	Source	———	AFP13802
			Sink/source	———	AFP13803
	8 Input: 4 Output: 4	———	Source	Relay	AFP13812
				Transistor (NPN open collector)	AFP13842
			Sink/source	Relay	AFP13813
				Transistor (NPN open collector)	AFP13843
				Transistor (PNP open collector)	AFP13853
	8 Output: 8	———	———	Relay	AFP13810
				Transistor (NPN open collector)	AFP13840
				Transistor (PNP open collector)	AFP13850
				Triac	AFP13870
E16	16 Input: 16	———	Sink/source	———	AFP13103
	16 Input: 8 Output: 8	———	Source	Relay	AFP13112
				Transistor (NPN open collector)	AFP13142
			Sink/source	Relay	AFP13113
				Transistor (NPN open collector)	AFP13143
				Transistor (PNP open collector)	AFP13153
	16 Output: 16	———	———	Relay	AFP13110
				Transistor (NPN open collector)	AFP13140
E24	24 Input: 16 Output: 8	24 V DC	Source	Relay	AFP13212
				Transistor (NPN open collector)	AFP13242
			Sink/source	Relay	AFP13213
				Transistor (NPN open collector)	AFP13243
				Transistor (PNP open collector)	AFP13253
		100 V to 240 V AC	Source	Relay	AFP13216
				Transistor (NPN open collector)	AFP13246
			Sink/source	Relay	AFP13217
				Transistor (NPN open collector)	AFP13247
				Transistor (PNP open collector)	AFP13257
E40	40 Input: 24 Output: 16	24 V DC	Source	Relay	AFP13412
				Transistor (NPN open collector)	AFP13442
			Sink/source	Relay	AFP13413
				Transistor (NPN open collector)	AFP13443
				Transistor (PNP open collector)	AFP13453
		100 V to 240 V AC	Source	Relay	AFP13416
				Transistor (NPN open collector)	AFP13446
			Sink/source	Relay	AFP13417
				Transistor (NPN open collector)	AFP13447
				Transistor (PNP open collector)	AFP13457

3. Intelligent Units

Type	Specification	Operating voltage	Part number
FP1 A/D Converter Unit	• Analog input points: 4 channels/unit • Analog input range: 0 to 5 V, 0 to 10 V, 0 to 20 mA • Digital output range: K0 to K1000	24 V DC	AFP1402
		100 V to 240 V AC	AFP1406
FP1 D/A Converter Unit	• Analog output points: 2 channels/unit • Analog output range: 0 to 5 V, 0 to 10 V, 0 to 20 mA • Digital input range: K0 to K1000	24 V DC	AFP1412
		100 V to 240 V AC	AFP1416

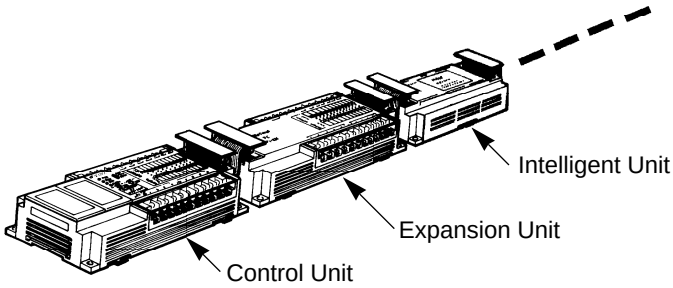
4. Link Units

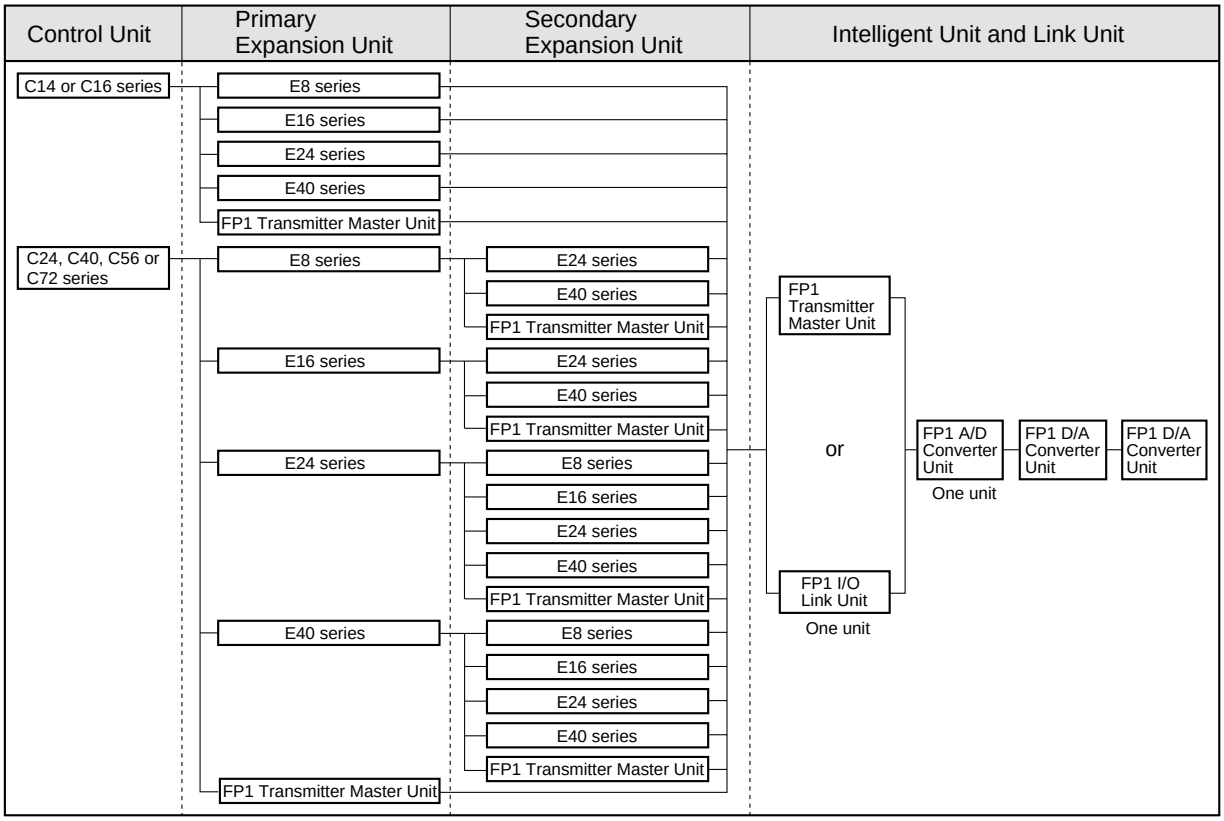
Type	Specification	Operating voltage	Part number
FP1 Transmitter Master Unit	FP1 Transmitter Master Unit enables the FP1 to exchange I/O information with slave stations at a remote site using a twisted pair cable. By connecting with another FP1 Transmitter Master Unit or with an FP3 Transmitter Master Unit, you can exchange I/O information with another FP1. Communication medium (RS485 port): Twisted pair cable up to 32 inputs and 32 outputs can be controlled per unit.	24 V DC	AFP1752
		100 V to 240 V AC	AFP1756
FP1 I/O Link Unit	The FP1 I/O Link Unit is the interface unit for exchanging I/O information between an FP3/FP5 and an FP1. When the FP1 is connected to the FP3/FP5 Remote I/O System via the FP1 I/O Link Unit, you can exchange I/O information serially, using a 2-conductor cable.	24 V DC	AFP1732
		100 V to 240 V AC	AFP1736
C-NET Adapter	RS485 ↔ RS422/RS232C signal converter Used for communication between the Programmable Controller and your computer. Communication medium (RS485 port): 2-conductor cable or twisted pair cable	24 V DC	AFP8532
		100 V to 240 V AC	AFP8536
C-NET Adapter S1 type (for FP1 Control Unit only)	RS485 ↔ RS422 signal converter for FP1 Control Unit. Used for communication between the C-NET Adapter and FP1 Control Unit.	———	AFP15401

1-3. Expansion and Configurations

1. Expansion of Units

Example:





Be sure to check that the units are expanded according to the following restrictions:

1) Expansion Units

■ Control Units (C14 and C16 series)

- Number of expandable units: 1 unit
- Total number of I/O points:
  C14 series: Max. 54 points
  C16 series: Max. 56 points

■ Control Units (C24, C40, C56 or C72 series)

- Number of expandable units: Max. 2 units
- Total number of I/O points:
  C24 series: Max. 104 points
  C40 series: Max. 120 points
  C56 series: Max. 136 points
  C72 series: Max. 152 points

Note:

- Expansion units (E8 and E16 series) which do not require power supply cannot be connected in succession. For this reason, when an E8 series or an E16 series is used as a primary expansion unit, it can only be combined with E24 or E40 series as secondary expansion unit.

2) Intelligent Units and Link Unit

- Number of expandable units together:
  FP1 A/D Converter Unit: 1 unit; FP1 D/A Converter Unit: 2 units; FP1 Transmitter Master Unit and FP1 I/O Link Unit: 1 of each unit; FP1 I/O Link Unit: 1 unit
- There are no restrictions on the order of connection of intelligent units and link unit.

2. Combination of Units

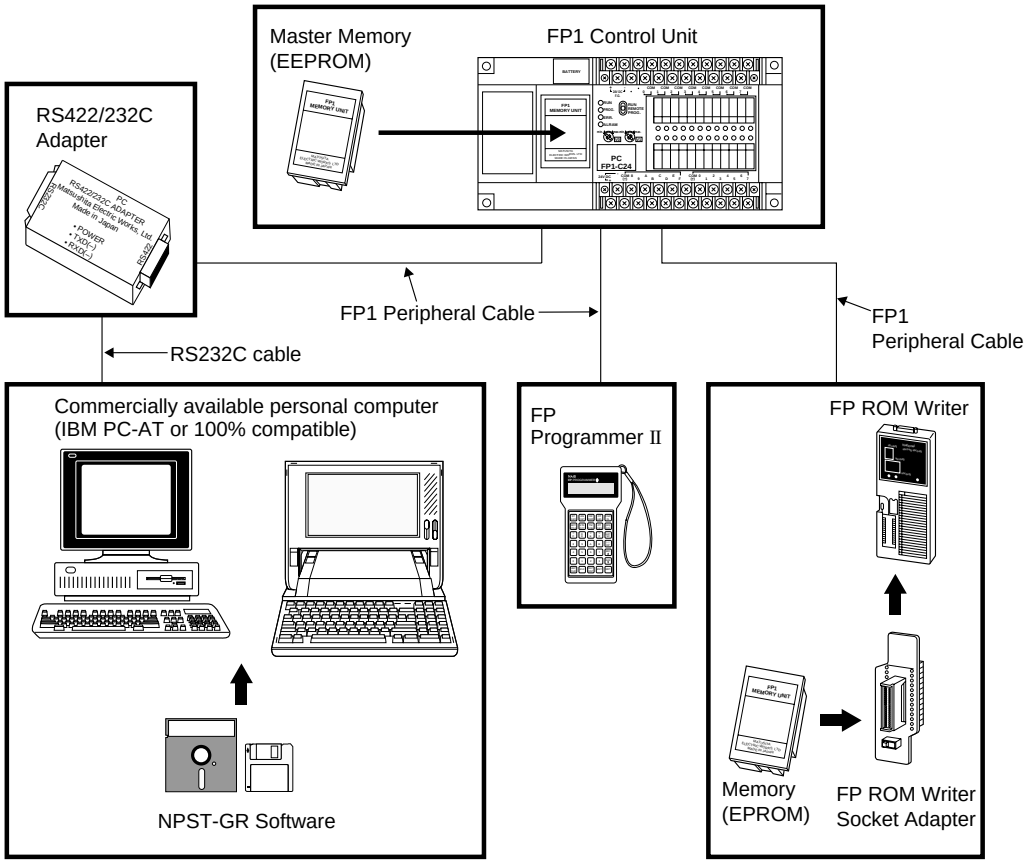
Requested I/O point			Control Unit			Primary Expansion Unit			Secondary Expansion Unit		
Total	Input	Output	Series	Input	Output	Series	Input	Output	Series	Input	Output
14	8	6	C14	8	6	—			—		
16	8	8	C16	8	8	—			—		
22	8	14	C14	8	6	E8	0	8	—		
	12	10		8	6		4	4	—		
	16	6		8	6		8	0	—		
24	16	8	C24	16	8	—			—		
	8	16	C16	8	8	E8	0	8	—		
	12	12		8	8		4	4	—		
	16	8		8	8		8	0	—		
30	8	22	C14	8	6	E16	0	16	—		
	16	14		8	6		8	8	—		
	24	6		8	6		16	0	—		
32	8	24	C16	8	8	E16	0	16	—		
	16	16		8	8		8	8	—		
	24	8		8	8		16	0	—		
	16	16	C24	16	8	E8	0	8	—		
	20	12		16	8		4	4	—		
	24	8		16	8		8	0	—		
38	24	14	C14	8	6	E24	16	8	—		
40	24	16	C40	24	16	—			—		
	24	16	C16	8	8	E24	16	8	—		
	16	24	C24	16	8	E16	0	16	—		
	24	16		16	8		8	8	—		
	32	8		16	8		16	0	—		
48	32	16	C24	16	8	E24	16	8	—		
	24	24	C40	24	16	E8	0	8	—		
	28	20		24	16		4	4	—		
	32	16		24	16		8	0	—		
54	32	22	C14	8	6	E40	24	16	—		
56	32	24	C56	32	24	—			—		
	32	24	C16	8	8	E40	24	16	—		
	32	24	C24	16	8	E24	16	8	E8	0	8
	36	20		16	8		16	8		4	4
	40	16		16	8		16	8		8	0
	24	32	C40	24	16	E16	0	16	—		
	32	24		24	16		8	8	—		
	40	16		24	16		16	0	—		

Requested I/O point			Control Unit			Primary Expansion Unit			Secondary Expansion Unit		
Total	**Input**	**Output**	**Series**	**Input**	**Output**	**Series**	**Input**	**Output**	**Series**	**Input**	**Output**
64	40	24	C24	16	8	E40	24	16	—		
	32	32		16	8	E24	16	8	E16	0	16
	40	24		16	8		16	8		8	8
	48	16		16	8		16	8		16	0
	40	24	C40	24	16	E24	16	8	—		
	32	32	C56	32	24	E8	0	8	—		
	36	28		32	24		4	4	—		
	40	24		32	24		8	0	—		
72	40	32	C72	40	32	—			—		
	48	24	C24	16	8	E24	16	8	E24	16	8
	40	32		16	8	E40	24	16	E8	0	8
	44	28		16	8		24	16		4	4
	48	24		16	8		24	16		8	0
	40	32	C40	24	16	E24	16	8	E8	0	8
	44	28		24	16		16	8		4	4
	48	24		24	16		16	8		8	0
	32	40	C56	32	24	E16	0	16	—		
	40	32		32	24		8	8	—		
	48	24		32	24		16	0	—		
80	40	40	C24	16	8	E40	24	16	E16	0	16
	48	32		16	8		24	16		8	8
	56	24		16	8		24	16		16	0
	48	32	C40	24	16	E40	24	16	—		
	40	40		24	16	E24	16	8	E16	0	16
	48	32		24	16		16	8		8	8
	56	24		24	16		16	8		16	0
	48	32	C56	32	24	E24	16	8	—		
	40	40	C72	40	32	E8	0	8	—		
	44	36		40	32		4	4	—		
	48	32		40	32		8	0	—		
88	56	32	C24	16	8	E40	24	16	E24	16	8
	56	32	C40	24	16	E24	16	8	E24	16	8
	48	40		24	16	E40	24	16	E8	0	8
	52	36		24	16		24	16		4	4
	56	32		24	16		24	16		8	0
	48	40	C56	32	24	E24	16	8	E8	0	8
	52	36		32	24		16	8		4	4
	56	32		32	24		16	8		8	0
	40	48	C72	40	32	E16	0	16	—		
	48	40		40	32		8	8	—		
	56	32		40	32		16	0	—		

Requested I/O point			Control Unit			Primary Expansion Unit			Secondary Expansion Unit		
Total	**Input**	**Output**	**Series**	**Input**	**Output**	**Series**	**Input**	**Output**	**Series**	**Input**	**Output**
96	48	48	C40	24	16	E40	24	16	E16	0	16
	56	40		24	16		24	16		8	8
	64	32		24	16		24	16		16	0
	56	40	C56	32	24	E40	24	16			
	48	48		32	24	E24	16	8	E16	0	16
	56	40		32	24		16	8		8	8
	64	32		32	24		16	8		16	0
	56	40	C72	40	32	E24	16	8			
104	64	40	C24	16	8	E40	24	16	E40	24	16
	64	40	C40	24	16	E40	24	16	E24	16	8
	64	40	C56	32	24	E24	16	8	E24	16	8
	56	48		32	24	E40	24	16	E8	0	8
	60	44		32	24		24	16		4	4
	64	40		32	24		24	16		8	0
	56	48	C72	40	32	E24	16	8	E8	0	8
	60	44		40	32		16	8		4	4
	64	40		40	32		16	8		8	0
112	56	56	C56	32	24	E40	24	16	E16	0	16
	64	48		32	24		24	16		8	8
	72	40		32	24		24	16		16	0
	64	48	C72	40	32	E40	24	16			
	56	56		40	32	E24	16	8	E16	0	16
	64	48		40	32		16	8		8	8
	72	40		40	32		16	8		16	0
120	72	48	C40	24	16	E40	24	16	E40	24	16
	72	48	C56	32	24	E40	24	16	E24	16	8
	72	48	C72	40	32	E24	16	8	E24	16	8
	64	56		40	32	E40	24	16	E8	0	8
	68	52		40	32		24	16		4	4
	72	48		40	32		24	16		8	0
128	64	64	C72	40	32	E40	24	16	E16	0	16
	72	56		40	32		24	16		8	8
	80	48		40	32		24	16		16	0
136	80	56	C56	32	24	E40	24	16	E40	24	16
	80	56	C72	40	32	E40	24	16	E24	16	8
152	88	64	C72	40	32	E40	24	16	E40	24	16

1-4. Programming Tools

■ System Configurations of Programming Tools



1. Programming Tools

Program editing can be done with a commercially available personal computer and FP Programmer II.

1) NPST-GR Software

Using the NPST-GR program editing software, programs can be easily created with any personal computer on hand.

Necessary tools

- Computer: Commercially available personal computer (IBM PC-AT or 100% compatible machine)
  System required:
  - Main memory: 550 KB or more free
  - EMS: 800 KB or more free
  - Hard disk space: 2 MB or more
  - Operating System: MS-DOS Ver. 3.30 or later
  - Video mode (Display mode): EGA or VGA
- NPST-GR Software Ver. 3: AFP266538

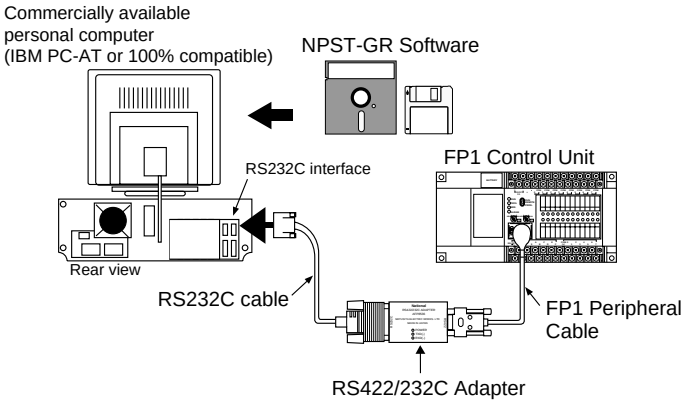
Note:

> • The .EXE files in NPST-GR Software are compressed in the system disks. When installing NPST-GR, you will have to expand them.

- RS232C cable (3 m / 9.843 ft.): AFB85833/AFB85853
- RS422/232C Adapter: AFP8550
- FP1 Peripheral Cable:
  0.5 m / 1.640 ft.: AFP15205
  3 m / 9.843 ft.: AFP1523

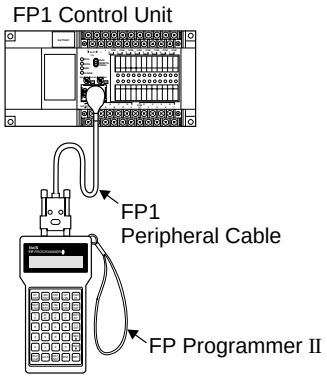
Notes:

- Refer to page 86, “4-5. Memory Unit Creation and ROM Operation” and “NPST-GR Manual”, for details about writing programs using the NPST-GR Software.
- Refer to page 260, “8-10. Product Types”, for details about RS232C cable wiring.
- When using NPST-GR Software Ver. 2, refer to page 241, “1. Differences Between NPST-GR Ver. 2.4 and Ver. 3.1.”



2) FP Programmer Ⅱ

With the hand-held FP Programmer Ⅱ, such operations as writing, reading, and retrieval of programs can be performed.



Necessary tools

- FP1 Peripheral Cable:
  0.5 m / 1.640 ft.: AFP15205
  3 m / 9.843 ft.: AFP1523
- FP Programmer Ⅱ: AFP1114

Note:

- Refer to page 86, “4-5. Memory Unit Creation and ROM Operation” and “FP PROGRAMMER Ⅱ Operation Manual”, for details about writing programs using the FP Programmer Ⅱ.

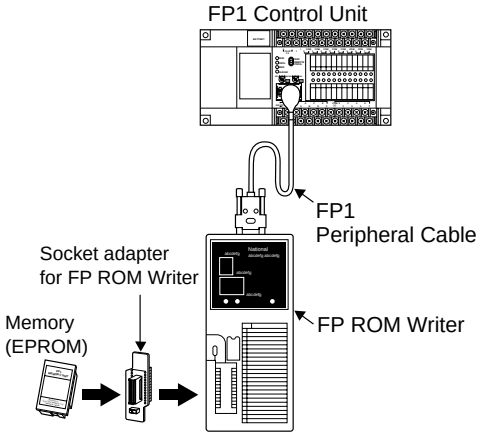
2. How to Program ROM

- Using an FP ROM Writer or a commercially available ROM programmer, the contents of the FP1’s internal RAM can be written to ROM (memory).
- The following types of ROM (memory) are available:
  - Memory (EPROM): AFP1201
    Memory for storing programs. Writing is done with an FP ROM Writer or a commercially available ROM writer.
  - Master Memory (EEPROM): AFP1202 (for C24 and C40 series), AFP1203 (for C56 and C72 series)
    Memory for copying programs. Writing is done with a master memory attached to the FP1 Control Unit.

■ Writing a program to the memory (EPROM) with an FP ROM Writer

[FP1’s internal RAM Memory]

The content of the FP1’s internal RAM is written directly to the memory (EPROM).



Necessary tools

- FP1 Peripheral Cable:
  0.5 m / 1.640 ft.: AFP15205
  3 m / 9.843 ft.: AFP1523
- FP ROM Writer: AFP5651
- Socket adapter for FP ROM Writer: AFP1810
- Memory (EPROM): AFP1201

Note:

- Refer to page 86, “4-5. Memory Unit Creation and ROM Operation” and “FP ROM WRITER Technical Manual”, for details about programming ROM.

■ Writing a program to the memory (EPROM) via the master memory (EEPROM) with a commercially available ROM programmer

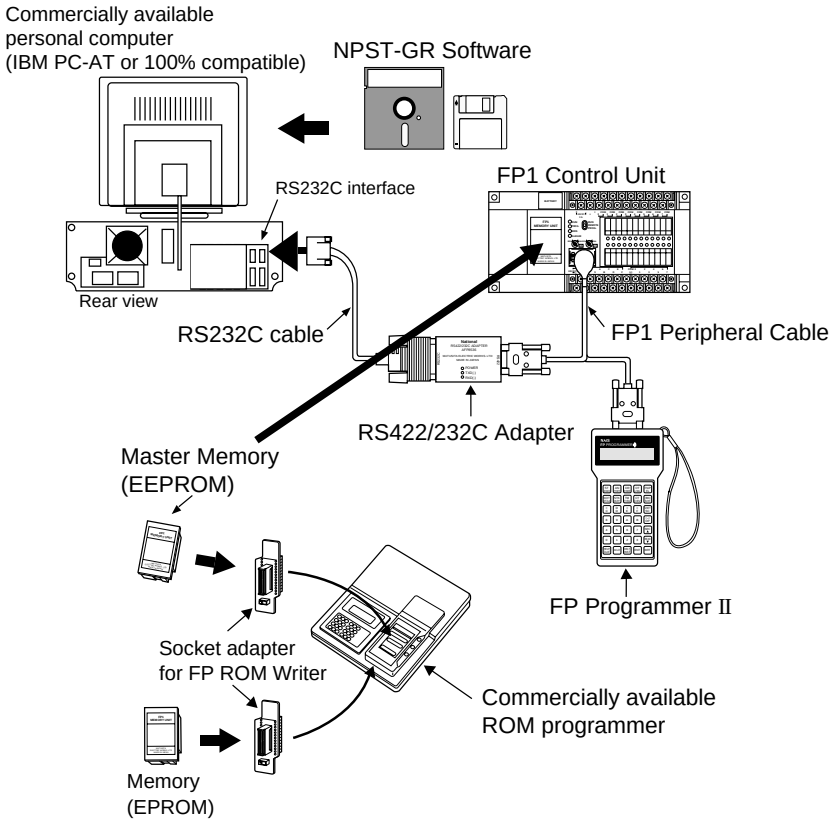
[Program in FP1's internal RAM → Master memory (EEPROM) → commercially available ROM programmer's internal memory → memory (EPROM)]

Procedure:

① Attach master memory (EEPROM) to FP1 Control Unit. Transfer to master memory (EEPROM) using FP Programmer in FP1's internal RAM.
Remove master memory (EEPROM) from FP1, and attach to commercially available ROM programmer.

② Transfer contents of that master memory (EEPROM) to the internal memory of the ROM programmer. Replace the ROM programmer's master memory (EEPROM) with the memory (EPROM).

③ Write the contents of the ROM programmer's internal memory to the memory (EPROM).



Necessary tools

- Computer: Commercially available personal computer (IBM PC-AT or 100% compatible machine)
  Main memory: 550 KB or more free
  EMS: 800 KB or more free
  Hard disk space: 2 MB or more required
  Operating System: MS-DOS Ver. 3.30 or later
  Video mode (Display mode): EGA or VGA
- NPST-GR Software Ver. 3: AFP266538

Note:

- The .EXE files are compressed in the system disks. When installing the NPST-GR, you will have to expand them.

- RS232C cable (3 m / 9.843 ft.): AFB85833/AFB85853
- RS422/232C Adapter: AFP8550
- FP1 Peripheral Cable:
  0.5 m / 1.640 ft.: AFP15205
  3 m / 9.843 ft.: AFP1523
- FP Programmer II: AFP1114
- Socket adapter for FP ROM Writer: AFP1810
- Master Memory (EEPROM): AFP1202 (for C24 and C40 series)
  AFP1203 (for C56 and C72 series)
- Memory (EPROM): AFP1201
- Commercially available ROM programmer: We recommend Aval Data Corporation's PECKER 11.

Note:

- When using NPST-GR Software Ver. 2, refer to page 241, "1. Differences Between NPST-GR Ver. 2.4 and 3.1."

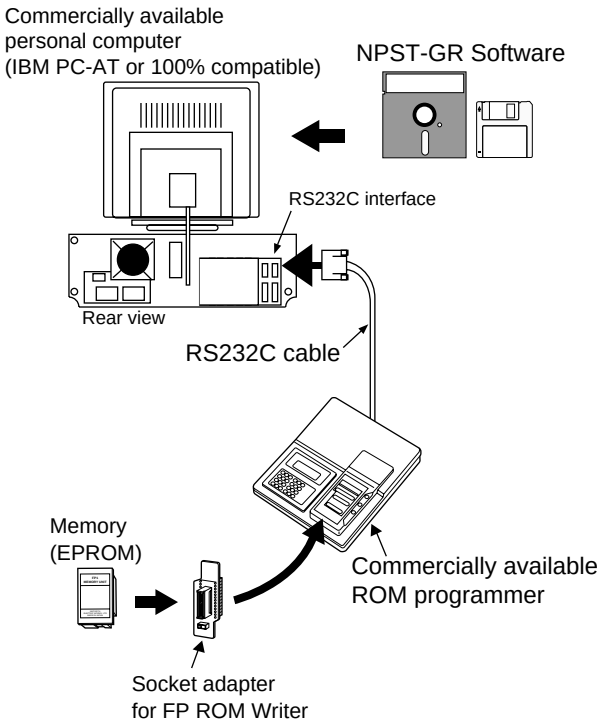
■ Writing a program to the memory (EPROM) with NPST-GR Software and a commercially available ROM programmer

[Program with NPST-GR Software → Commercially available ROM programmer's internal memory → memory (EPROM)]

Procedure:

① Transfer the program from the personal computer to the commercially available ROM programmer's internal memory with NPST-GR Software.

② Attach the memory (EPROM) to the ROM programmer, and write the program.



Necessary tools

- Computer: Commercially available personal computer (IBM PC-AT or 100% compatible machine)
  System required:
  - Main memory: 550 KB or more free
  - EMS: 800 KB or more free
  - Hard disk space: 2 MB or more
  - Operating System: MS-DOS Ver. 3.30 or later
  - Video mode (Display mode): EGA or VGA
- NPST-GR Software Ver. 3: AFP266538

Note:

> • The .EXE files are compressed in the system disks. When installing the NPST-GR, you will have to expand them.

- RS232C cable:
  Select in accordance with the specifications of the commercially available ROM programmer.
- Commercially available ROM programmer:
  We recommend Aval Data Corporation's PECKER 11.
- Socket adapter for FP ROM Writer: AFP1810
- Memory (EPROM): AFP1201

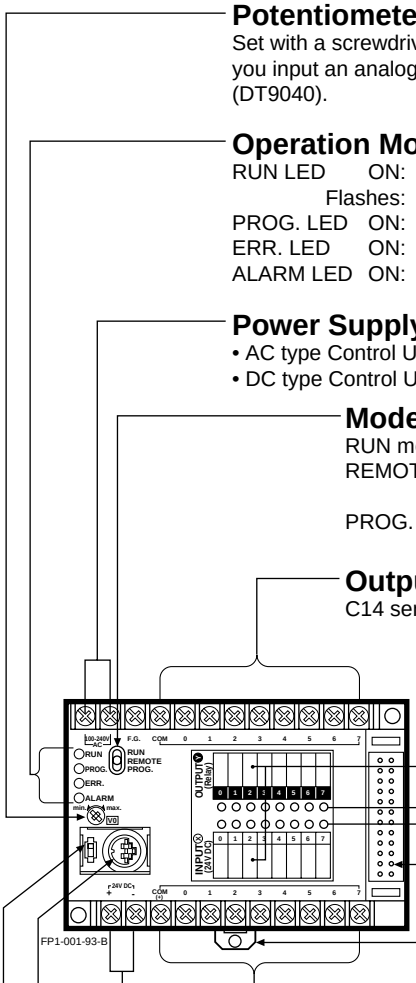
CHAPTER 2

SPECIFICATIONS

2-1. Parts Terminology and Functions

1. Control Unit

1) C14 and C16 Series (Illustration: C16 series, AC type)



Potentiometer (V0):
Set with a screwdriver, the potentiometer allows you to manually adjust the controller. This feature lets you input an analog value ranging from 0 to 255. The set value is stored in the manual dial-set register (DT9040).

Operation Monitor LEDs:

RUN LED	ON:	when program is executed
	Flashes:	when forcing input/output is executed in RUN mode
PROG. LED	ON:	when the Control Unit halts program execution
ERR. LED	ON:	when a self-diagnostic error occurs
ALARM LED	ON:	when an abnormality is detected or watchdog timer error occurs

Power Supply Terminals:
- AC type Control Unit: power supply terminals for 100 V AC to 240 V AC
- DC type Control Unit: power supply terminals for 24 V DC

Mode Selector:

RUN mode:	The Control Unit executes programs.
REMOTE mode:	The mode (RUN mode or PROG. mode) can be changed using programming tools (e.g., FP Programmer Ⅱ and personal computer with NPST-GR Software).
PROG. mode:	You can edit a program.

Output Terminals:
C14 series: 6 points, C16 series: 8 points

I/O Name Board

I/O State Indicators:
Indicates the input and output ON/OFF states.

Expansion Connector:
Connects to the FP1 Expansion Unit or FP1 Intelligent Unit (FP1 A/D Converter Unit or FP1 D/A Converter Unit) or FP1 I/O Link Unit. See page 12 and 42.

DIN Rail Attachment Lever

Input Terminals:
C14 and C16 series: 8 points
Input voltage range: 12 V DC to 24 V DC

Built-in DC Power Output Terminals for Inputs (AC type only):
DC power for inputs can be supplied from these terminals. See page 45.

Programming Tools Connector (RS422 port):
Use this connector to connect the programming tools (e.g., FP Programmer Ⅱ or personal computer with NPST-GR Software) using the FP1 Peripheral Cable.

Baud Rate Selector:
Selects the baud rate for communication with a peripheral device (FP Programmer, FP Programmer Ⅱ or personal computer with NPST-GR Software).
Sets the baud rate selector according to the peripheral device to be connected to the RS422 port.

FP Programmer (AFP1112):	19,200 bps
FP Programmer (AFP1112A):	19,200 bps or 9,600 bps
FP Programmer Ⅱ (AFP1114):	19,200 bps or 9,600 bps
Personal computer with NPST-GR:	9,600 bps

2) C24, C40, C56, and C72 Series (Illustration: C72 series, AC type)

RS232C Port (C24C, C40C, C56C, and C72C types only):
Use this connector to connect a peripheral device. [e.g., I.O.P. (Intelligent Operating Panel), Bar-code reader and Serial printer, etc.]

Operation Monitor LEDs:
RUN LED ON: when program is executed
Flashes: when forcing input/output is executed in RUN mode
PROG. LED ON: when the Control Unit halts program execution
ERR. LED ON: when a self-diagnostic error occurs
ALARM LED ON: when an abnormality is detected or watchdog timer error occurs

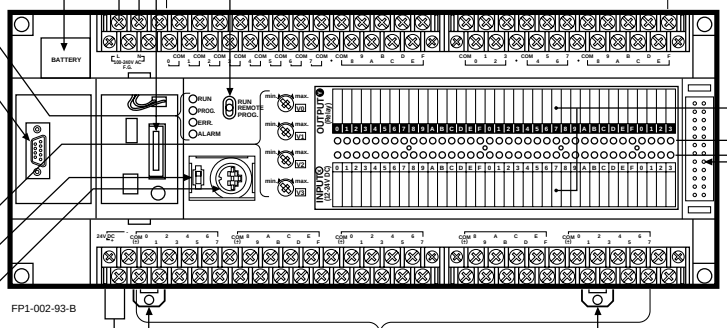
Backup Battery Holder:
Refer to page 216, "7-3. Maintenance", for details about backup battery replacement.

Power Supply Terminals:
- AC type Control Unit: power supply terminals for 100 V AC to 240 V AC
- DC type Control Unit: power supply terminals for 24 V DC

Connector for Memory (EPROM) and Master Memory (EEPROM):
Use this connector to connect the Memory (EPROM) and the Master Memory (EEPROM).

Mode Selector:
RUN mode: The Control Unit executes programs.
REMOTE mode: The mode (RUN mode or PROG. mode) can be changed using programming tools (e.g., FP Programmer Ⅱ and personal computer with NPST-GR Software).
PROG. mode: You can edit a program.

Output Terminals:
C24 series: 8 points, C40 series: 16 points, C56 series: 24 points, C72 series: 32 points
This terminal block is removable with screws at both ends.
Terminals marked with "•" cannot be used as output terminals.



I/O Name Board

I/O State Indicators:
Indicates the input and output ON/OFF states.

Expansion Connector:
Connects to the FP1 Expansion Unit or FP1 Intelligent Unit (FP1 A/D Converter Unit or FP1 D/A Converter Unit) or FP1 I/O Link Unit.
See page 12 and 42.

DIN Rail Attachment Lever

DIN Rail Attachment Lever

Input Terminals:
C24 series: 16 points, C40 series: 24 points, C56 series: 32 points, C72 series: 40 points
Input voltage range: 12V DC to 24 V DC
This terminal block is removable with screws at both ends.
Terminals marked with "•" cannot be used as input terminals.

Built-in DC Power Output Terminals for Inputs (AC type only):
DC power for inputs can be supplied from these terminals. See page 45.

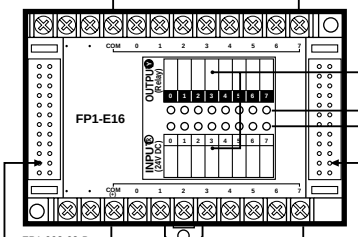
Programming Tools Connector (RS422 port):
Use this connector to connect the programming tools (e.g., FP Programmer Ⅱ or personal computer with NPST-GR Software) using the FP1 Peripheral Cable.

Baud Rate Selector:
Selects the baud rate for communication with a peripheral device (FP Programmer, FP Programmer Ⅱ or personal computer with NPST-GR Software).
Sets the baud rate selector according to the peripheral device to be connected to the RS422 port.
FP Programmer (AFP1112): 19,200 bps
FP Programmer (AFP1112A): 19,200 bps or 9,600 bps
FP Programmer Ⅱ (AFP1114): 19,200 bps or 9,600 bps
Personal computer with NPST-GR: 9,600 bps

Potentiometers (V0 to V3):
Set with a screwdriver, the potentiometers allow you to manually adjust the controller.
This feature lets you input an analog value ranging from 0 to 255.
Each set value is stored respectively in manual dial-set registers (V0: DT9040, V1: DT9041, V2: DT9042 and V3: DT9043).
C24 series: 2 (V0 and V1); C40, C56, and C72 series: 4 (V0 to V3)

2. Expansion Unit

1) E8 and E16 Series (Illustration: E16 series, I/O type)



I/O Terminals:
- Input only type and I/O type:
  E8 series (Input 4 points)/E16 series (Input 8 points)
- Output only type:
  E8 series (Output 4 points)/E16 series (Output 8 points)

I/O Name Board

I/O State Indicators:
Indicates the input and output ON/OFF states.

Expansion Connector (right side):
Connects to the FP1 Expansion Unit or FP1 Intelligent Unit (FP1 A/D Converter Unit or FP1 D/A Converter Unit) or FP1 I/O Link Unit.
See page 12 and 42.

I/O Terminals:
- Input only type and I/O type:
  E8 series (Input 4 points)/E16 series (Input 8 points)
- Output only type:
  E8 series (Output 4 points)/E16 series (Output 8 points)

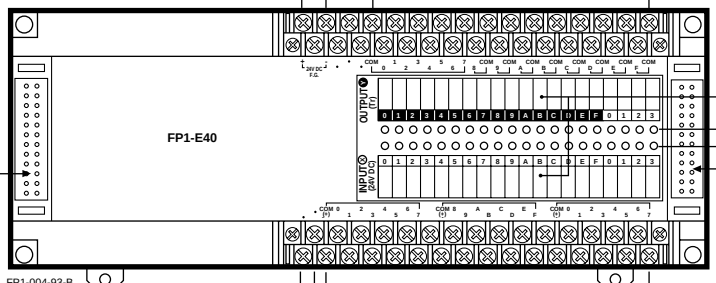
DIN Rail Attachment Lever

Expansion Connector (left side):
Connects to the FP1 Control Unit or FP1 Expansion Unit.
See page 12 and 42.

2) E24 and E40 Series (Illustration: E40 series, DC type)

Power Supply Terminals:
- AC type Control Unit: power supply terminals for 100 V AC to 240 V AC
- DC type Control Unit: power supply terminals for 24 V DC

Output Terminals:
E24 series: 8 points, E40 series 16 points
This terminal block is removable with screws at both ends.
Terminals marked with "•" cannot be used as output terminals.



I/O Name Board

I/O State Indicators:
Indicates the input and output ON/OFF states.

Expansion Connector (right side):
Connects to the FP1 Expansion Unit or FP1 Intelligent Unit (FP1 A/D Converter Unit or FP1 D/A Converter Unit) or FP1 I/O Link Unit.
See page 12 and 42.

DIN Rail Attachment Lever

Input Terminals:
E24 series: 16 points, E40 series: 24 points
Input voltage range: 12 V DC to 24 V DC
This terminal block is removable with screws at both ends.
Terminals marked with "•" cannot be used as output terminals.

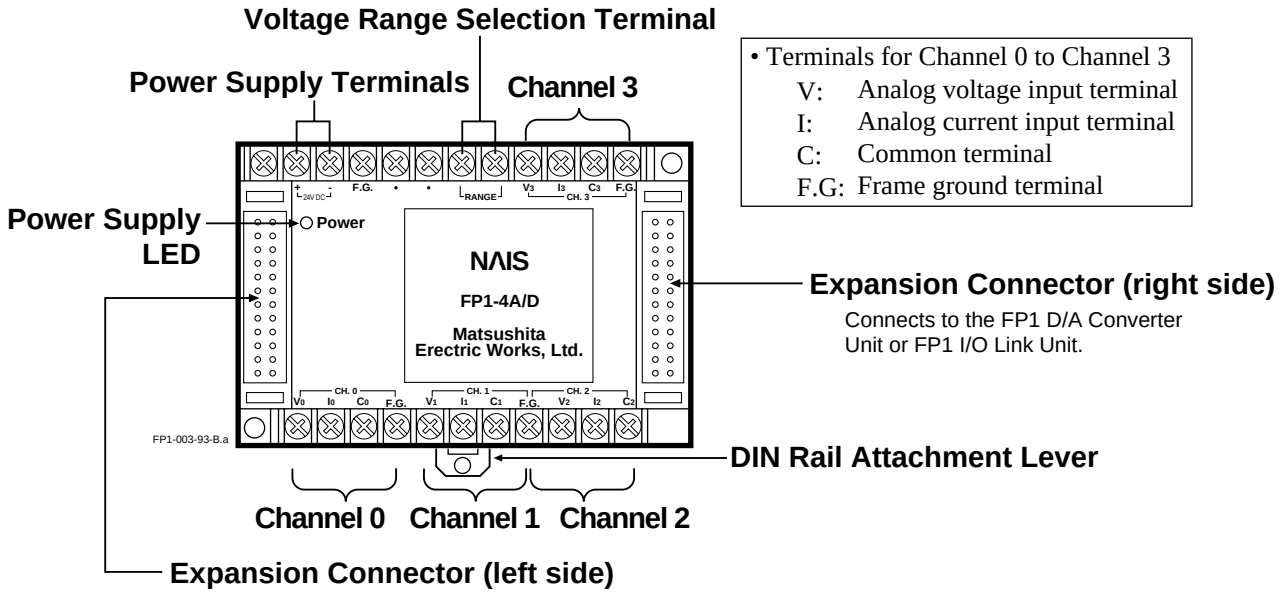
Built-in DC Power Output Terminals for Inputs (AC type only):
DC power for inputs can be supplied from these terminals.
See page 45.

DIN Rail Attachment Lever

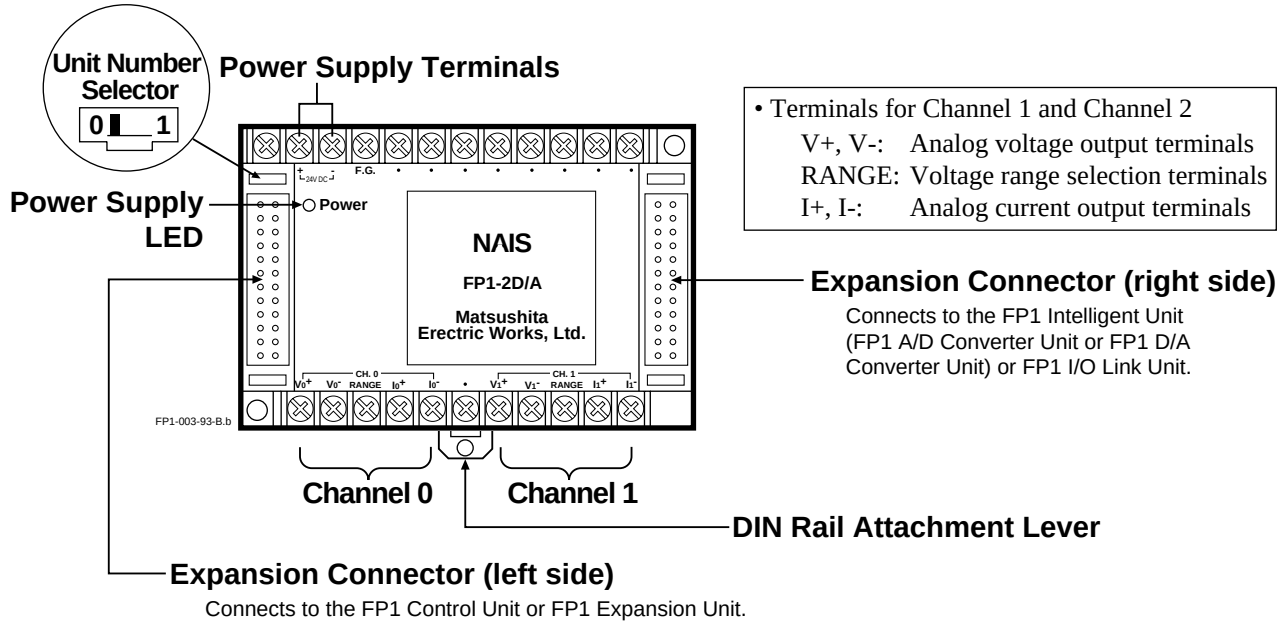
Expansion Connector (left side):
Connects to the FP1 Control Unit or FP1 Expansion Unit. See page 12 and 42.

3. Intelligent Unit

1) FP1 A/D Converter Unit (Illustration: DC type)



2) FP1 D/A Converter Unit (Illustration: DC type)

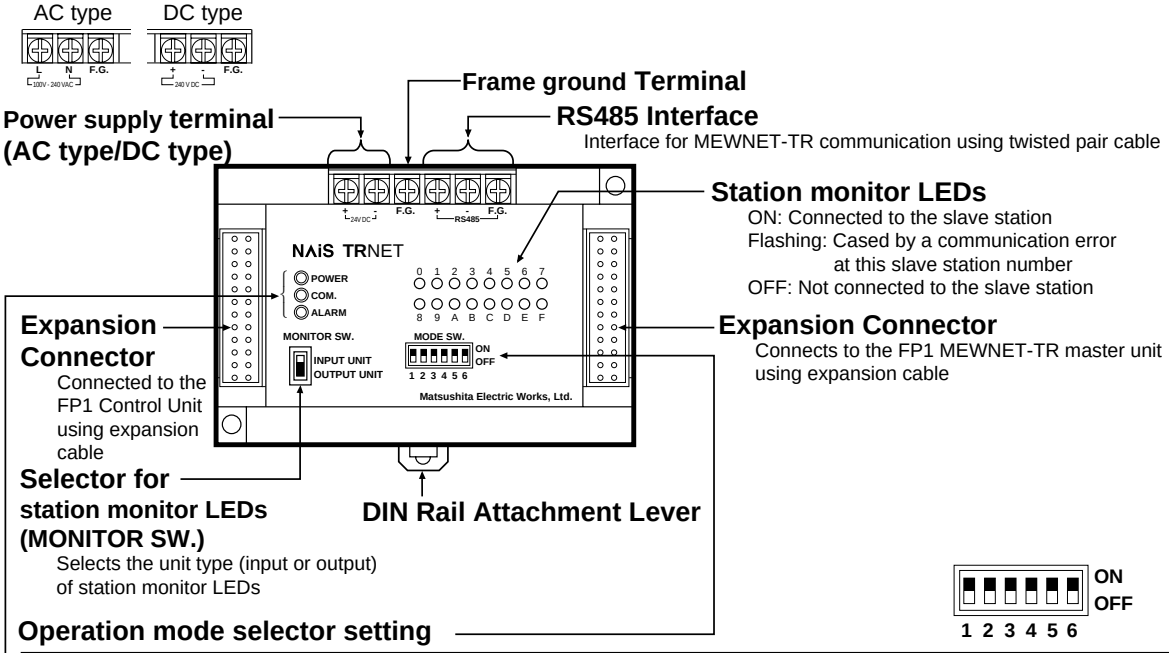


Note:

• Terminals marked with "•" cannot be used as output terminals.

4. Link Unit

1) FP1 Transmitter Master Unit



Selector Number	Function	Description		Selector position 1	2	3	4	5	6
1	System configuration selection	Remote I/O control disabled, Master B of I/O link		ON					
		Remote I/O control enabled, Master A of I/O link		OFF					
2	Output opration condition during a communication error	Start (continues I/O control operation)			ON				
		Stop			OFF				
3	Terminal station setting	Terminal station				ON			
		Not a terminal station				OFF			
4	Error flag (R9036) setting	ON when an I/O link error occurs					ON		
		Not setting					OFF		
5 and 6	I/O allocation setting (use I/O address for expansion board)	Pattern NO. 1	32 inputs: X70 to X8F 32 outputs: Y70 to Y8F					–	OFF
		Pattern NO. 2	48 inputs: X30 to X47, X50 to X67 32 outputs: Y30 to Y3F, Y50 to Y5F					ON	ON
		Pattern NO. 3	24 inputs: X30 to X47 or X50 to X67 16 outputs: Y30 to Y3F or Y50 to Y5F					OFF	ON

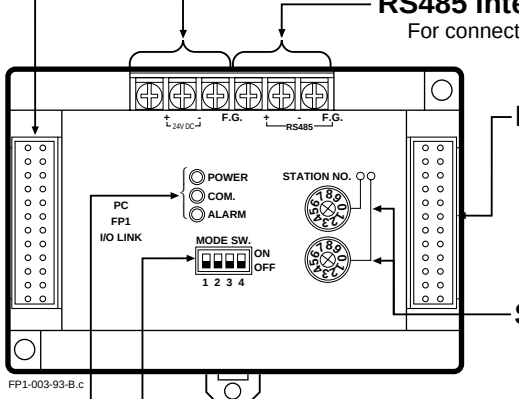
Operation Monitor LEDs

LED	Descriptions	
POWER	ON:	Power is supplied
	OFF:	Power is not supplied
COM.	Flashing:	Normal communication status (Flash in approx. 0.2 s intervals)
	ON:	Not communicating
	Flashing slowly:	A communication error occurred at the slave station. The normal slave station continues I/O control operation. (Flash in approx. 1 s intervals)
	OFF:	A communication error with a slave station
ALARM	Flashing:	Station number setting error
	ON:	Error on FP-M transmitter master board (MEWNET-TR)
	OFF:	Normal

Notes:

- The operation mode selectors are set to all OFF position when shipped.
- Operation mode selector upper state is “OFF(▀)” and the lower state is “ON (▄)”.
- Be sure to power is OFF when changing the switch position.

2) FP1 I/O Link Unit



Expansion Connector (left side)
Connects to the FP1 Control Unit or FP1 Expansion Unit.

Power Supply Terminals (AC type/DC type)

RS485 Interface
For connecting a communication cable.

Expansion Connector (right side)
Connects to the FP1 Intelligent Unit (FP1 A/D Converter Unit or FP1 D/A Converter Unit).

Station Number Selector:
Set the slave station number of the Remote I/O System.
Setting range: 01 to 32

DIN Rail Attachment Lever

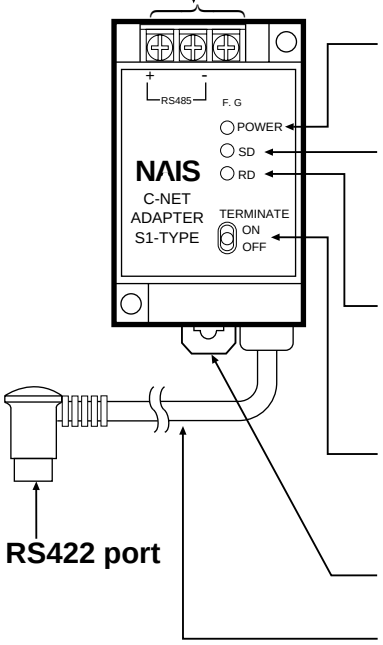
Mode Selector Switches

Switch Number	Specification		Switch position 1	2	3	4
1 & 2	Terminal station setting	Not a terminal station	OFF	OFF		
		Terminal station	ON	ON		
3	Slave station output condition during a communication error	Stop	OFF			
		Start (maintains its output condition)	ON			

Operation Monitor LEDs
Indicate communication status and operation modes.

LED	Descriptions	
Power (POWER)	ON:	When power is supplied
	OFF:	When power is not supplied
Communication (COM.)	ON:	Not communicating
	Flashing:	Communicating (Normal)
	Flashing slowly:	Remote I/O control halted, caused by a communication error at the slave station.
	OFF:	Abnormal condition
Alarm (ALARM)	ON:	Unit error
	Flashing:	Station number setting error
	OFF:	Normal unit

3) C-NET Adapter S1 Type



RS485 Interface
Connects to the RS485 interface on the C-NET Adapter or other C-NET Adapter S1 Type using transmission cable (shielded twisted pair or 2-conductor cable).

POWER LED (green)
Flashes: when receiving power
OFF: when not receiving power

Send Data Monitor LED
(green)
Flashes: when sending
OFF: when not sending

Receive Data Monitor LED
(green)
ON: when receiving
OFF: when not receiving

TERMINATE Switch
Turn this switch ON when the adapter is installed at terminal station.

DIN Rail Attachment Lever

Cable
Connects the cable to the programming tools connector (RS422 port) of FP1 Control Unit.

2-2. Specifications

1. General Specifications

Item		Description
Ambient temperature		0˚C to +55˚C/32˚F to +131˚F
Ambient humidity		30 % to 85 % RH (non-condensing)
Storage temperature		–20˚C to +70˚C/–4˚F to +158˚F
Storage humidity		30 % to 85 % RH (non-condensing)
Breakdown voltage		AC type: 1,500 Vrms for 1 min Between AC terminal and Frame ground terminal DC type: 500 Vrms for 1 min Between DC terminal and Frame ground terminal
Insulation resistance		Min. 100 MΩ (measured with a 500 V DC megger) Between AC terminal and Frame ground terminal Between DC terminal and Frame ground terminal
Vibration resistance		10 Hz to 55 Hz, 1 cycle/min: double amplitude of 0.75 mm/0.030 in., 10 min on 3 axes
Shock resistance		Shock of 98 m/s^2 or more, 4 times on 3 axes
Noise immunity		1,000 Vp-p with pulse widths 50 ns and 1 μs (based on in-house measurements)
Operating condition		Free from corrosive gases and excessive dust
Rated operating voltage	Control Unit (all series)	AC type: 100 V to 240 V AC DC type: 24 V DC
	Expansion Unit (E24 and E40 series only)	
	FP1 A/D Converter Unit	
	FP1 D/A Converter Unit	
	FP1 Transmitter Master Unit	
	FP1 I/O Link Unit	
Operating voltage range	Control Unit (all series)	AC type: 85 V to 264 V AC DC type: 20.4 V to 26.4 V DC
	Expansion Unit (E24 and E40 series only)	
	FP1 A/D Converter Unit	
	FP1 D/A Converter Unit	
	FP1 Transmitter Master Unit	
	FP1 I/O Link Unit	

Item		Description
Current consumption	Control Unit (all series)	AC type C14, C16 series: 0.3 A or less (at 100 V AC) 0.2 A or less (at 200 V AC) C24, C40 series: 0.5 A or less (at 100 V AC) 0.3 A or less (at 200 V AC) C56, C72 series: 0.6 A or less (at 100 V AC) 0.4 A or less (at 200 V AC) DC type C14, C16 series: 0.3 A or less (at 24 V DC)(See note.) C24 series: 0.4 A or less (at 24 V DC) C40 series: 0.5 A or less (at 24 V DC) C56, C72 series: 0.6 A or less (at 24 V DC)
	Expansion Unit (E24 and E40 series only)	AC type E24, E40 series: 0.5 A or less (at 100 V AC) 0.3 A or less (at 200 V AC) DC type E24 series: 0.4 A or less (at 24 V DC) E40 series: 0.5 A or less (at 24 V DC)
	FP1 A/D Converter Unit FP1 D/A Converter Unit	AC type 0.2 A or less (at 100 V AC) 0.2 A or less (at 200 V AC) DC type 0.3 A or less (at 24 V DC)
	FP1 Transmitter Master Unit	AC type 0.7 A or less (at 100 V AC) 0.5 A or less (at 200 V AC) DC type 0.7 A or less (at 24 V DC)
	FP1 I/O Link Unit	AC type 0.12 A or less (at 100 V AC) 0.08 A or less (at 200 V AC) DC type 0.2 A or less (at 24 V DC)
Built-in DC Power Output for inputs	Control Unit (AC type only)	C14, C16 series: 110 mA C24, C40 series: 230 mA C56, C72 series: 400 mA
	Expansion Unit (AC type only)	E24, E40 series: 230 mA
No-influence time by momentary power drop		Min.10 ms

Note:

- When the Expansion Unit E16 output type (Part number: AFP13110) is connected, the rated current consumption is 0.4 A or less.

2. Performance Specifications of Control Unit and Expansion Unit

1) Control Specifications

Item		C14 Series	C16 Series	C24 Series	C40 Series	C56 Series	C72 Series
Programming method		Relay symbol					
Control method		Cyclic operation					
Program memory		Built in EEPROM (without battery)		Built in RAM (lithium battery backup) EEPROM (master memory unit)/EPROM (memory unit)			
Program capacity		900 steps		2,720 steps		5,000 steps	
Operation speed		1.6 μs/step, basic instruction					
Kinds of instruction	Basic	41		80		81	
	High-level	85		111			
External input (X)		208 points, Note 1					
External output (Y)		208 points, Note 1					
Internal relay (R)		256 points		1,008 points			
Special internal relay (R)		64 points					
Timer/Counter (T/C)		128 points		144 points			
Auxiliary timer		Not available				Unlimited number of points (0.01 s to 327.67 s)	
Data register (DT)		256 words		1,660 words		6,144 words	
Special data register (DT)		70 words					
Index register (IX, IY)		2 words					
MCR points		16 points		32 points			
Number of labels (JMP,LOOP)		32 points		64 points			
Differential points (DF or DF*I*)		Unlimited number of points					
Number of step ladders		64 stages		128 stages			
Number of subroutines		8 subroutines		16 subroutines			
Number of interrupt programs		Not available		9 programs			
Special functions	High speed counter	1 point Count input (X0, X1) Reset input (X2)		Counting mode: 1 CH (Up mode, Down mode, Up/Down mode, 2 phases mode) Counting range: –8,388,608 to 8,388,607 Max. counting speed: Up/Down mode 10 k Hz, 2 phases mode 5 k Hz Min. input pulse width: 1 phase 50 μs • 2 phases 100 μs			
	Manual dial-set register	1 potentiometer		2 potentiometers	4 potentiometers		
	Pulse catch input	4 points (X0 to X3)		Total 8 points (X0 to X7)			
	Interrupt input	Not available					
	Periodical interrupt	Not available		10 ms to 30 s interval			
	RS232C port*	Not available		Communication rate: 300/600/1,200/2,400 /4,800/9,600/19,200 bps Communication distance per port: 15 m/49.213 ft. Connector: D-SUB 9 pins connector			
	Clock/Calendar*	Not available		Clock/Calendar available			
	I/O link	32 inputs, 32 outputs					
	Pulse output	1 point (Y7), pulse output frequency: 45 Hz to 4.9 k Hz				2 points (Y6, Y7), pulse output frequency: 45 Hz to 4.9 k Hz, Note 2	
	Constant scan	2.5 ms × set value (160 ms or less)					

*C24C, C40C, C56C, C72C types only

Item	C14 Series	C16 Series	C24 Series	C40 Series	C56 Series	C72 Series
Adjustable input time filtering	1 to 128 ms					
Self-diagnosis function	Such as watchdog timer, battery detection, program check					
Memory backup (at 25°C)	Note 3		Approx. 27,000 h (C24C, C40C, C56C, and C72C types) Approx. 53,000 h (except C24C, C40C, C56C, and C72C types)			

Notes:

1. The actual number of points that can be used is the total number of I/O points of the Control Unit and the Expansion Unit.
2. The two pulse outputs, Y6 and Y7, are not available at the same time.
3. For C14 and C16 series, the hold type data are backed up by the internal capacitor. Back-up time for them is 10 days at 25°C.

2) Input Specifications of Control Unit and Expansion Unit

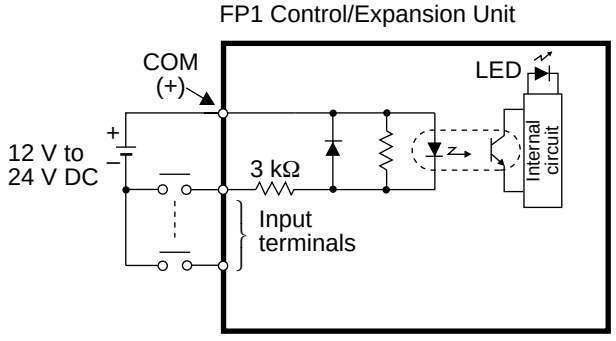
Item	Description
Rated input voltage	12 V to 24 V DC
Operating voltage range	10.2 V to 26.4 V DC
ON voltage/current	10 V or less/3 mA or less
OFF voltage/current	2.5 V or more/1 mA or more
Input impedance	Approx. 3 kΩ
Response time ON ↔ OFF	2 ms or less (at normal input) (See note.) 50 μs or less (in setting high speed counter) 200 μs or less (in setting interrupt input) 500 μs or less (in setting pulse catch)
Operating mode indicator	LED
Connection method	Terminal block (M3.5 screw)
Insulation method	Optical coupler

Note:

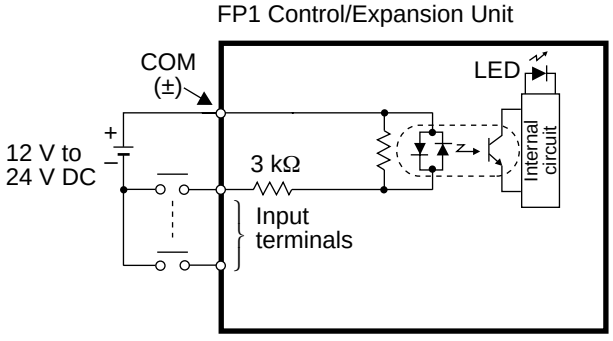
• Input response time can be changed using the input time filtering function as 1 ms, 2 ms, 4 ms, 8 ms, 16 ms, 32 ms, 64 ms or 128 ms in 8 input units. However, for E8 and E16 series, the input response time is fixed as 2 ms.

■ Wiring diagram examples

• (+) common input version



• (+)/(–) common input version



Note:

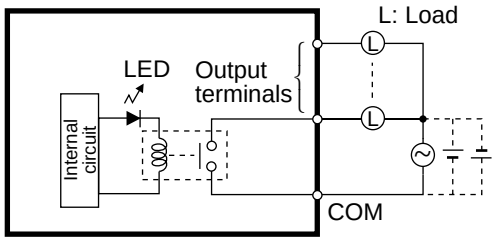
• C14, C56, C72 and E16 (Input type only) series do not have (+) common input version.

3) Output Specifications of Control Unit and Expansion Unit

■ Relay output type

Item	Description
Output type	Normally open (1 Form A)
Rated control capacity	2 A 250 V AC, 2 A 30 V DC (5 A/common)
Response time OFF → ON	8 ms or less
ON → OFF	10 ms or less
Mechanical life time	5×10^6 operations or more
Electrical life time	10^5 operations or more
Surge absorber	None
Operating mode indicator	LED
Connection method	Terminal block (M3.5 screw)

• **Wiring diagram** (FP1 Control/Expansion Unit)



■ Transistor output type (PNP or NPN open collector)

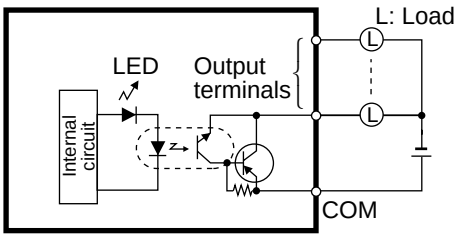
Item	Description
Insulation method	Optical coupler
Output type	Transistor PNP or NPN open collector
Rated load voltage range	5 V to 24 V DC
Operating load voltage range	4.75 V to 26.4 V DC
Max. load current	0.5 A/point (at 24 V DC) (See note 1.)
Max. surge current	3A
OFF state leakage current	100 μA or less
ON state voltage drop	1.5 V or less
Response time OFF → ON	1 ms or less
(See note 2.) ON → OFF	1 ms or less
Surge absorber	Zener diode
Operating mode indicator	LED
Connection method	Terminal block (M3.5 screw)

Notes:

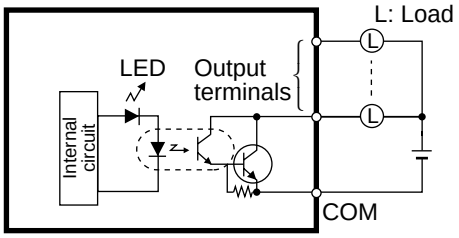
1. For C56 and C72 series Control Units, make the current for one common no more than the following values.
   1 point/common circuit: 0.5 A/common
   4 points/common circuit: 1 A/common
   8 points/common circuit: 2 A/common
2. For C14, C16, C24, and C40 series, Y7 only is 100 μs maximum, and for C56 and C72 series, Y6 and Y7 are 100 μs maximum.

• **Wiring diagram** (FP1 Control/Expansion Unit)

PNP open collector type



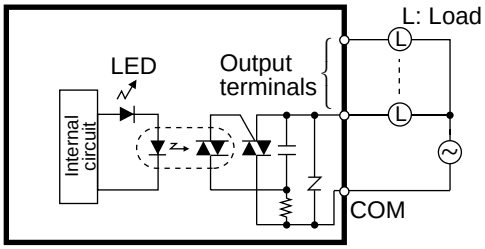
NPN open collector type



■ Triac output type

Item	Description
Insulation method	Optical coupler
Output type	Triac
Rated load voltage range	100 V to 240 V AC
Operating load voltage range	85 V to 250 V AC
Max. load current	1 A/point, 1 A/common
Min. load current	30 mA
Max. surge current	15 A, 100 ms or less
OFF state leakage current	4 mA or less (at 240 V AC)
ON state voltage drop	1.5 V or less (at 0.3 A to 1 A load), 5 V or less (at 0.3 A or less load)
Response time OFF → ON	1 ms or less
ON → OFF	0.5 cycle + 1 ms or less
Surge absorber	Varister
Operating mode indicator	LED
Connection method	Terminal block (M3.5 screw)

• **Wiring diagram** (FP1 Expansion Unit)



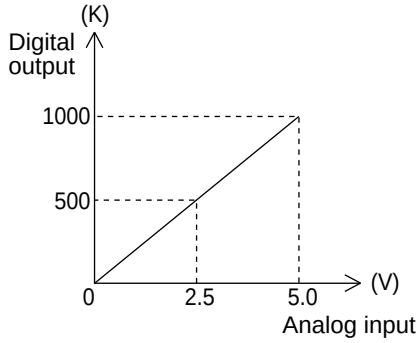
3. Performance Specifications of Intelligent Unit

1) FP1 A/D Converter Unit

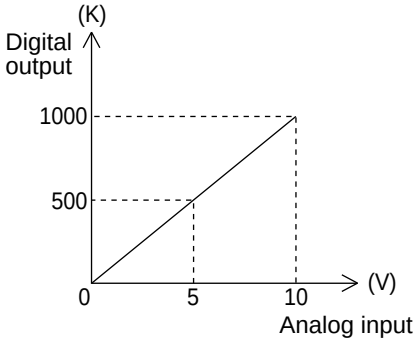
Item	Description
Analog input points	4 channels/unit
Analog input range	0 to 5 V and 0 to 10 V 0 to 20 mA
Resolution	1/1000
Overall accuracy	±1 % of full scale
Response time	2.5 ms/channel
Input impedance	1 MΩ or more (at 0 to 5 V and 0 to 10 V range) 250 Ω (at 0 to 20 mA range)
Absolute input range	+7.5 V (at 0 to 5 V range), +15 V (at 0 to 10 V range) +30 mA (at 0 to 20 mA range)
Digital output range	K0 to K1000 (H0000 to H03E8)
Insulation method	Optical coupler: between terminal and internal circuit Not insulated: between channels
Connection method	Terminal block (M 3.5 screw)

■ I/O Conversion Characteristics

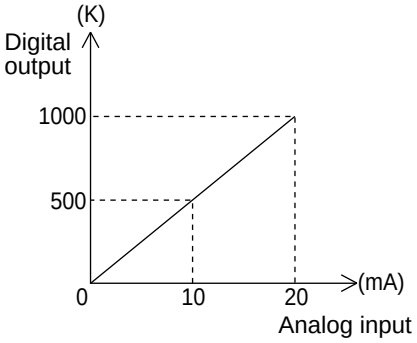
• 0 to 5 V range



• 0 to 10 V range



• 0 to 20 mA range

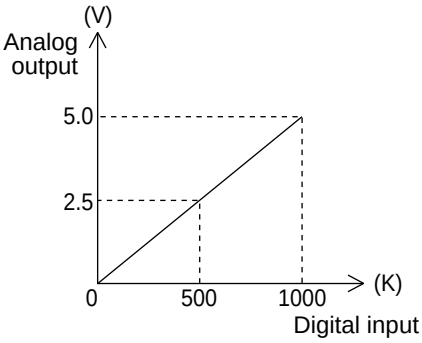


2) FP1 D/A Converter Unit

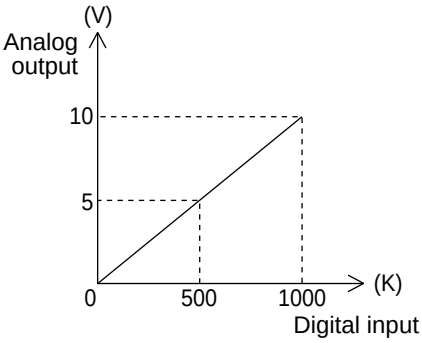
Item	Description
Analog output points	2 channels/unit
Analog output range	0 to 5 V and 0 to 10 V 0 to 20 mA
Resolution	1/1000
Overall accuracy	±1 % of full scale
Response time	2.5 ms/channel
Output impedance	0.5 Ω or less (at voltage output terminal)
Maximum output current	20 mA (at voltage output terminal)
Allowable load resistance	0 to 500 Ω (at current output terminal)
Digital output range	K0 to K1000 (H0000 to H03E8)
Insulation method	Optical coupler: between terminal and internal circuit Not insulated: between channels
Connection method	Terminal block (M 3.5 screw)

■ I/O Conversion Characteristics

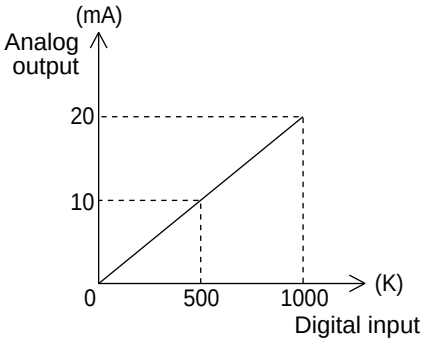
• 0 to 5 V range



• 0 to 10 V range



• 0 to 20 mA range



4. Performance Specifications of Link Unit

1) FP1 Transmitter Master Unit

Item	Description
Interface	RS485
Data Transmission velocity	0.5 M bps
Number of controllable I/O points	64 points (Input: 32, Output: 32, setting when shipped) When 2 transmitter master units are connected, the I/O points are as follows, 104 points (Input: 56, Output: 48, C14, C16 series) 144 points (Input: 80, Output: 64, C24, C40, C56 and C72 series)
Transmission distance	Max. 700 m (with twisted pair cable)

2) FP1 I/O Link Unit

Item	Description
Number of controllable Input/Output points	64 points (Input: 32 points and Output: 32 points)
Slot occupation per FP1 I/O Link Unit	1 slot

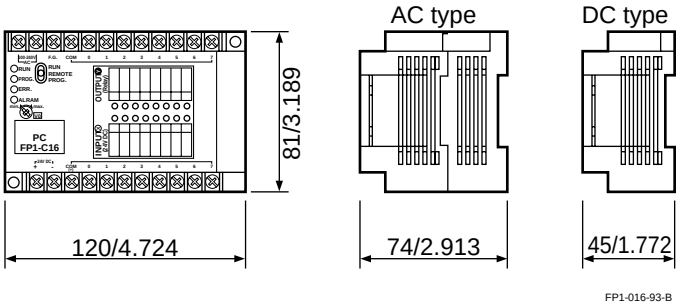
3) C-NET Adapter S1 Type

Item	Description
Interface	RS485 × 1 port, RS422 × 1 port
Conversion format	Between RS485 and RS422 interfaces

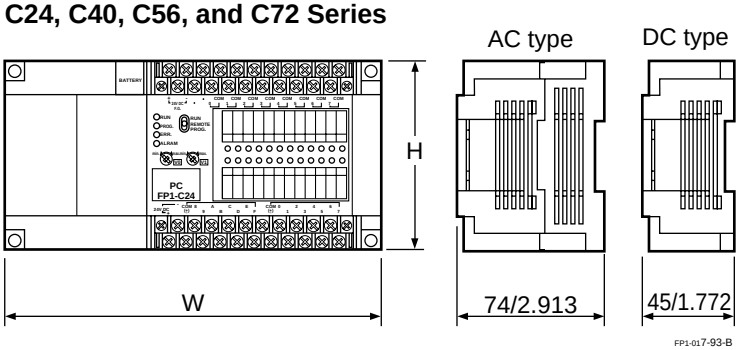
5. Dimensions

1) Control Unit

C14 and C16 Series



C24, C40, C56, and C72 Series

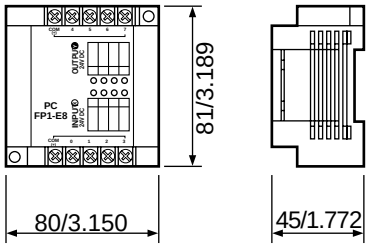


Item	W (mm/in.)	H (mm/in.)
C24 Series	190/7.480	96/3.780
C40 Series	260/10.236	
C56 Series		120/4.724
C72 series	300/11.811	

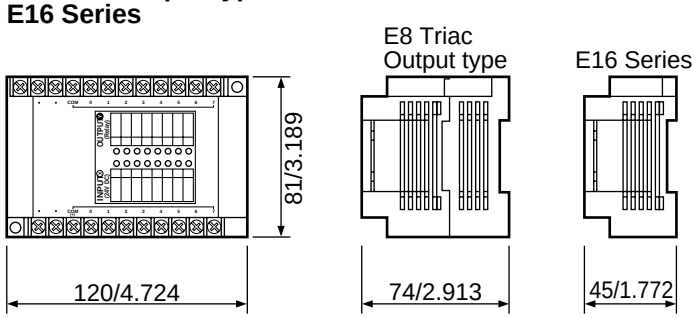
(unit: mm/in.)

2) Expansion Unit

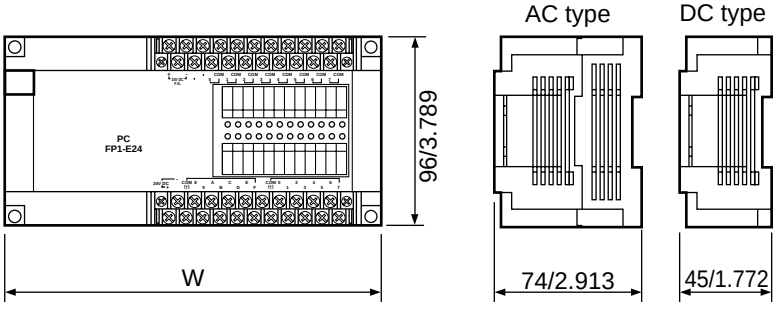
E8 Series (except E8 Triac Output type)



E8 Triac Output type and E16 Series



E24 and E40 Series

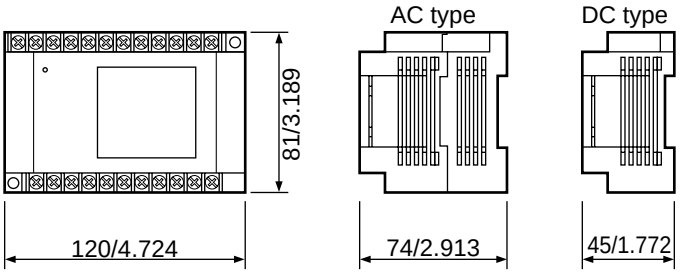


Item	W (mm/in.)
E24 Series	190/7.480
E40 Series	260/10.236

(unit: mm/in.)

3) Intelligent Unit

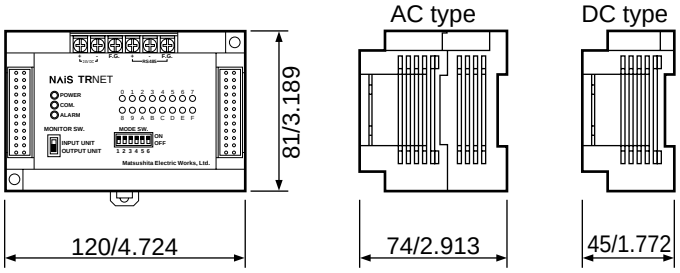
FP1 A/D Converter Unit, FP1 D/A Converter Unit



FP1-016-93-B

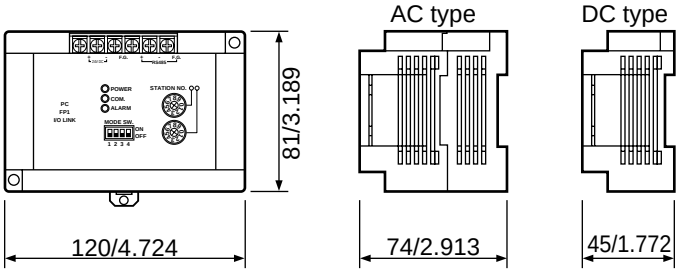
4) Link Unit

FP1 Transmitter Master Unit



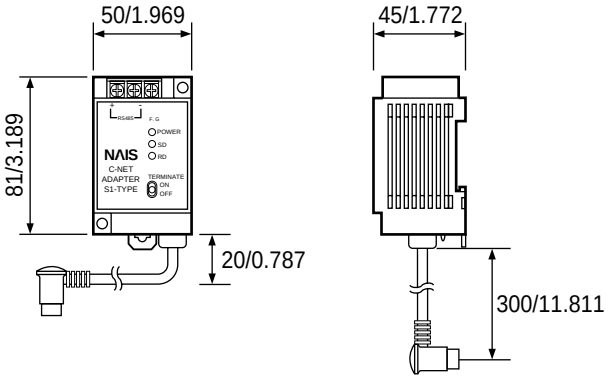
FP1-021-93-H

FP1 I/O Link Unit



FP1-021-93-H

C-NET Adapter S1 Type



(unit: mm/in.)

CHAPTER 3

INSTALLATION AND WIRING

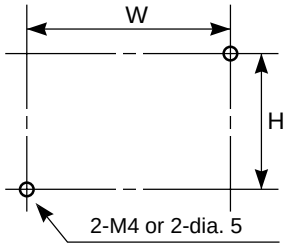
3-1. Installation

1. Panel Mounting

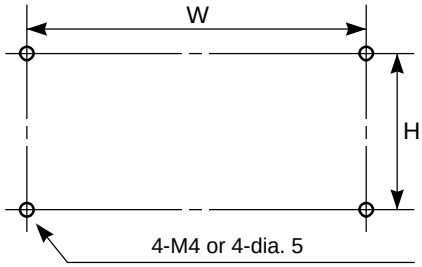
Mount the Control Unit, Expansion Unit, FP1 A/D Converter Unit, FP1 D/A Converter Unit, and FP1 I/O Link Unit on the mounting panel with M4 size screws.

Mounting Hole Dimensions

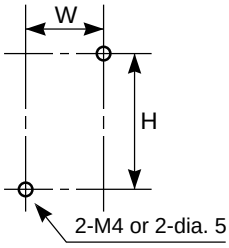
Control Units (C14 and C16 series)
Expansion Units (E8 and E16 series)
FP1 A/D Converter Units
FP1 D/A Converter Units
FP1 I/O Link Units



Control Units (C24, C40, C56, and C72 series)
Expansion Units (E24 and E40 series)



C-NET Adapter S1 type

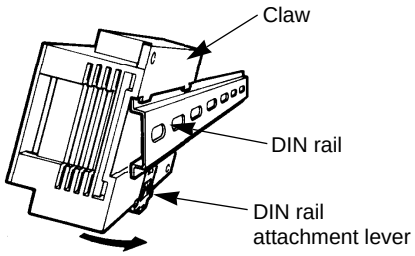


Unit		W (mm/in.)	H (mm/in.)
Control Unit	C14 series	110/4.331	71/2.795
	C16 series	110/4.331	71/2.795
	C24 series	180/7.087	86/3.386
	C40 series	250/9.843	86/3.386
	C56 series	250/9.843	110/4.331
	C72 series	290/11.417	110/4.331
Expansion Unit	E8 series (except E8 Triac output type)	70/2.756	71/2.795
	E8 Triac output type	110/4.331	71/2.795
	E16 series	110/4.331	71/2.795
	E24 series	180/7.087	86/3.386
	E40 series	250/9.843	86/3.386
Intelligent Unit	FP1 A/D Converter Unit	110/4.331	71/2.795
	FP1 D/A Converter Unit	110/4.331	71/2.795
Link Unit	FP1 Transmitter Master Unit	110/4.331	71/2.795
	FP1 I/O Link Unit	110/4.331	71/2.795
	C-NET Adapter S1 Type	40/1.575	71/2.795

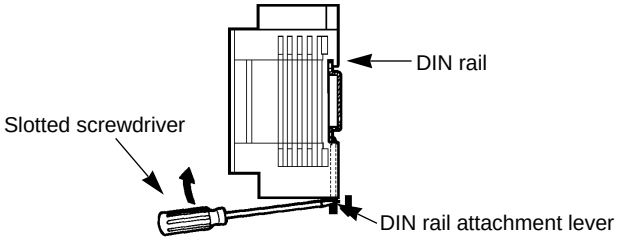
2. DIN Rail Mounting

To mount the Control Unit, Expansion Unit, FP1 A/D Converter Unit, FP1 D/A Converter Unit, and FP1 I/O Link Unit on a DIN rail, use the DIN rail attachment lever which is attached to the mounting panel.

• Align the unit with the mounting rail groove and push the unit down to install it.



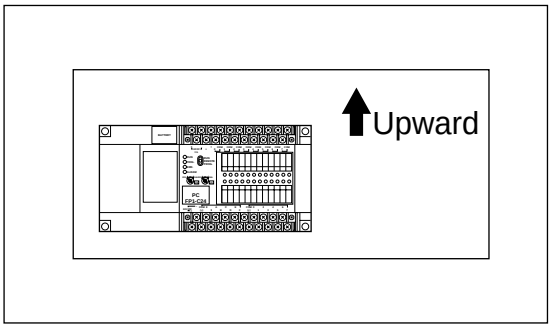
• To detach the unit from the DIN rail, pull the lever down with a slotted screwdriver.



3. Cautions

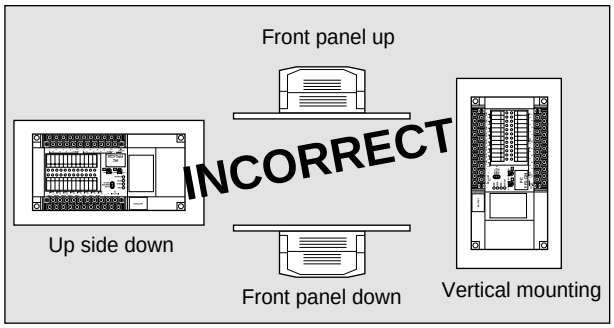
- Install and remove the Control Unit, Expansion Unit, FP1 A/D Converter Unit, FP1 D/A Converter Unit, and FP1 I/O Link Unit when all power is turned OFF.
- Do not drop the unit or apply excessive force to it.
- Do not allow pieces of wire or other objects to fall into the unit when wiring.
- Do not use the unit where it will be exposed to the following:
  - Ambient temperatures of 0˚C to 55˚C (32˚F to 131˚F).
  - Ambient humidity of 35 % to 85 % RH.
  - Sudden temperature changes causing condensation.
  - Inflammable or corrosive gas.
  - Excessive airborne dust or metal particles.
  - Benzine, paint thinner, alcohol or other organic solvents or strong alkaline solutions such as ammonia or caustic soda.
  - Excessive vibration or shock.
  - Influence from power transmission lines, high voltage equipment, power cables, power equipment, radio transmitters, or any other equipment that would generate high switching surges.
  - Water in any form including spray or mist.
  - Direct sunlight.
- Do not install the unit above devices which generate heat such as heaters, transformers or large scale resistors.

- Install as shown below, for heat radiating units. (Illustration: FP1 Control Unit)



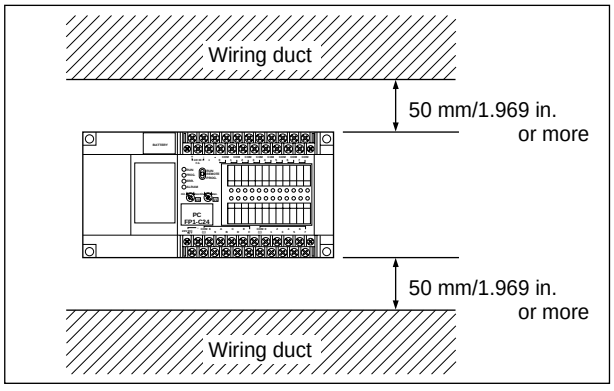
FP1-020-93-B

- Do not install the unit as shown below. (Illustration: FP1 Control Unit)



FP1- 021-93-B

- When mounting a wiring duct, maintain a clearance between the unit and duct as shown in the figure. (Illustration: FP1 Control Unit)

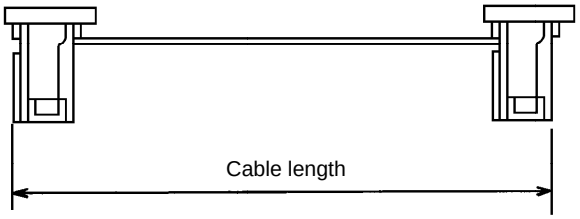


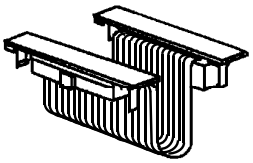
FP1-022-93-B

- The FP1 unit is wrapped in a protective sheet to prevent scraps and wire debris from getting inside. Please remove this sheet when installation and wiring is finished.

3-2. Expansion

1. Expansion Cable



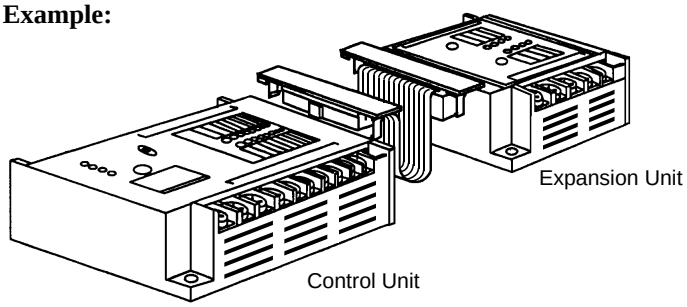


Cable length	Part number
7 cm/0.230 ft.	AFP15101
30 cm/0.984 ft.	AFP15103
50 cm/1.640 ft.	AFP15105

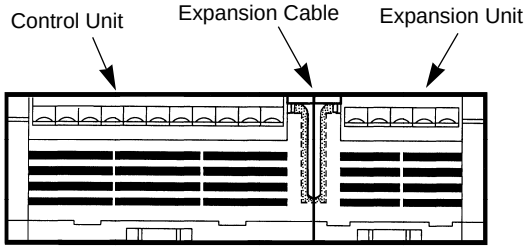
2. Unit Expansion

• Connect the Control Unit to the Expansion Unit, Intelligent unit (FP1 A/D Converter Unit, FP1 D/A Converter Unit) or FP1 I/O Link Unit using Expansion Cable that folds out of sight and out of the way. In addition, concealing the Expansion Cable helps avoid the potentially adverse effects of electrical noise.

Example:



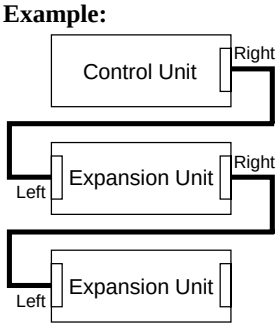
• The Expansion Cable can be concealed in the between the units.



Notes:

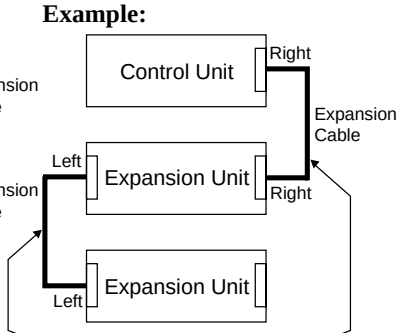
• A maximum of two Expansion Units, one FP1 A/D Converter Unit, two FP1 D/A Converter Units, and one FP1 I/O Link Unit can be simultaneously connected to one Control Unit.
• There are no restrictions on the order in which units are connected.
• An E8 series and E16 series Expansion Unit cannot be connected in succession.
Refer to page 11, “1-3. Expansion and Configurations”, for details about combination of units.
• Units must be connected left to right of each unit, therefore, please use the Expansion Cable (30 cm/0.984 ft.: AFP15103, 50 cm/1.640 ft.: AFP15105) when the units are aligned as shown in the right illustration.

Example:



CORRECT

Example:

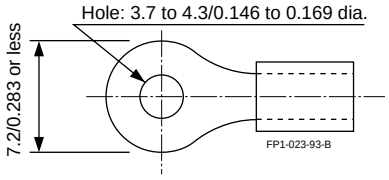


INCORRECT

3-3. Wiring

1. Crimp Terminal

- M3.5 screws are used for the I/O terminal block.
- Use of crimp terminals is recommended for wiring to the terminals.
- Be sure to connect the cables and the interface terminals correctly using crimp terminals.
- Suitable crimp terminals are ring terminals, insulated ring terminals and fork terminals.

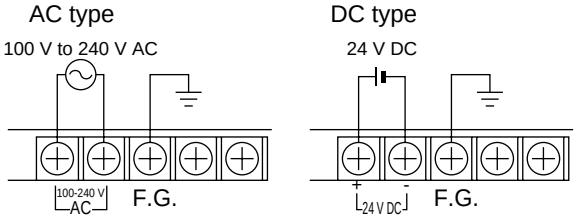


(unit: mm/in.)

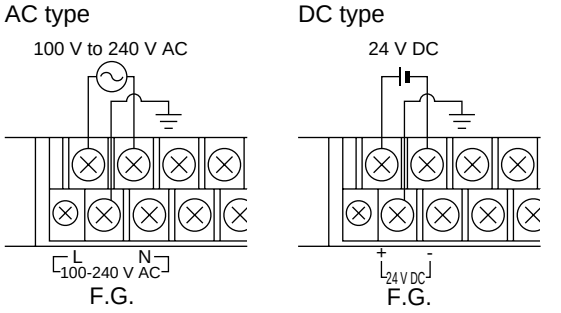
2. Wiring Power Supply

1) Wiring Example for Power Supply Terminal

- FP1 Control Unit (C14 and C16 series), FP1 A/D Converter Unit, FP1 D/A Converter Unit, and FP1 I/O Link Unit



- FP1 Control Unit (C24, C40, C56, and C72 series) FP1 Expansion Unit (E24 and E40 series)



- Operating power is not required for E8 and E16 series Expansion Units.

■ Operating Voltage

Item	AC type	DC type
Rated operating voltage	100 V to 240 V AC	24 V DC
Operating voltage range	85 V to 264 V AC	20.4 V to 26.4 V DC

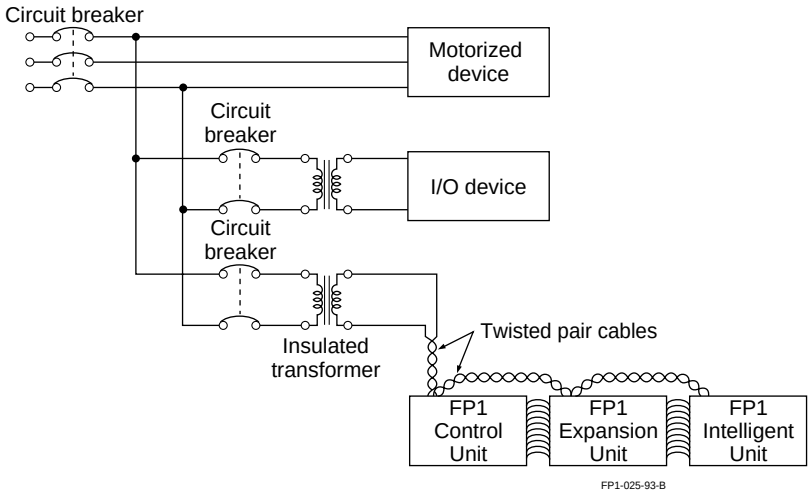
■ Grounding

- The FP1 has sufficient noise resistance under low noise level conditions. However, ground the FP1 unit for safety.
- When grounding, an earth-ground resistance of 100 Ω or less is recommended to limit the effect of noise due to electromagnetic interference.
- Do not use a grounding wire that is shared with other devices.

2) Power Supply Lines

- The power supply lines for the FP1, I/O devices and motorized devices should be isolated as shown below.
- Design the power supply lines for the Control Unit, Expansion Unit, and Intelligent units (FP1 A/D Converter Unit and FP1 D/A Converter Unit) and FP1 I/O Link Unit so that the power for each can be turned ON and OFF at the same time.
- Use twisted pair cable with 2 mm^2 or larger conductors as the power supply lines.
- Excessive noise and line voltage fluctuations can result in FP1 CPU misoperation or in system shutdown. To prevent accidents caused by noise and line voltage fluctuations, be sure to employ countermeasures (such as use of an insulated transformer, etc.) when wiring the power supply lines.

Example:



3) Momentary Power Drop

- The FP1 is not influenced by momentary power drops (less than 10 ms).

4) Safety

- In certain applications, malfunction may occur for the following reasons.
  Power on timing differences between the FP1 Control Unit and I/O or motorized devices.
  An operation time lag when a momentary power drop occurs.
  Abnormality in the FP1, power supply circuit, or other devices.
- In order to prevent malfunction from resulting in system shutdown, the following special attention is required.

Start up sequence:

The FP1 should be operated after all of the outside devices are energized. To keep this sequence, the following measures are recommended.
Set the Mode selector from PROG. mode to RUN mode after power is supplied to all of the outside devices.
Program the FP1 so as to disregard the inputs and outputs until the outside devices are energized.

Emergency stop circuit:

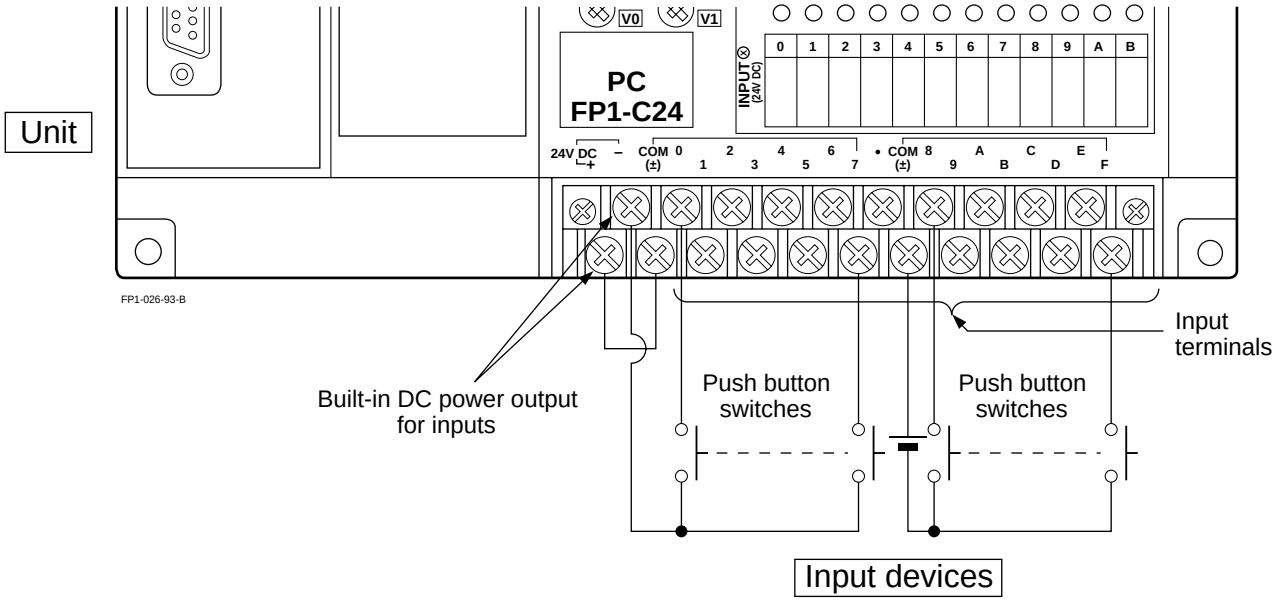
Add an emergency stop circuit to controlled devices in order to prevent a system shutdown or an irreparable accident when malfunction occurs.

Interlock circuit:

When two motions that are opposed to each other are controlled, add an interlock circuit between the programmable controller's outputs and the control device.
Example:
When a motor clockwise/counter-clockwise operation is controlled, provide an interlock circuit that prevents clockwise and counter-clockwise signals from inputting into the motor at the same time.

3. Input Terminals of Control Unit and Expansion Unit

1) Wiring Example for Input Terminals (Illustration: FP1 Control Unit)



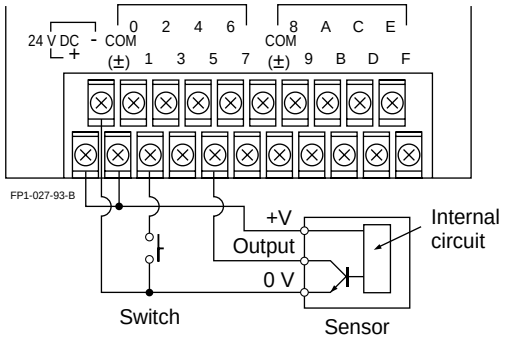
Note:

• Do not connect input devices to the input terminals indicated with a "•" symbol.

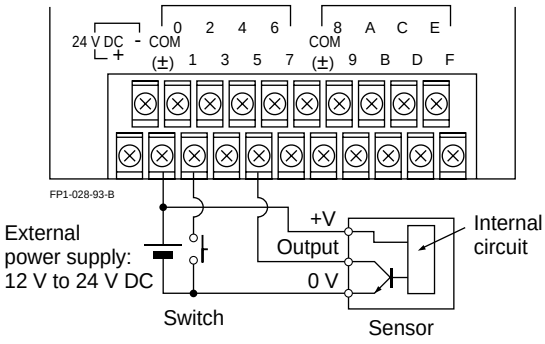
2) Description

- Keep the input lines as far away from output lines as possible.
- Keep the input lines at least 100 mm/3.937 in. away from the motor and high voltage line.
- With the AC type, the built-in DC power output for inputs can be used.
- If the capacity of the DC type or the power output for inputs are insufficient, use an exterior power supply.

Using the built-in DC power output for inputs



Using the external input supply



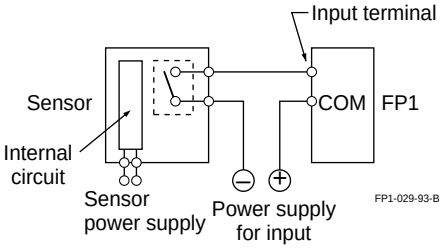
- Refer to page 29, "1. General Specifications", for details about built-in DC power output for inputs.
- Do not supply power from an exterior source to the built-in DC power output terminal (the part indicated as 24 V DC+-) of AC type unit.
- Do not connect power supplies for inputs together in parallel, and do not connect to another power supply in parallel.
- Refer to page 31, "2. Performance Specifications of Control Unit and Expansion Unit".

3) Input Wiring Examples

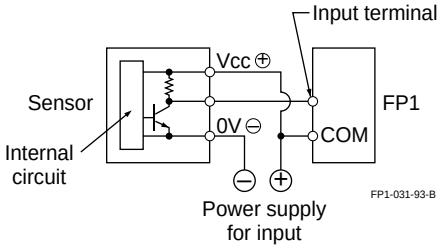
■ Wiring the Photoelectric Sensors

Due to the difference in the photoelectric sensor's output scheme, connect as shown below:

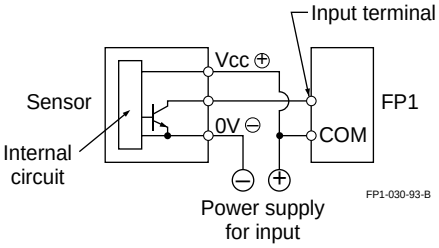
• Relay output type



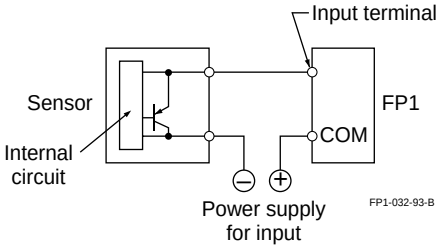
• Universal output type



• NPN open collector output type

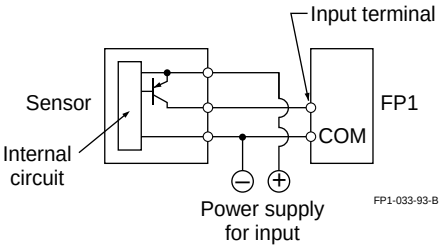


• Two-wire type



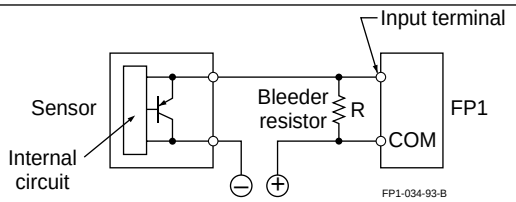
• PNP open collector output type

(Control Units and Expansion Units with common +/– inputs)



■ Wiring the Two-wire Type Sensor

• If the input of the FP1 is not turned OFF because of leakage current from the sensor, the use of a bleeder resistor is recommended, as shown below.



I: Sensor's leakage current (mA)

The OFF voltage of the FP1 input is 2.5 V, therefore, select an R value so that the voltage between the COM terminal and the input terminal will be less than 2.5 V. (The impedance of the FP1 input terminal is 3 kΩ.)

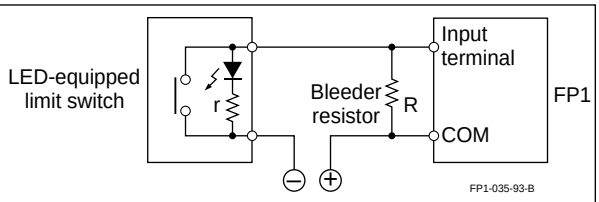
The resistance R of the bleeder resistor is : $R \leqq \frac{7.5}{3I-2.5}$

The wattage W of the resistor is:

$$W = \frac{(\text{Power supply voltage})^2}{R} \times (3\sim5)$$

■ Wiring the LED-equipped Limit Switch

• If the input of the FP1 is not turned OFF or if the LED of the limit switch is kept ON because of the leakage current, the use of a bleeder resistor is recommended, as shown below.



r: Internal resistor of limit switch (kΩ)
R: Bleeder resistance (kΩ)

The OFF voltage of the FP1 input is 2.5 V, therefore when the power supply voltage is 24 V, select R so that the current will be greater than $I = \frac{24 - 2.5}{r}$

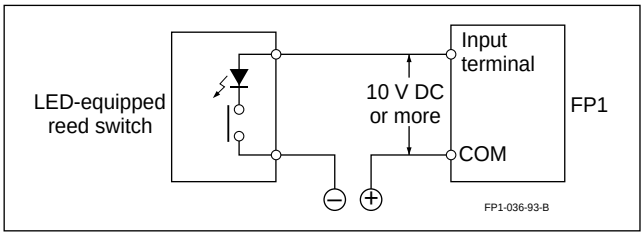
The resistance R of the bleeder resistor is: $R \leqq \frac{7.5}{3I-2.5}$

The wattage W of the resistor is:

$$W = \frac{(\text{Power supply voltage})^2}{R} \times (3\sim5)$$

■ Wiring the LED-equipped Reed Switch

• When a LED is connected in serial to an input contact such as the LED-equipped reed switch, make the voltage applied to the FP1 input circuit greater than 10 V. In particular, take care when connecting a number of switches in serial.

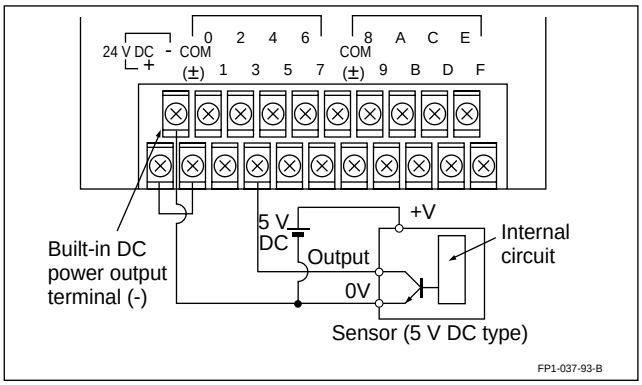


■ Connecting an input device with a different voltage (ex.: a 5 V sensor, etc.)

• When connecting a device with a power supply voltage different from the FP1 input voltage, such as a 5 V sensor, connect in common to the - side of the built-in DC power output terminal as shown in the diagram.

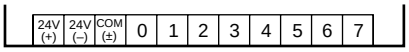
Note:

• Some sensors do not allow for this type of use, therefore check the specifications of the sensor before wiring.

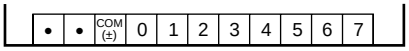


4) Input Terminal Layouts

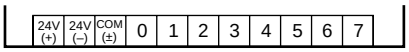
• C14 series: **AC type**



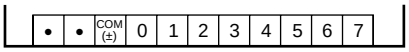
DC type



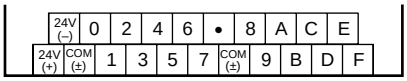
• C16 series: **AC type**



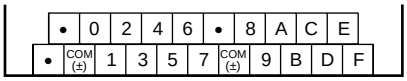
DC type



• C24, E24 series: **AC type**



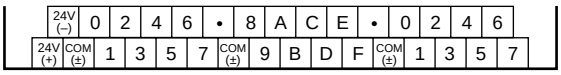
DC type



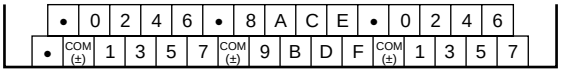
Notes:

• Do not connect input devices to the input terminals indicated with a "•" symbol.
• The + common input type is also available for C16, C24 and E24 series.

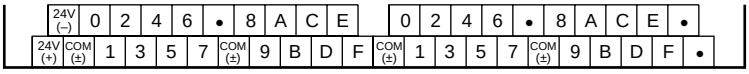
• C40, E40 series: AC type



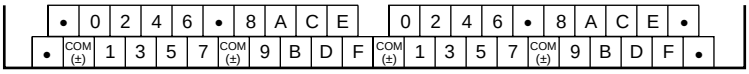
DC type



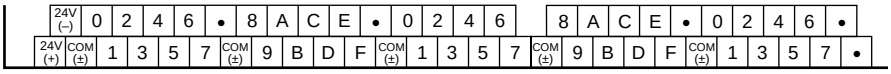
• C56 series: AC type



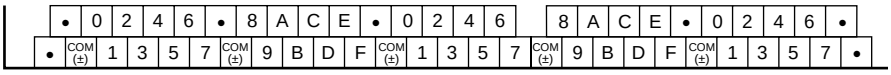
DC type



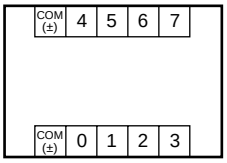
• C72 series: AC type



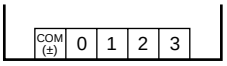
DC type



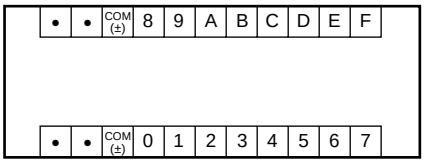
• E8 series: Input only type (I: 8-point)



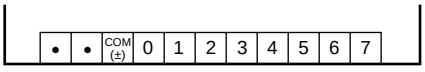
I/O type (I: 4-point)



• E16 series: Input only type (I: 16-point)



I/O type (I: 8-point)

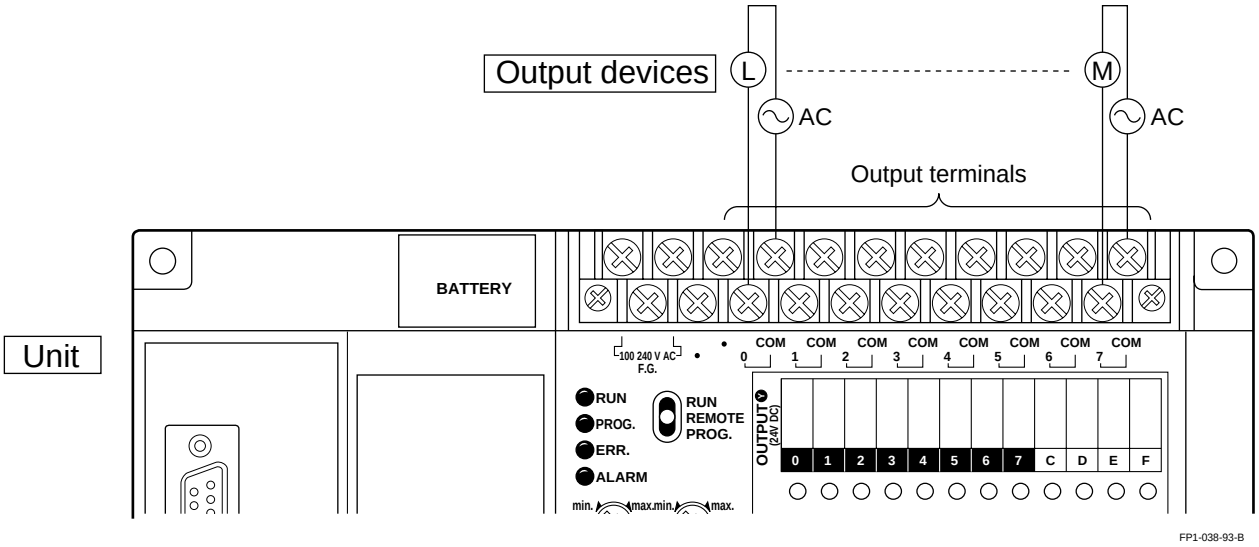


Notes:

- Do not connect input devices to the input terminals indicated with a "•" symbol.
- The + common input type is also available for C40, E40, E8 series and E16 series I/O type.

4. Output Terminals of Control Unit and Expansion Unit

1) Wiring Example for Output Terminals (Illustration: FP1 Control Unit)

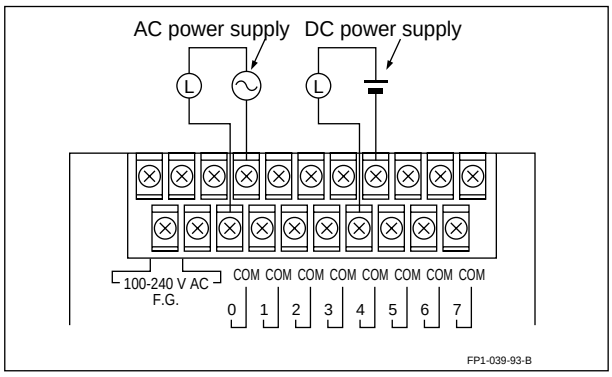


Note:

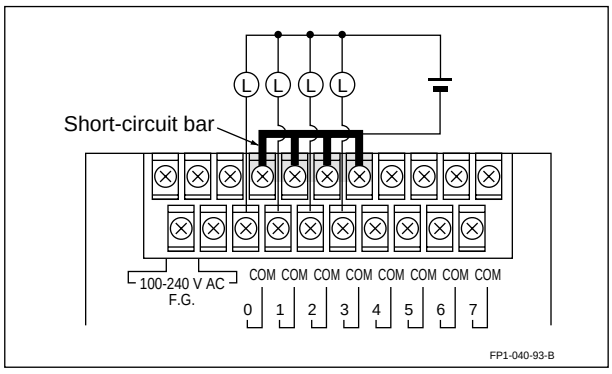
• Do not connect output devices to the output terminals indicated with a "•" symbol.

2) Description

• A different voltage can be used with each independent common.



• When more than one loade is connected to the same power supply, short the COM terminal with the short-circuit bar (Part number AFP1803).

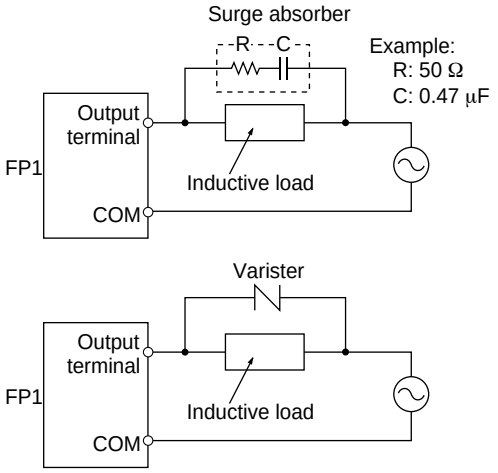


• Refer to page 33, "3) Output Specifications of Control Unit and Expansion Unit", for details about output specifications.

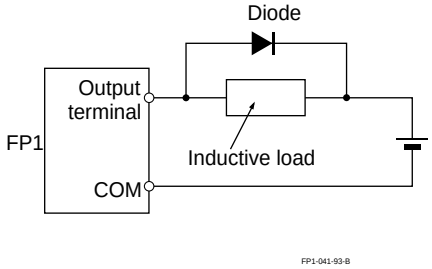
3) Output Wiring Examples

• Connect a protective circuit such as the one shown below when switching inductive loads.
When switching DC type inductive loads with a relay type output unit, be sure to connect a diode across the ends of the load.

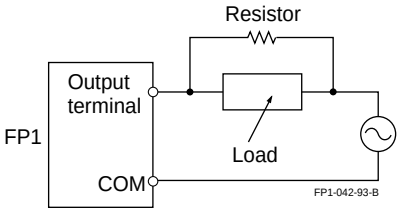
When using an AC inductive load



When using a DC inductive load



• When there is a low current load with the triac output type, the load may not go off because of the leakage current. If this type of trouble should arise, connect a resistor in parallel with the load, as shown in the diagram below.



• There is no fuse in the output circuit. Please provide a fuse externally in order to protect the output circuit from load shorts.

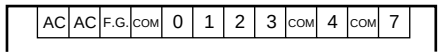
• **Mounting the Protective Device**
In the actual circuit, it is necessary to locate the protective device (diode, resistor, capacitor, varistor, etc.) in the immediate vicinity of the load or contact. If located too far away, the effectiveness of the protective device may diminish. As a guide, the distance should be within 50 cm (19.685 in.)

• **Type of Load and Inrush Current**
The type of load and its inrush current characteristics, together with the switching frequency are important factors which cause contact welding. Particularly for loads with inrush currents, measure the steady state current and inrush current and use a relay or magnet switch which provides an ample margin of safety. The table on the right shows the relationship between typical loads and their inrush currents.

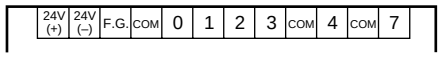
Type of load	Inrush current
Resistive load	Steady state current
Solenoid load	10 to 20 times the steady state current
Motor load	5 to 10 times the steady state current
Incandescent lamp load	10 to 15 times the steady state current
Mercury lamp load	Approx. 3 times the steady state current
Sodium vapor lamp load	1 to 3 times the steady state current
Capacitive load	20 to 40 times the steady state current
Transformer load	5 to 15 times the steady state current

4) Output Terminal Layouts

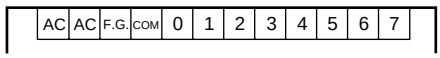
• C14 series: **AC type**



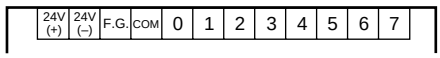
DC type



• C16 series: **AC type**



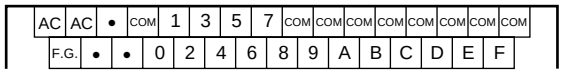
DC type



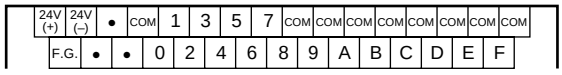
• C24, E24 series: **AC type**

DC type

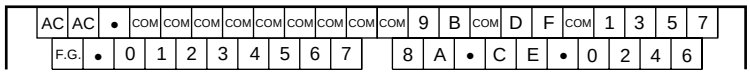
• C40, E40 series: **AC type**



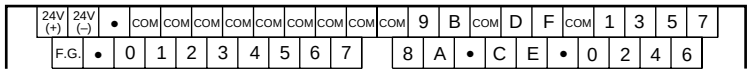
DC type



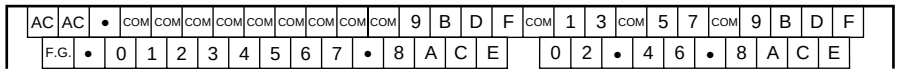
• C56 series: **AC type**



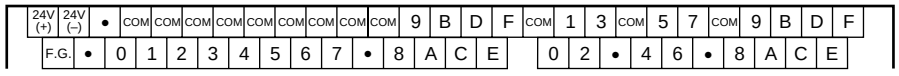
DC type



• C72 series: **AC type**



DC type

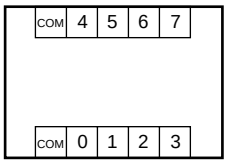


Notes:

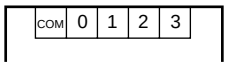
- Do not connect output devices to the output terminals indicated with a "•" symbol.
- There are differing output types such as relay, NPN open collector, PNP open collector, and triac output, therefore, take care when selecting the type of load to be connected.

• E8 series:

Output only type (O: 8-point)

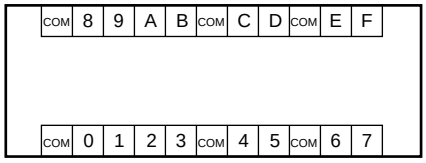


I/O type (O: 4-point)

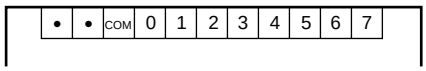


• E16 series:

Output only type (O: 16-point)



I/O type (O: 8-point)



Notes:

- Do not connect output devices to the output terminals indicated with a "•" symbol.
- There are differing output types such as relay, NPN open collector, PNP open collector, and triac output, therefore, take care when selecting the type of load to be connected.

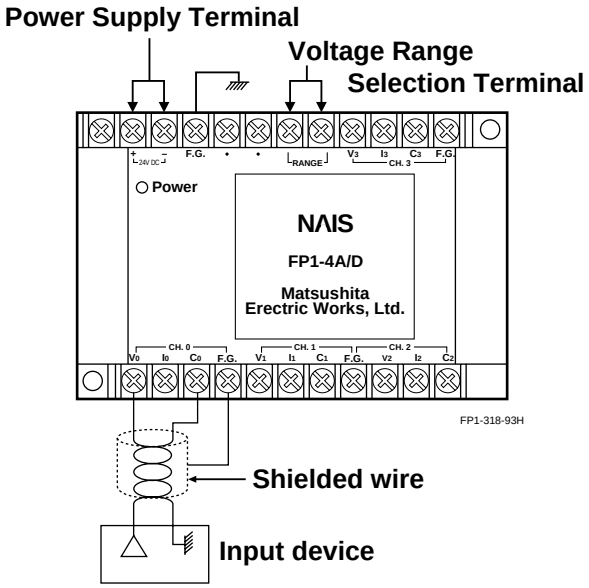
5. Wiring the FP1 A/D Converter Unit

1) Wiring for Voltage Input

Connect the input device to the analog voltage input terminal (V). Switch the input range with the voltage range selection terminal (RANGE), as shown below.

Analog input range	Voltage range selection terminal
0 to 5 V	Between terminals: Not short-circuit
0 to 10 V	Between terminals: Short-circuit

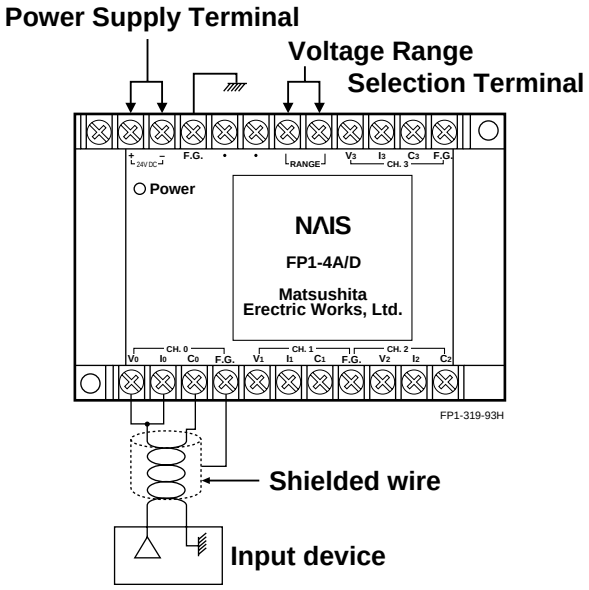
Wiring diagram



2) Wiring for Current Input

After connecting the analog voltage input terminal (V) and the analog current input terminal (I), connect the device. Open the voltage range selection terminal (RANGE) when current is input.

Wiring diagram



Notes:

- To prevent the influence of induction and noise in the input signal line, use 2-conductor twisted pair shielded cable.
- It is recommended that the shield cable be grounded to a frame ground terminal (F.G.). However, depending on the noise situation, you may get better results by grounding it externally.
- If the voltage range selection terminal (RANGE) shorts, be sure to short it at the terminal block. Also, do not pull on its lead wire.
- Keep the main circuit wiring away from high voltage lines .
- Make sure that the power is supplied to the Control Unit and the A/D Converter Unit from the same power supply line.

6. Wiring the FP1 D/A Converter Unit

1) Wiring for Voltage Output

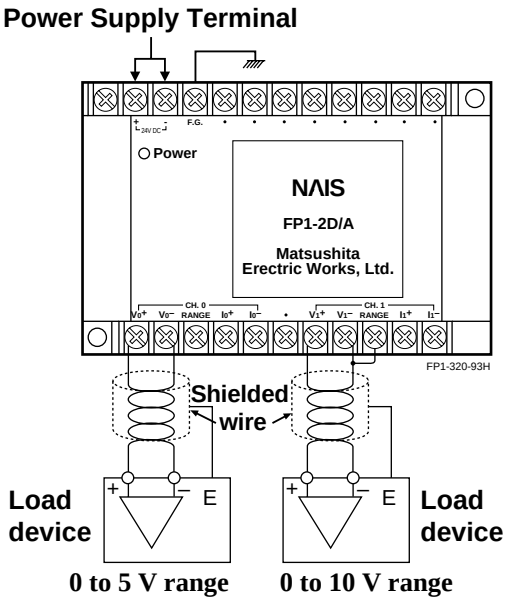
Connect the load device to the analog voltage output terminals (V+, V-). Switch the output range with the voltage range selection terminal (RANGE), as shown below.

■ Analog voltage output range

0 to 5 V range: The voltage range selection terminal (RANGE) is not connected.

0 to 10 V range: After connecting the analog voltage output terminal (V-) and the voltage range selection terminal (RANGE), connect the load device.

Wiring diagram



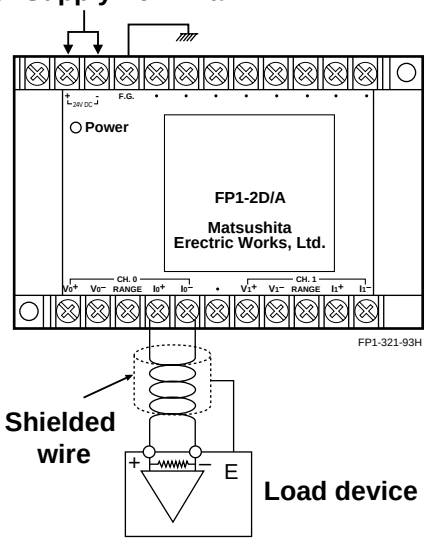
2) Wiring for Current Output

Connect the load device to the analog current output terminals (I+, I-).

■ Analog current output range:

0 to 20 mA range only

Wiring diagram

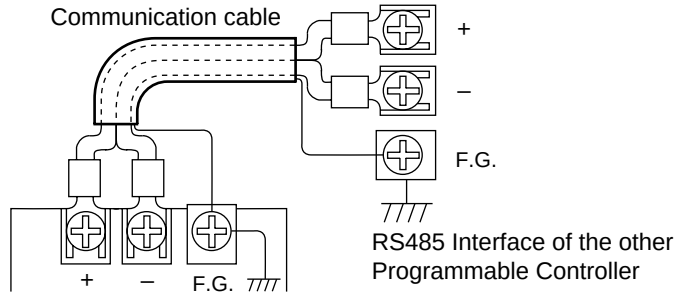


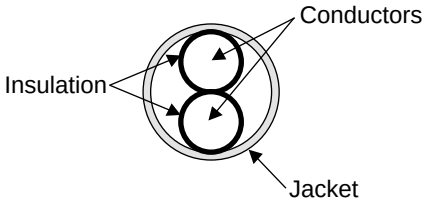
Notes:

- To prevent the influence of induction and noise in the output signal line, use 2-conductor twisted pair shielded cable.
- Simultaneous use of voltage output and current output is not possible on the same channel. Also, keep unused output terminals open.
- Keep the main circuit wiring away from high voltage line.
- Make sure that the power is supplied to the Control Unit and the D/A Converter Unit from the same power supply line.
- It is recommended that the shielded cable is grounded at the load device side. However, depending on the external noise situation, you may get better results by leaving the shield open or grounding it to the minus input terminal of the FP1 D/A Converter Unit.

7. Wiring the FP1 Transmitter Master Unit

Connect the RS485 interfaces on the FP1 Transmitter Master Unit and on the other Programmable Controller with a communication cable. When connecting the communication cable, be sure to connect positive (+) to positive, and negative (-) to negative of the RS485 interface.

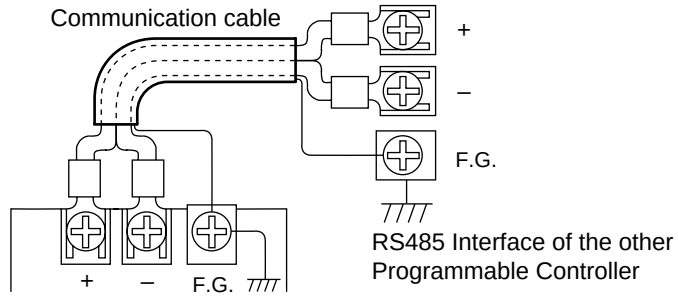




- Conductor
  - Size: Min. 1.25mm^2 (AWG16 or lager)
  - Resistance: Max. 16.8 Ω/km (at 20 ˚C/68 ˚F)
- Cable
  - Insulation material: Polyethylene
  - Insulation thickness: Max. 0.5 mm/0.020 in.
  - Jacket thickness: Approx. 8.5 mm/0.335 in.

8. Wiring the FP1 I/O Link Unit

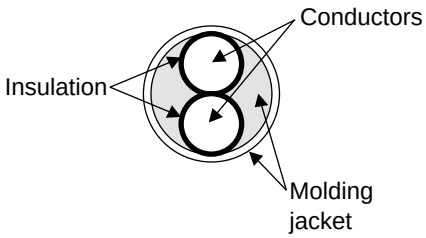
Connect the RS485 interfaces on the FP1 I/O Link Unit and on the other Programmable Controller with a communication cable. When connecting the communication cable, be sure to connect positive (+) to positive, and negative (-) to negative of RS485 the interface.



1) Cable Specifications

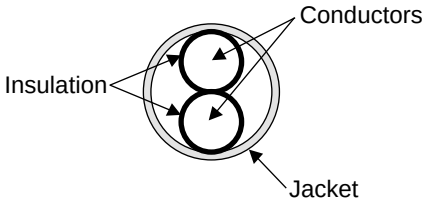
Vinyl Cabtyre Cable (VCTF): 2-conductor

- Conductor
  - Size: Min. 0.75 mm^2 (AWG18 or lager)
  - Resistance: Max. 25.1 Ω/km (at 20˚C/68˚F)
- Cable
  - Insulation thickness: Max. 0.6 mm/0.24 in.
  - Molding jacket diameter: Approx. 6.6 mm/2.60 in.



Twisted Pair Cable: 1-pair

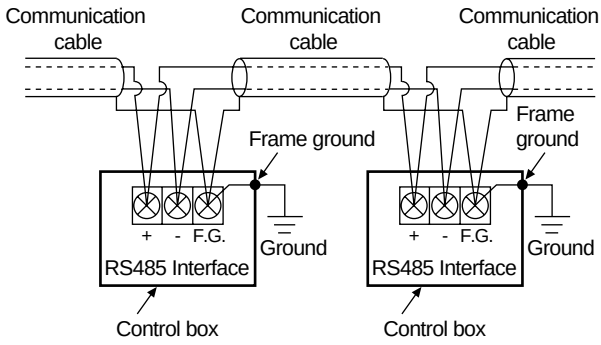
- Conductor
  - Size: Min. 0.5 mm^2 (AWG20 or lager)
- Cable
  - Insulation material: Polyethylene
  - Insulation thickness: Max. 0.5 mm/0.20 in.
  - Jacket thickness: Approx. 1.5 mm/0.59 in.



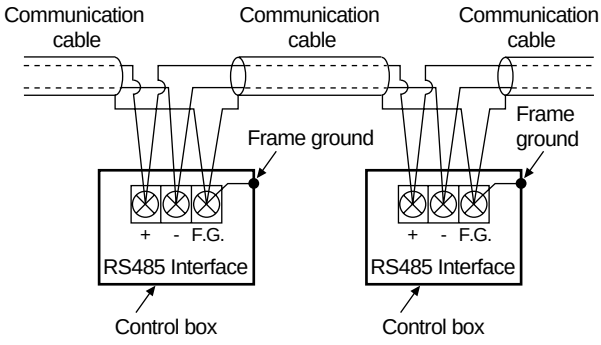
Notes:

1. Three or more parts of cable should not be connected to one RS485 port.
2. Grounding example

• When the control box is grounded:



• When the control box is not grounded:



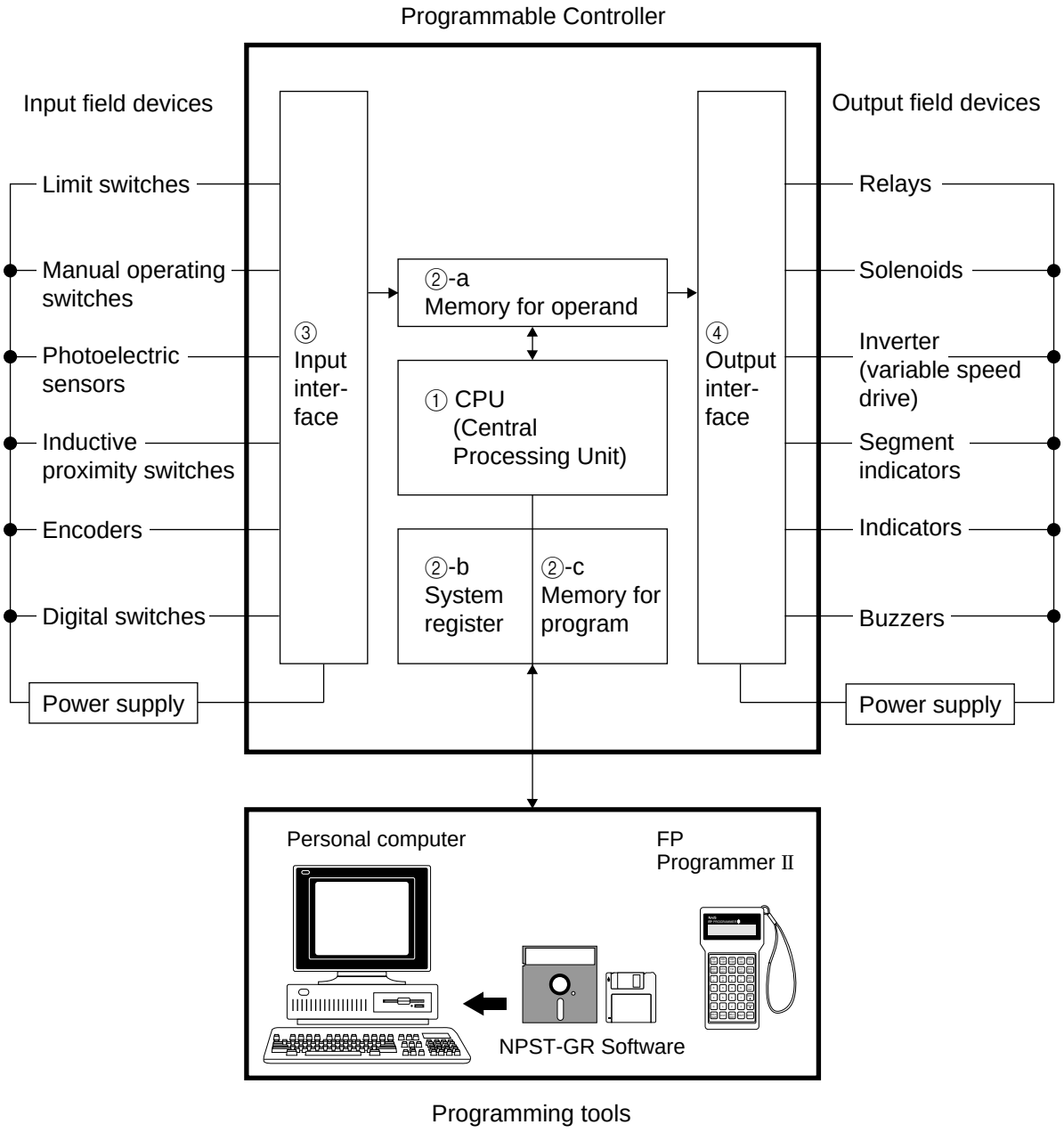
CHAPTER 4

BEFORE PROGRAMMING

4-1. Operating Principles of the Programmable Controller

1. Basic Configuration

A programmable controller is composed of four basic sections: ① CPU, ② memory, ③ input interface, and ④ output interface. An inside look at these sections will help you understand their functions and operation of the programmable controller.



■ Functions of the Four Sections

① CPU (Central Processing Unit)

Controls the operation of the programmable controller including the I/Os according to the program

② Memory

Memory areas where the program and information needed for operation of the programmable controller are stored.

Types of Memory

② -a: Memory for operands

The memory area for storing operand data (external input relays, timer/counter set value, and data registers, etc.). Data for the program to handle and the data from and to field devices are centralized in this area.

Refer to page 93, for details about operands.

② -b: System register

The memory area for storing the system settings of programmable controllers. Information in this area decides the operand characteristics, advanced control function availabilities, and so on. The system registers can be set using an FP Programmer Ⅱ or personal computer using NPST-GR Software.

② -c: Memory for program

The memory area to store the program for execution. Programs are written using an FP Programmer Ⅱ or personal computer using NPST-GR Software.

③ Input interface

Interface that receives data from the field device and transfers it to the memory for operands.

④ Output interface

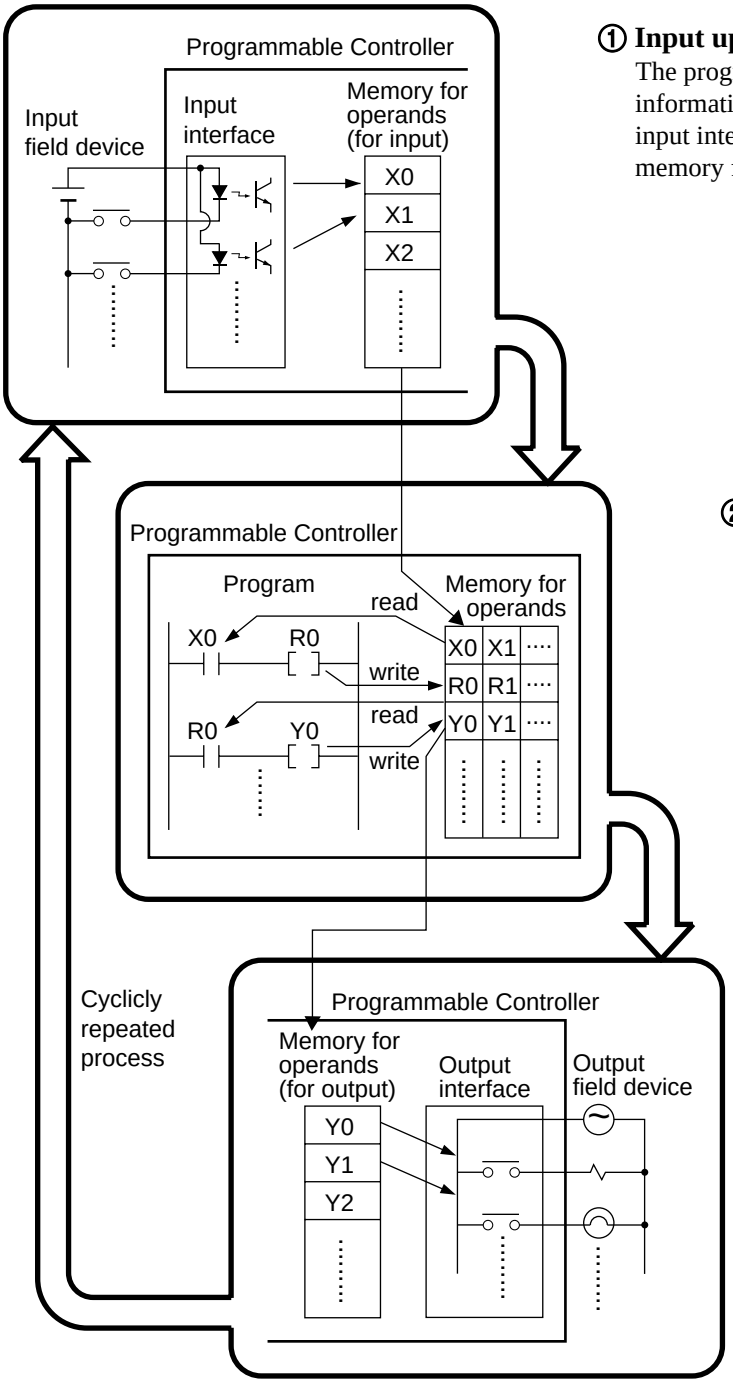
Interface that outputs data from the memory for operands to the field devices.

2. Basic Operation

The basic operation of the programmable controller is:

- To read data from all the input field devices
- To execute the program according to the logic programmed
- To turn the output field devices ON or OFF

The process of reading inputs, executing the program, and updating the outputs is cyclicly repeated in the same manner.



① Input update stage

The programmable controller reads information (ON or OFF) at the input interface and stores it in the memory for operands.

② Program execution stage

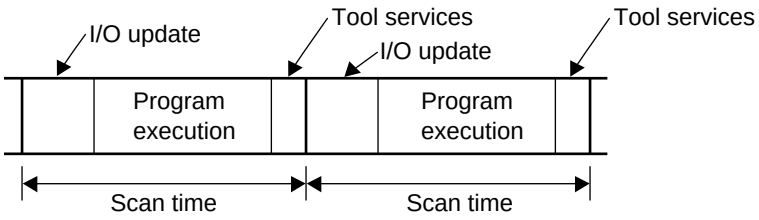
The CPU of the programmable controller executes the program according to the logic programmed by reading and writing the information from and to the memory for operands.
The memory for operands is successively updated according to the execution of the program.

③ Output update stage

After program execution, the information (ON or OFF) in the memory for operands is written to the output interface and turns the output field devices ON or OFF.

■ Scan Time of the Programmable Controller

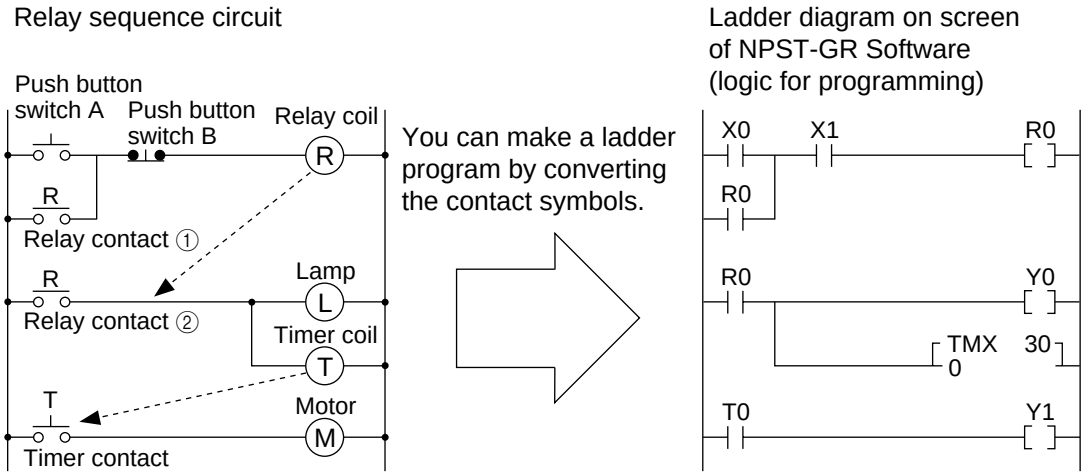
- The process of input update, program execution, and output update is referred to as a **scan** and the process repeated over and over in the same manner is referred to as the **cyclic execution method**.
- In the cyclic execution method, since the process of input update is performed immediately after the output update, the process of input update and output update is sometimes called **I/O update** for the purpose of simplification.
- In addition to program execution and I/O update, the programmable controller also performs a variety of error checking (self-diagnostic function) and also communicates with the programming tools. These operations are referred to, as a whole, as **tool services** and are performed after program execution.
- Since the **scan time** is defined as the time required for one scan, the cyclic operation of a scan (I/O update, program execution, and tool service) can be shown below.



4-2. How to Program the Programmable Controller

1. Making a Ladder Diagram

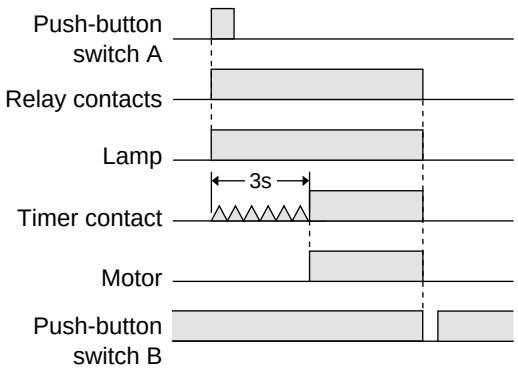
Originally, programmable controllers were designed as a replacement for relay-controlled systems. Therefore, programs can be easily created with a relay sequence circuit as shown below.



■ Explanation of Movement

1) When push-button switch A is pressed, the coil of relay R0 is energized and its contacts turn ON.
2) Since contact ① of relay R0 supplies power to the coil of relay R0, the coil stays energized even if switch A is turned OFF (self-hold circuit).
3) Contact ② of relay R0 supplies power to lamp Y0 and timer T0. The lamp turns ON and the timer starts timing operation.
4) After the preset time (e.g., 3 s), timer contact T0 turns ON and motor Y1 starts operation.
5) When push-button switch B is pressed, the coil of relay R0 is de-energized and all the power turns OFF.

■ Time chart



■ I/O Allocation

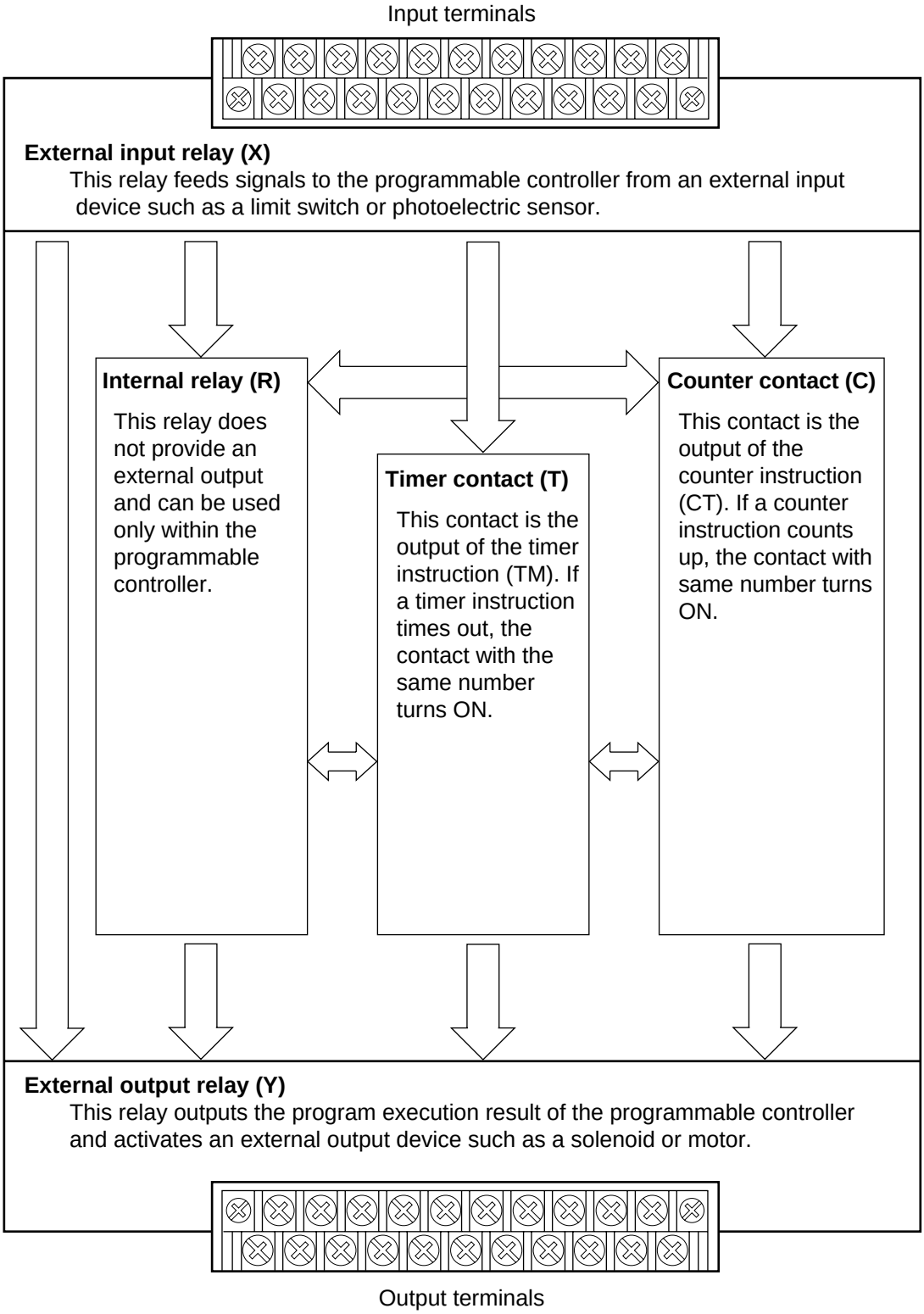
The input and output addresses of the programmable controller are allocated according to the condition in the sequence diagram.

Item	Name of device	I/O assignment
External input	Push-button switch A	X0
	Push-button switch B	X1
External output	Lamp	Y0
	Motor	Y1
Internal relay	Supplemental relay	R0
Timer	Timer	T0

• All relays and timers used in the sequence circuit are replaced with internal relays and timers in the programmable controller.

2. Relays and Timer/Counter Contacts in the FP1

The FP1 programmable controller contains many relays and timer/counter contacts as follows.

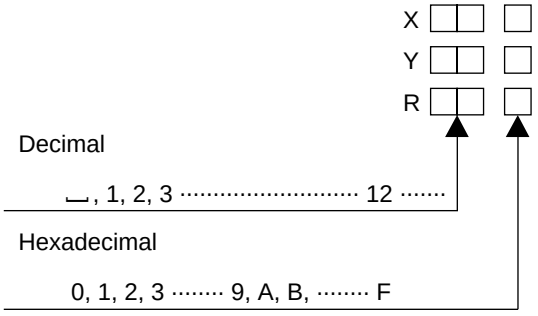


■ Memory area

Item		Numbering	
		C14 and C16 series	**C24, C40, C56, and C72 series**
Relay	External input relay (X)	208 points (X0 to X12F)	
	External output relay (Y)	208 points (Y0 to Y12F)	
	Internal relay (R)	256 points (R0 to R15F)	1,008 points (R0 to R62F)
	Special internal relay (R)	64 points (R900 to R903F)	
Timer/ Counter contact	Timer contact (T)	100 points (T0 to T99)	
	Counter contact (C)	28 points (C100 to C127)	44 points (C100 to C143)

■ External input relay (X), external output relay (Y), internal relay (R)

• The lowest digit for these relay's X, Y, and R numbers is expressed in hexadecimals and the second and higher digits are expressed in decimal to enable both bit and word processing.



Example:

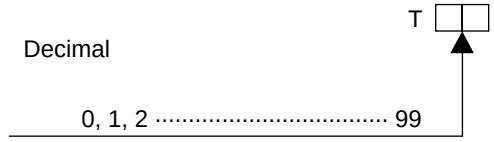
Relay number

X0, X1, X2, X3, X4, X5, X6, X7, X8, X9, XA, XB, XC, XD, XE, XF
X10, ····· X1F
X20, ····· X2F
. .
. .
. .
. .
. .
. .
. .
. .
X90, ····· X9F
X100, ····· X10F
X110, ····· X11F
X120, ····· X12F

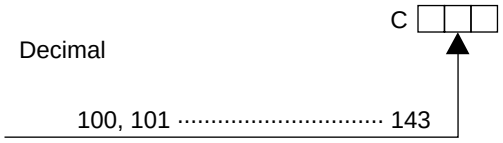
■ Timer contact (T), counter contact (C)

• The timer contact (T) and counter contact (C) numbers are expressed in decimal.

Timer contact (T)



Counter contact (C)



3. I/O Allocation in the FP1

The I/O addresses for the FP1 control unit, primary and secondary expansion units, and intelligent units (FP1 Transmitter Master Unit, FP1 I/O Link Unit) are assigned as follows.

Unit type			Input allocation	Output allocation
Control Unit	C14 series		X0 to X7	Y0 to Y4, Y7
	C16 series		X0 to X7	Y0 to Y7
	C24 series		X0 to XF	Y0 to Y7
	C40 series		X0 to XF X10 to X17	Y0 to YF
	C56 series		X0 to XF X10 to X1F	Y0 to YF Y10 to Y17
	C72 series		X0 to XF X10 to X1F X20 to X27	Y0 to YF Y10 to Y1F
Primary Expansion Unit	E8 series	Input type	X30 to X37	——
		I/O type	X30 to X33	Y30 to Y33
		Output type	——	Y30 to Y37
	E16 series	Input type	X30 to X3F	——
		I/O type	X30 to X37	Y30 to Y37
		Output type	——	Y30 to Y3F
	E24 series	I/O type	X30 to X3F	Y30 to Y37
	E40 series	I/O type	X30 to X3F X40 to X47	Y30 to Y3F
Secondary Expansion Unit	E8 series	Input type	X50 to X57	——
		I/O type	X50 to X53	Y50 to Y53
		Output type	——	Y50 to Y57
	E16 series	Input type	X50 to X5F	——
		I/O type	X50 to X57	Y50 to Y57
		Output type	——	Y50 to Y5F
	E24 series	I/O type	X50 to X5F	Y50 to Y57
	E40 series	I/O type	X50 to X5F X60 to X67	Y50 to Y5F
Transmitter Master Unit	SW5: ON SW6: ON (When used as two expansion units)		X30 to X47 X50 to X67	Y30 to Y3F Y50 to Y5F
	SW5: OFF SW6: ON (When used as an expansion unit)		X30 to X47 X50 to X67 (See notes below.)	Y30 to Y3F Y50 to Y5F (See notes below.)
	SW5: varies SW6: ON (When used as an I/O Link Units)		X70 to X8F	Y70 to Y8F
I/O Link Unit			X70 to X7F (WX7) X80 to X8F (WX8)	Y70 to Y7F (WY7) Y80 to Y8F (WY8)

Notes:

- X50 to X67 and Y50 to Y5F are allocated for the FP1 Transmitter Master Unit when it is used instead of an expansion unit for FP1 C24, C40, C52 and C72 series, which have expansion units.
- The maximum number of expansion units that can be connected to the control unit is as follows:
  - FP1 C14 and C16 series: 1 expansion unit (including FP1 Transmitter Master Unit)
  - FP1 C24, C40, C56 and C72 series: 2 expansion units (including FP1 Transmitter Master Unit)
- Number of expandable units together:
  - FP1 Transmitter Master Unit/FP1 I/O Link Unit: Max. 1 unit

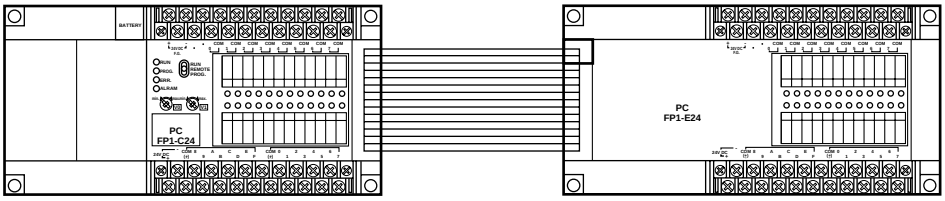
Unit type			Input allocation	Output allocation
FP1 A/D Converter Unit		Channel 0	X90 to X9F (WX9)	———
		Channel 1	X100 to X10F (WX10)	———
		Channel 2	X110 to X11F (WX11)	———
		Channel 3	X120 to X12F (WX12)	———
FP1 D/A Converter Unit	Unit number 0	Channel 0	———	Y90 to Y9F (WY9)
		Channel 1	———	Y100 to Y10F (WY10)
	Unit number 1	Channel 0	———	Y110 to Y11F (WY11)
		Channel 1	———	Y120 to Y12F (WY12)

Example:

When an E24 series Expansion Unit is connected to a C40 series Control Unit, inputs and outputs are allocated as follows:

Output allocation

C40 Series Y0 ·····YF



E24 Series Y30 ·····Y37

X0···XF, X10···X17

X30 ·····Y3F

Input allocation

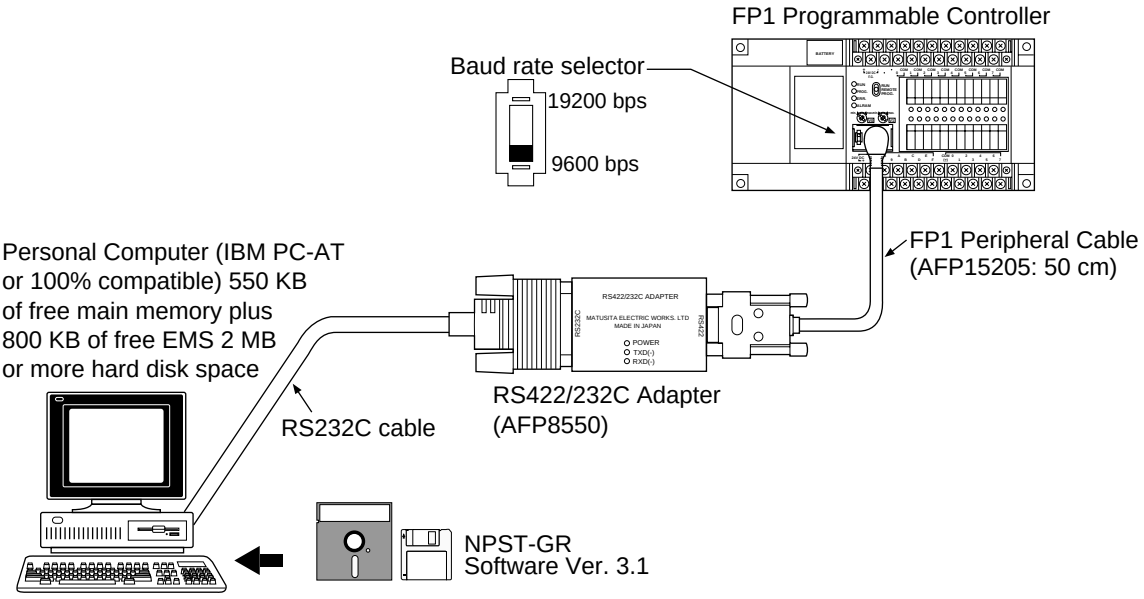
Notes:

- The maximum number of expansion units that can be connected to the control unit is as follows:
  - FP1 C14 and C16 series: 1 expansion unit (including FP1 Transmitter Master Unit)
  - FP1 C24, C40, C56 and C72 series: 2 expansion units (including FP1 Transmitter Master Unit)
- Number of expandable units together:
  - FP1 I/O Link Unit: Max. 1 unit
  - FP1 A/D Converter Unit: Max. 1 unit
  - FP1 D/A Converter Unit: Max. 2 units
- Be sure to set different unit numbers when two FP1 D/A converter units are connected.

4-3. Programming with NPST-GR Software

NPST-GR Software Ver. 3.1 offers program entry, editing, and monitoring of FP series programmable controllers. With this software, you can concentrate on the control pattern rather than wasting time learning how to enter the program.

1. System Configuration



■ Connection between a Programmable Controller and a Computer

- An FP1 Peripheral Cable, an RS422/232C Adapter, and an RS232C cable are required to connect a personal computer to an FP1.

■ Setting of FP1

- Set the baud rate selector of the FP1 to 19200 or 9600.

Note:

- If the microprocessor of your computer works at 8 M Hz or 16 M Hz, set the baud rate selector of the FP1 to 9600 bps.

■ Personal Computer Setting

- Set your personal computer's RS232C parameter to asynchronous. Refer to the manuals that came with your computer.

2. Features of NPST-GR Software Ver. 3

NPST-GR Software is a programming support tool for the FP1 programmable controller. The things you can do with the NPST-GR are briefly introduced in the following:

• Programming

NPST-GR provides three programming modes.

- programming by entering ladder symbols: the program will be displayed in ladder diagrams (Ladder symbol mode)
- programming by entering Boolean: the program will be displayed in ladder diagrams (Boolean ladder mode)
- programming by entering Boolean: the program will be displayed in Boolean (Boolean non-ladder mode)

You can create a program using any of these methods and you can change the method any time. The display will change automatically according to the method you select. With any method, you can create a program by selecting instructions from the function keys.
NPST-GR Software also provides various features which enable effective programming such as the ability to customize it to make program creation easier.
While creating a program, you can copy, delete, move, and search for a part of the program.

• Comment function

You can enter comments for relays and output instructions.
These comments show you which device the relay corresponds to, or for what application the relay is used.

• Program check

With the program checking function, you can check the created program for grammatical errors.

• Monitoring

To support programming capability, NPST-GR Software can monitor the program you created and perform a test run for verifications. You can check the status of relays and registers, and the programmable controller operating status. This makes it easy to perform debugging and field adjustments.

• System register setting

You can set the system registers using NPST-GR Software. Using the screen messages makes option selection and value entry much easier.

• Documentation

You can print-out all the settings you made, such as program and system register settings.

• Data transfer

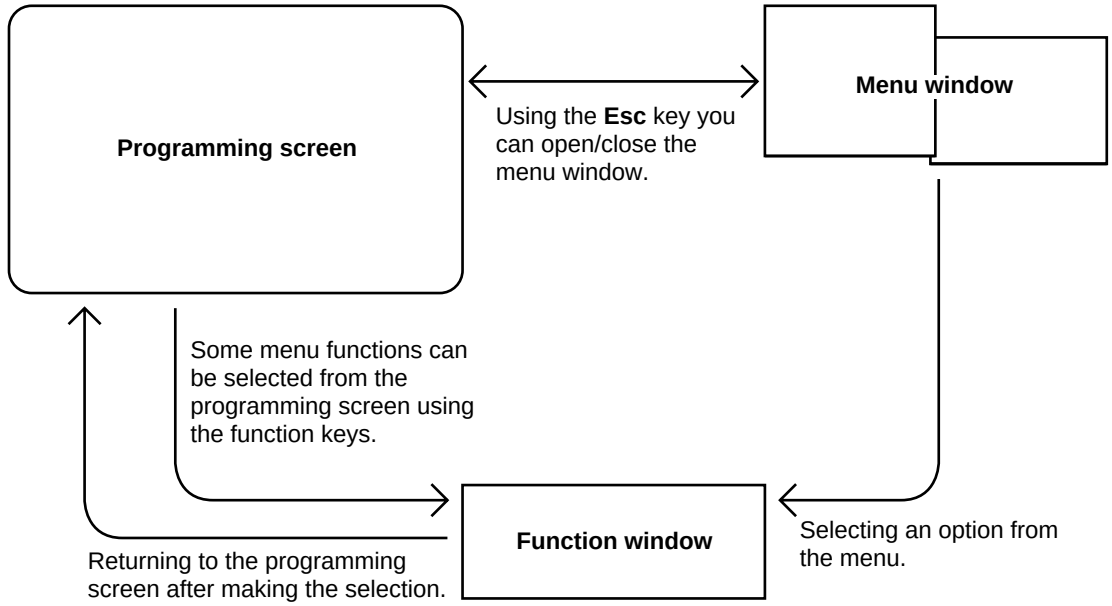
You can transfer the program created with the NPST-GR Software to the programmable controller easily by key operation. You can also transfer the data to ROM.

• Data management

You can save the data to a disk, which is useful for back-ups and temporary storage before transferring the data to the programmable controller.

3. NPST-GR Configuration

The NPST-GR Software is configured as follows.



• Programming screen

The screen where a program is created or edited. Just after the software is activated, the programming screen is displayed in the ladder symbol mode. Next, the menu window appears over it.

• Menu window

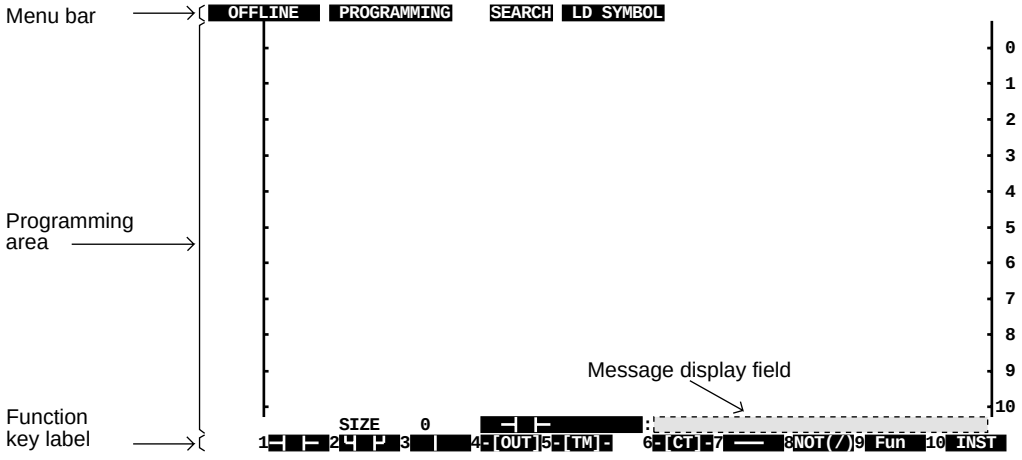
The window to select an option. The various functions of the NPST-GR Software can be selected from this window. Functions selected from the menu window are called menu functions.
When you start the software, the menu screen automatically overlaps the programming screen.

• Function window

When you select a menu function from the menu window, the corresponding window will be displayed.

1) Overview of the Programming Screen

The programming screen consists of a menu bar, a programming area and function key labels, as shown below. The display varies depending on the programming mode you are in.
The following figure shows the programming screen when you are in the ladder symbol mode.



• Menu bar

The uppermost line on the screen is called the “menu bar”.
The menu bar indicates which mode, what function and which programming mode you are currently in.

When you are in the ONLINE mode, it indicates whether you are monitoring the program or not, and which mode the programmable controller is currently in.

When you are in the OFFLINE mode

① Indicates which mode you are in: the OFFLINE mode or the ONLINE mode.
In the OFFLINE mode, the software cannot communicate with the programmable controller, and in the ONLINE mode, it can communicate with the programmable controller. Depending on the function you use or how you use the function, you must be in the OFFLINE mode or ONLINE mode. For example, you should be in the OFFLINE mode when you enter comments, and in the ONLINE mode when you monitor the program. When creating a program, if you are in the ONLINE mode, the program will be transferred to the programmable controller simultaneously with entry of the program.

Note:

- When you use NPST-GR in the ONLINE mode, you must connect the computer on which the NPST-GR is activated with the programmable controller.

② Indicates what function you are currently using.
For example, when you are creating a program, “PROGRAMMING” will be displayed.

③ Displayed when you are in the ladder symbol mode to indicate whether you are in the SEARCH mode or the ENTRY mode.

④ Indicates which programming style you are currently in.
The software provides three programming styles: Ladder symbol mode, Boolean ladder mode and Boolean non-ladder mode.

Ladder symbol mode

The ladder symbol mode allows you to create a program by entering ladder symbols. Ladder symbols are graphic symbols which show logical elements, such as ⊣ ⊢. The program will be displayed as a logic diagram on the screen. This diagram is called a “ladder diagram”.
When you are in the ladder symbol mode, you will be in the SEARCH mode or the ENTRY mode.

Boolean ladder mode

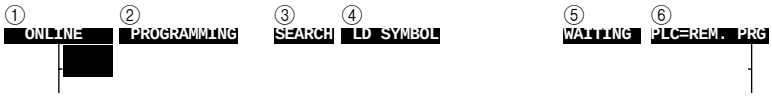
In the Boolean ladder mode, you can create a program by entering Boolean, but the program will be displayed as a ladder diagram.

Boolean non-ladder mode

The Boolean non-ladder mode allows you to create programs by entering Boolean. The program will be displayed as you entered it, in order of the addresses.

When you are in the ladder symbol mode, “LD SYMBOL” is displayed.
In the Boolean ladder mode or Boolean non-ladder mode, “BOOLEAN” is displayed. The difference can be recognized by the display in the programming area.

When you are in the ONLINE mode



When you are in ladder symbol mode <default display>

① to ④ are the same when you are in the OFFLINE mode.

⑤ Indicates whether NPST-GR is monitoring a program or not.
While monitoring a program, “MONITOR” will be displayed here.
When not monitoring, “WAITING” will be displayed here.

⑥ Indicates the status, such as the current mode, of the programmable controller connected to the computer.

• Programming area

Depending on the programming mode (Ladder symbol mode, Boolean ladder mode, and Boolean non-ladder mode) you select, the display will vary.

• Function key labels

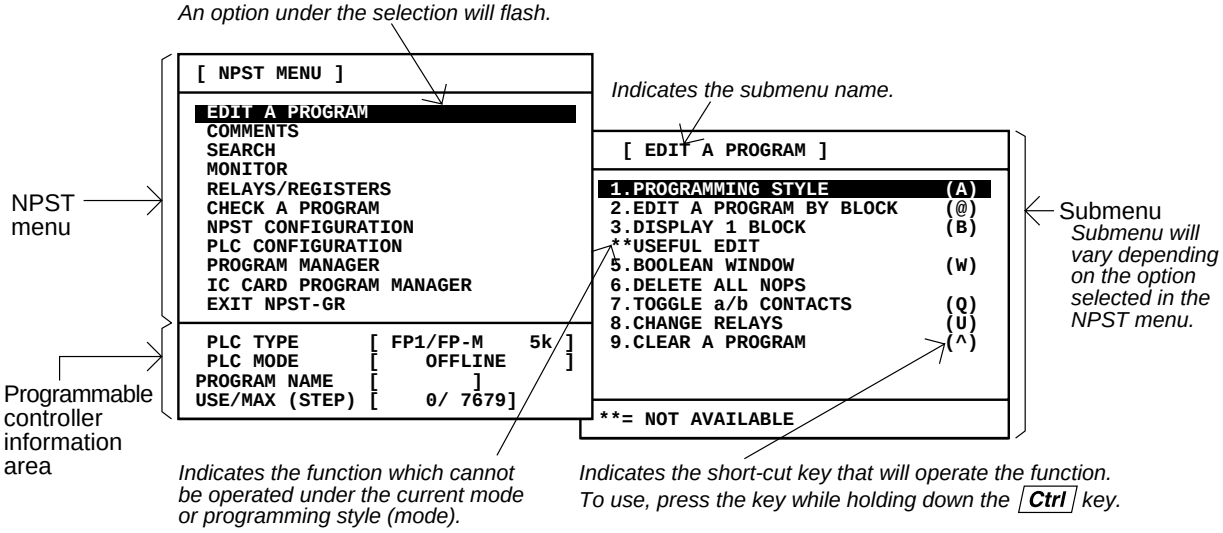
Corresponds to the function keys on the keyboard.
You may also use a function key in combination with **Shift** or **Ctrl**.

• Message display field

Any message from the software, such as error messages, will be displayed on the lower right of the screen.

2) Overview of the Menu Window

Immediately after starting NPST-GR, the menu window will overlap the programming screen.
On the menu bar, you will see “NPST MENU” while the menu window is being displayed.



• NPST menu

On the NPST menu, the submenu names are listed.
From the NPST menu, select a submenu that the menu function you want to use belongs to.

• Submenu

In the submenu, the menu functions are listed.

• Programmable controller information area

PLC TYPE

Indicates the type of programmable controller currently specified.

PLC TYPE:	FP1	0.9 k
	FP1/FP-M	2.7 k
	FP1/FP-M	5 k
	FP3	10 k
	FP3/FP-C	16 k
	FP5	16 k
	FP10/FP10S	30 k
	FP10	60 k

PLC MODE

Indicates the operation mode of the programmable controller.
When you are in the OFFLINE mode, “OFFLINE” will be displayed here.
In the ONLINE mode, the display will vary according to the setting on the programmable controller.

PROGRAM NAME

The name of program is displayed on the screen. When you create a new program, nothing will be displayed. When you load the program from a disk or the programmable controller, the filename you registered for the program will be displayed.

USE/MAX (STEP)

Indicates the number of steps (program size). The number of steps you have already used for the program during editing or creation, and the maximum of number of steps you can use for the program is indicated.

4. NPST-GR Installation and Configuration

1) Preparing for Installation

This section describes how to install the device driver ANSI.SYS. Install the software using the installation program. The installation program is included in the NPST-GR system disk. The installation program cannot start if the device driver ANSI.SYS provided with the MS-DOS system disk has been installed in the disk on which you want to install NPST-GR. If ANSI.SYS has not been installed, install ANSI.SYS first and then install NPST-GR.

Procedure

1. If the ANSI.SYS file does not exist on the disk on which you want to install NPST-GR, copy the ANSI.SYS file from the MS-DOS system disk to the hard disk. For example, to copy the ANSI.SYS file to the root directory of the hard disk, insert the MS-DOS system disk into drive A and type the following after the DOS prompt:

   `COPY A:\ANSI.SYS C:`(**Enter**)
2. If the DEVICE command for ANSI.SYS is not included in the CONFIG.SYS file, modify the CONFIG.SYS file. For example, to add the DEVICE command to the CONFIG.SYS file, type the following at the DOS prompt (C:\):

   `COPY CONFIG.SYS+CON CONFIG.SYS`(**Enter**)
   `DEVICE=ANSI.SYS`(**Enter**)

   Then, press **Ctrl** + **Z** and press **Enter**.
   The CONFIG.SYS file will now contain the new line.

Notes:

- After modifying the CONFIG.SYS file, reset the personal computer so that your changes take effect.
- Note that the directory in which the ANSI.SYS exists must match the pathname used for the DEVICE command.

2) NPST-GR Installation

This section describes how to install NPST-GR. Make a backup disk of the software and use it for installation.

Procedure

1. If the current drive is other than drive A, change to drive A by typing “A:” at the DOS prompt.
2. Insert the backup disk of the NPST-GR system disk into drive A.
3. Type the following at the DOS prompt (A:) to start the installation program:
   INSI (Enter)

   The installation program will start. The following screen will appear.

```
NPST-GR Installation Program                                    Ver.3.1


              To install the NPST-GR, type INSI and specify the source drive
              and the target drive.  The "source drive" is the drive where you
              place the NPST-GR System Disk.  The "target drive" is the drive
              on which you want to install the NPST-GR.

              [Format]

              INST [source drive]: [target drive]:

              [Example]

              When the NPST-GR System Disk is now in the drive A and you want
              to install the NPST-GR on the drive C, type:

              INSI A: C:(Enter)

A:\>
```

4. Type the following at the DOS prompt:
   INSI A: C: (Enter)

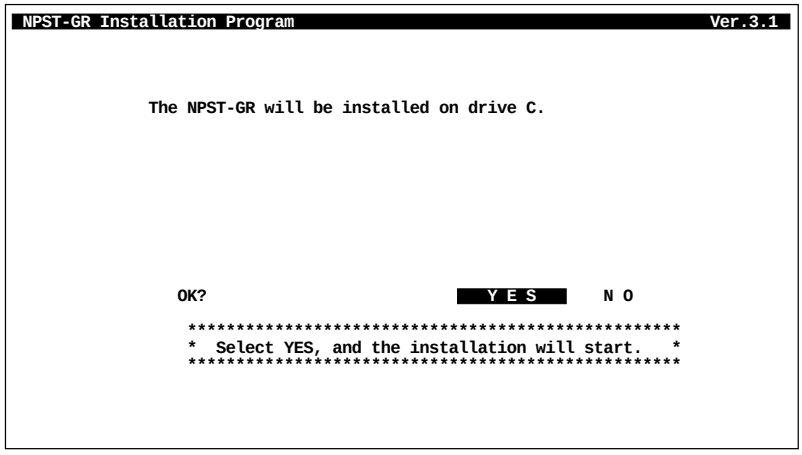
   This shows that the backup disk of the NPST-GR system disk is in drive A and that you are going to install NPST-GR onto drive C. The following screen will appear.

```
NPST-GR Installation Program                                    Ver.3.1


           The source drive    a:
           The target drive    c:




             OK?                          Y E S      N O
```

5. Make sure that the source drive and the target drive are specified correctly. The "**source drive**" shows the drive which the NPST-GR system disk is in. The "**target drive**" shows the drive onto which you want to install NPST-GR.

   When the source drive and the target drive are specified correctly, select "**YES**" and press **Enter**.
   If not, select "**NO**" and press **Enter**. You will return to the previous screen.

   When you select "**YES,**" the following screen will appear:



6. Check the message. To install, select "**YES**" and press **Enter**. The installation will start.
   If you do not want to install, select "**NO**" and press **Enter**. You will return to the previous screen.

   When the installation is complete, "**C:\NPST3**" will appear.

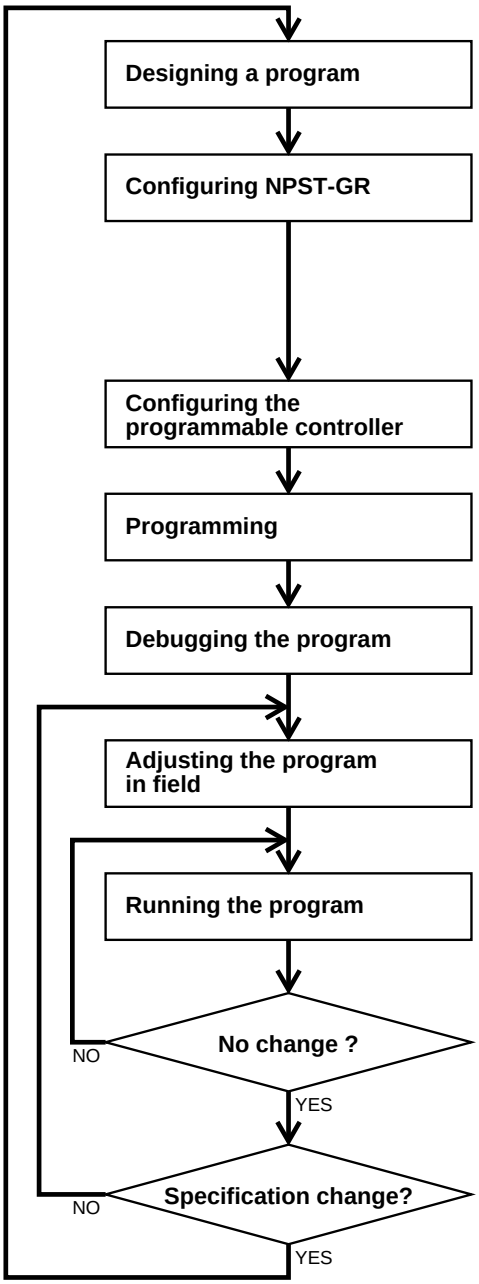
Note:

- When NPST-GR is installed successfully, the following files are stored in the NPST3 directory:

NPST.EXE	Contains a program which starts NPST-GR.
NPSTE.EXE	Contains the system program for NPST-GR.
NPST.HLP	Contains help messages.
NPSTP000.CIG	Contains information for printer control.

3) How to Use NPST-GR Effectively

The flowchart shown below is an example of how you can use NPST-GR before you run a program in the field. Except for the settings for NPST-GR and programmable controller configuration, you can freely change the order of the flowchart.



Design a program according to your system.
What type of programmable controller do you use?
What relays and registers do you use for the program, etc?

Customize NPST-GR. Set the communication conditions for communicating with peripheral devices. Select the type of programmable controller for the program you created or system registers you set. Specify the maximum number of comments you will add to a program.

Note:

* Once you save data together with NPST-GR on a disk, NPST-GR will start with that data.

Set system registers 0 to 418.

Create or edit a program according to your design.
There are various functions useful for creating or editing a program. Overview the NPST functions provided by the software, and create or edit the program.

With the program check, monitor, search, and test run functions, etc., you can debug the program you created or edited.
You can preset the register values.

4) NPST-GR Startup

To start NPST-GR, follow the procedure below.

Procedure

1. If the personal computer is OFF, turn it ON.
   You will see the DOS prompt C:\.
2. Change to the NPST3 directory by typing the following at the DOS prompt:
   `CD NPST3`(**Enter**)
3. Type the following to start the NPST-GR Software:
   `NPST`(**Enter**)
   NPST-GR will start.

5) Configuring NPST-GR

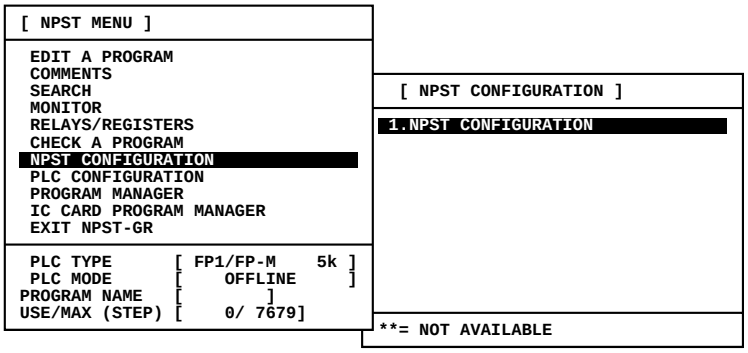
■ Selecting [NPST CONFIGURATION] from the Menu Window

Before you create a program, you must first configure the settings and change the default settings if necessary.

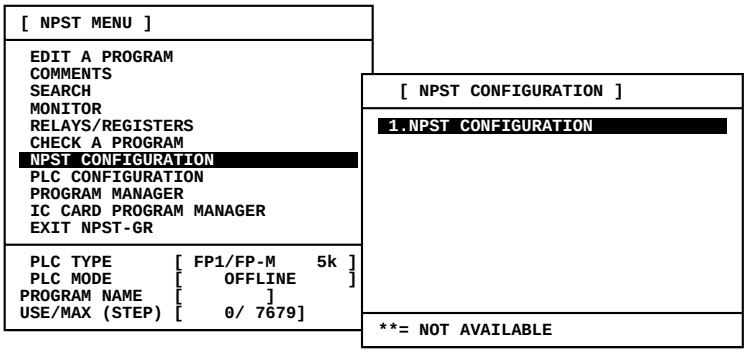
If the programming screen is displayed, press **Esc** to display the "NPST MENU" window.

Procedure

1. Move the cursor to an option on the NPST menu with the **up** and **down arrow** keys.
   The submenu which belongs to the option you select will be displayed.

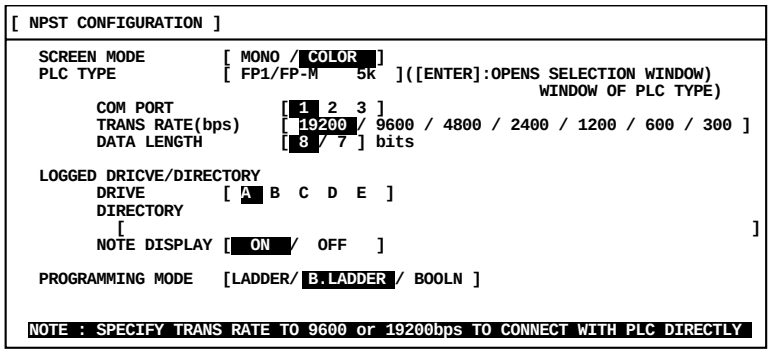


2. Press **Enter** or the **right arrow** key.
   The cursor will move to the submenu. The option currently selected with the cursor will blink.



3. Press **Enter**.

4. Move the cursor to the item you want to select with the **up** and **down arrow** keys.
   Select an option with the **right** and **left arrow** keys.



<SCREEN 1> window

• SCREEN MODE

You can select the NPST-GR screen mode between color and black/white.

MONO: Displays the screen in black and white.
COLOR: Displays the screen in color.
(Black/Cyan/Red/Magenta/Green/Bright Blue/Yellow or Brown/White)

• PLC TYPE

Before setting the configuration of the programmable controller and creating a program, you must specify the type of programmable controller for which you create a program.

You can select from;

FP1	0.9 k: FP1 C14/C16 series
FP1/FP-M	2.7 k: FP1 C24/C40 series and FP-M (2.7 k)
FP1/FP-M	5 k: FP1 C56/C72 series and FP-M (5 k)
FP3	10 k: FP3 (10 k)
FP3/FP-C	16 k: FP3 (16 k) and the FP-C (16 k)
FP5	16 k: FP5 (16 k)
FP10/FP10S	30 k: FP10 (30 k) and FP10S (30 k)
FP10	60 k: FP10 (60 k)

COM PORT

Specify the serial port which is connected to the programmable controller.

1: Use COM PORT 1
2: Use COM PORT 2
3: Use COM PORT 3

TRANS RATE (bps)

Specify the transmission rate for communication with the programmable controller or modem.
Select between 19200, 9600, 4800, 2400, 1200, 600 or 300.
For communication with the programmable controller, specify either 19200 or 9600.
If the clock frequency is a multiple of five, you must select 19200. If you do not select 19200, NPST-GR will not communicate with the programmable controller.

DATA LENGTH

Specify the data length for communication with the programmable controller.
Select either 8-bit or 7-bit.

• LOGGED DRIVE/DIRECTORY

Specify the logged drive when you manage files.

DRIVE/DIRECTORY

Specify the logged directory when you manage files. Include a \ at the beginning and at the end of the directory, eg., \npst\program\.
If you omit this, the root directory will be specified.

NOTE DISPLAY

Specify whether file notes, which are the notes entered for a file (such as filename and date), are to be displayed when the disk file list is displayed.

ON: Displays the file notes.
OFF: Omits displaying the file notes.

• PROGRAMMING MODE

Select the programming mode for creating or editing a program.

Select from;

LADDER: The ladder symbol mode
B.LADDER: The Boolean ladder mode
BOOLN: The Boolean non-ladder mode

■ Logging or Saving the Parameters

After you set the parameters in [**1.NPST CONFIGURATION**], you must log the settings so that NPST-GR will be reconfigured according to the parameters you set.
If you go to the programming screen or use other functions without logging the parameters you set, they will be aborted. If you try to exit [**1.NPST CONFIGURATION**] without logging the parameters by pressing **Esc**, the confirmation message "**EXIT OK ? (Y/N)**" will appear on the right bottom of the screen. Type **N** to return to the previous operation. Type **Y** if you want to abort the settings you made. The setting will be aborted and you will go to the programming screen. In each parameter window, you will see the SAVE label on the function key labels. If you set parameters on more than one window, you can save the parameters at one time after completing the settings. When you log the settings, you can also save the settings to the disk if necessary.

Procedure

1. Press the **F1** key on the screen where one of the windows for setting parameters is displayed.
   The <SAVE> window will be displayed at the lower left of the screen.
2. Select "YES" or "NO" for the message "**SAVE DISK ? [YES / N O]**"
   Select "YES" to save the parameters in the disk.
3. Type **Y** or **N** for the message "**LOG PARAMETERS ? (Y/N)**".
   Type **Y** to execute the operation. After execution, the window will close.
   If you selected "YES" for "**SAVE DISK ? [YES / N O]**", the message, "**SAVING TO THE DISK COMPLETED.**" will be displayed at the bottom of screen when the parameter has been successfully saved to the disk.

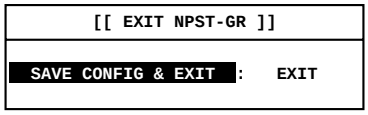
To quit the operation, type **N**. The window will close.

5. Exiting NPST-GR

The [**1.EXIT NPST-GR**] option allows you to exit NPST-GR and to return to the MS-DOS screen.

Procedure

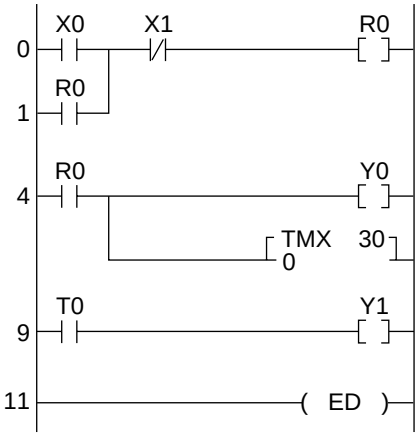
1. Select the [**EXIT NPST-GR**] option from the NPST menu.
2. Select the [**1.EXIT NPST-GR**] option from the [**EXIT NPST-GR**] menu.
   The [**EXIT NPST-GR**] window will open.



3. Select "**SAVE CONFIG & EXIT**" to save the parameters set with the [**NPST CONFIGURATION**] menu and exit NPST-GR . Select "**EXIT**" to exit NPST-GR without saving them.
4. Press **Enter**. You will exit NPST-GR and the DOS prompt will appear on the screen. When you turn OFF the computer, make sure that the DOS prompt is displayed on the screen.

6. Basic Key Operation for Programs

Input the following program using the ladder symbol mode.



Boolean Non-ladder		Key operation
Address	Instruction	
0	ST X 0	F1 F1 0 Enter
1	OR R 0	F2 F3 0 Enter
2	AN/ X 1	F3 F8 F1 1 Enter
3	OT R 0	F4 F3 0 Enter
4	ST R 0	F1 F3 0 Enter
5	OT Y 0	F4 F2 0 Enter
6	TM X 0	F5 F1 0 ⇤⇥
	K 30	F1 3 0 Enter
9	ST T 0	F1 F4 0 Enter
10	OT Y 1	F4 F2 1 Enter
11	ED	F10 Ctrl + F3 Enter

When you first start NPST-GR, you will be in the ladder symbol mode.
The **[1.PROGRAMMING STYLE]** option changes the programming style to the Boolean non-ladder mode.
Procedure

1. Select the **[EDIT A PROGRAM]** option from the NPST menu.
2. Select the **[1.PROGRAMMING STYLE]** option from the **[EDIT A PROGRAM]** menu.
3. Select "BOOLEAN NONLADDER" from the **[PROGRAMMING STYLE]** window.
4. Press **Enter**.

■ Program Input

Input the program using the function keys. The command language input will be displayed in the input field at the bottom of the screen. It will be interpreted and displayed as an element on the ladder diagram when you press the **Enter** key.
[Input Deletions]
When deleting from the input field.....Press **BS**.
When deleting from the ladder diagram display area.....Move the cursor to the location containing the mistake and press **Del**.
Refer to the "NPST-GR Software" manual for details.

7. Downloading a Program to the Programmable Controller

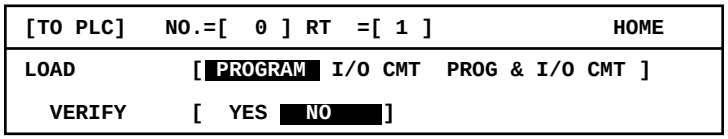
The [**4.LOAD A PROGRAM TO PLC**] option downloads the program and/or the I/O comments which are on the screen of the programmable controller. After you complete the program, you must download the program so that the programmable controller executes it.

Notes:

- The downloaded program will be executed when you set the mode of programmable controller to RUN.
- Before you start operation, make sure that NPST-GR is in the ONLINE mode.

Procedure

1. Select the [**PROGRAM MANAGER**] option from the NPST menu.
2. Select the [**4.LOAD A PROGRAM TO PLC**] option from the [**PROGRAM MANAGER**] menu.
   The [**LOAD TO PLC**] window will appear on the screen.



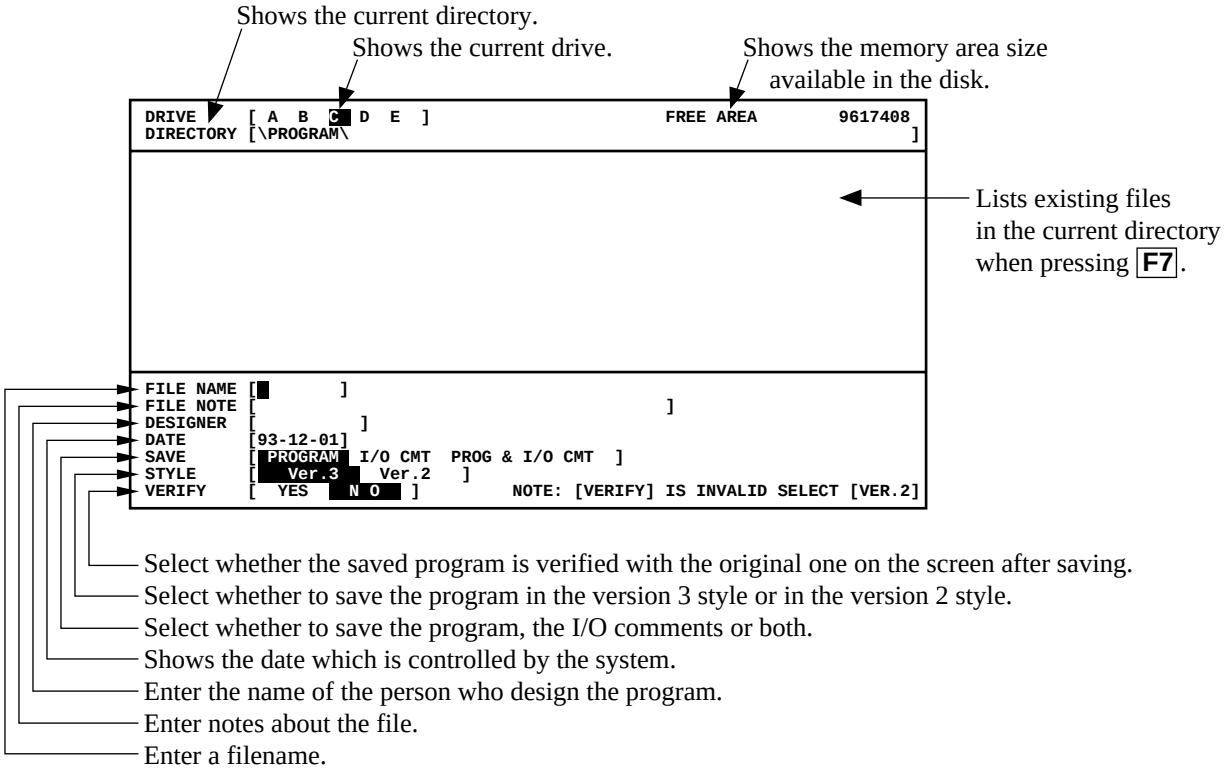
3. If you want to change the communicating station, press Ctrl + F7.
4. If the programmable controller is in the RUN mode, change to the PROG. Mode.
   When the programmable controller is in the REMOTE mode, you can change it by pressing Ctrl + F6.
5. Specify what you want to load to the programmable controller at "**LOAD.**"
   Select "**PROGRAM**" to download only the program.
   Select "**I/O CMT**" to download only the I/O comments.
   Select "**PROG & I/O CMT**" to download both the program and the I/O comments.
6. Specify whether or not to verify the programs.
   Select "**YES**" at "**VERIFY**" with the **arrow** keys when you want to verify the transferred program with the one displayed on the screen after downloading. Select "**NO**" if you do not want to verify the program.
7. Press Enter to start downloading.
   During the download, "**LOADING PROGRAM...**" will appear on the screen.
   If you select "**YES**" at "**VERIFY,**" the message "**VERIFYING PROGRAM...**" will appear.
   When completed successfully, "**VERIFY OK**" will appear on the bottom of the screen. The number of steps used for the program will be displayed at the bottom of the screen.

8. Saving a Program to Disk

The [**2.SAVE A PROGRAM TO DISK**] option saves the program and/or the I/O comments which exist on the screen to the disk of your personal computer.

Procedure

1. Select the [**PROGRAM MANAGER**] option from the NPST menu.
2. Select the [**2.SAVE A PROGRAM TO DISK**] option from the [**PROGRAM MANAGER**] menu.
   A window for saving the program and/or I/O comments will open on the screen. You will see "**SAVE PROGRAM**" on the menu bar.



3. If you want to change the drive, press **F6**.
4. If you want to change the directory, press **F8**.
5. Enter a filename in the "**FILE NAME**" area.
6. If necessary, enter the information for "**FILE NOTE**", "**DESIGNER**" and "**DATE**". These items are optional and can be skipped. Press the **down arrow** key to go to the next item.
7. Specify what you want to save to the disk at "**SAVE.**"
   Select "**PROGRAM**" to save only the program.
   Select "**I/O CMT**" to save only the I/O comments.
   Select "**PROG & I/O CMT**" to save both the program and the I/O comments.
8. Determine which version style you want to save in.
   Select "**Ver.3**" to save in the version 3 style.
   Select "**Ver.2**" to save in the version 2 style.
9. When you select "**Ver.3**", select whether you want to verify the programs.
   Select "**YES**" at "**VERIFY**" with the **arrow** keys, to verify the saved program with the program on the screen after saving. Select "**NO**" if you do not want to verify the program.
10. Press **Enter**.
    When you select "**Ver.3**," saving will start.

9. Printing

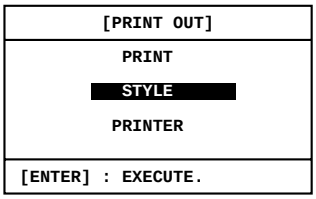
The **[A.PRINT OUT]** option prints out:

- the program displayed on the screen, as a ladder diagram or in Boolean.
- the list of the relays, registers or control instructions used in the program.
- the parameters set with the [**NPST CONFIGURATION**] menu
- the parameters set for system registers 0 to 418, the I/O map, and the remote I/O map

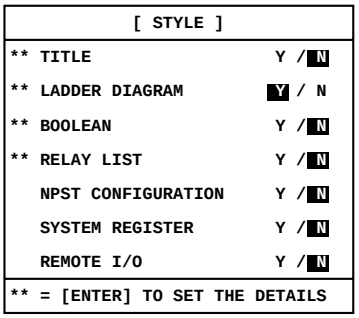
When you select the **[A.PRINT OUT]** option, the **[PRINT OUT]** window will open. First, select what you want to print out by selecting the "**STYLE**" option, and start printing by selecting the "**PRINT**" option. With the default settings, only the program will be printed in the ladder diagram style.

Procedure

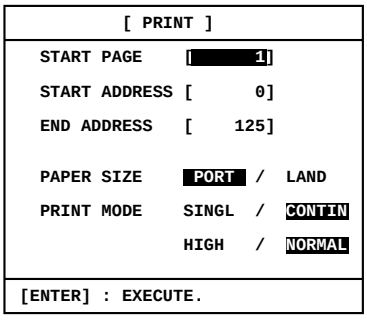
1. Select the **[PROGRAM MANAGER]** option from the NPST menu.
2. Select the **[A.PRINT OUT]** option from the **[PROGRAM MANAGER]** menu.
   The **[PRINT OUT]** window will open.



3. Select "**STYLE**" in the **[PRINT OUT]** window.
   The **[STYLE]** window will open.



4. Specify what you want to print out in the **[STYLE]** window.
   Select "Y" for the item which you want to print. Select "N" not to print it.
5. Press F1 to log the settings in each window and to return to the previous window.
   You must press F1 on every window on which you made any change. When pressing F1, you will be asked "**SURE?**" Type Y to log the changes you made. To cancel them, type N.
6. Select "**PRINT**" from the **[PRINT OUT]** window.
7. Press Enter. The **[PRINT]** windows shown right will open.

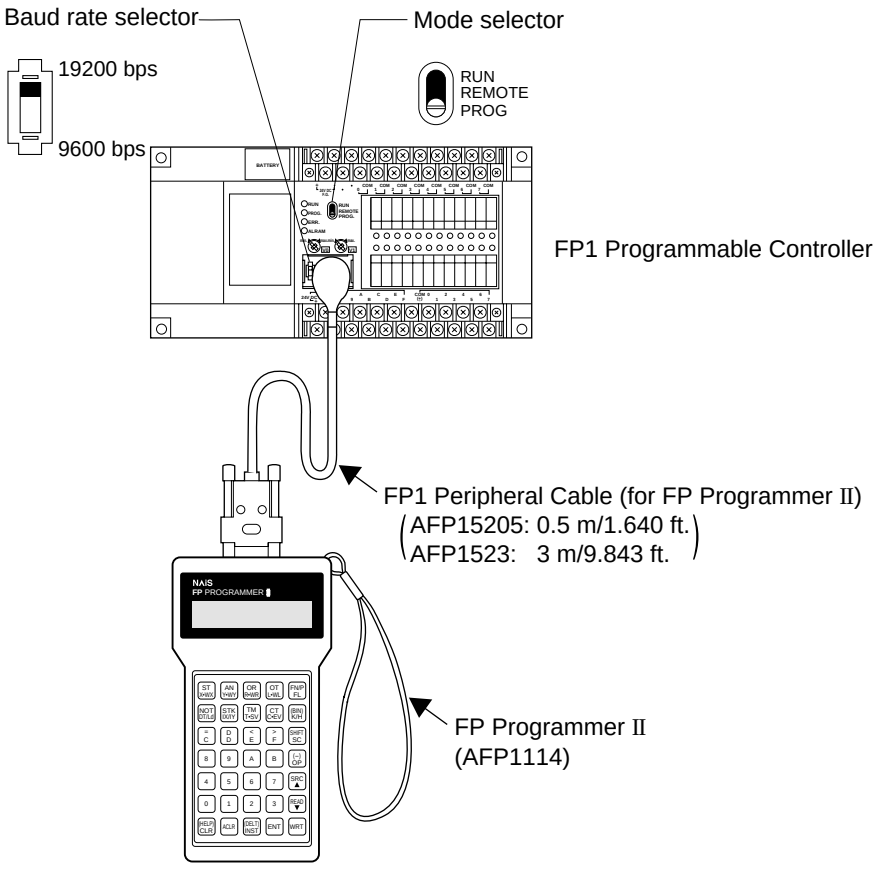


8. When you want to change the settings in the windows, select the desired options. To select an option, use the **right** or **left arrow** key. To go to the next item, press the **down arrow** key.
9. Press Enter to start printing.

4-4. Programming with the FP Programmer Ⅱ

The FP Programmer Ⅱ performs program entry, editing, and monitoring of FP series programmable controllers.

1. System Configuration



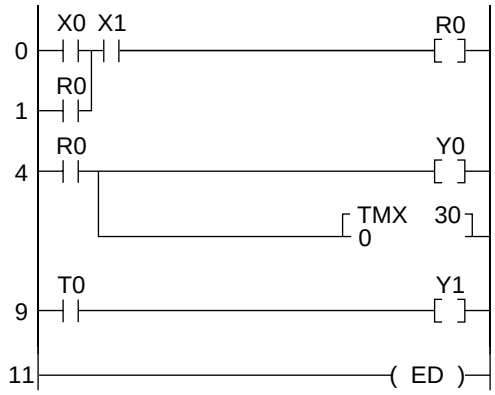
■ Connection between a Programmable Controller and an FP Programmer Ⅱ

- An FP1 Peripheral Cable (for FP Programmer Ⅱ) is required to connect an FP1 to an FP Programmer Ⅱ.

■ Setting of FP1

- Set the baud rate selector of the FP1 to 19200.

2. Downloading a Program to the Programmable Controller



Boolean Non-ladder				FP Programmer Ⅱ key operations
Address	Instruction			
0	ST	X	0	ST X-WX, ST X-WX, 0, WRT
1	OR	R	0	OR R-WR, OR R-WR, 0, WRT
2	AN	X	1	AN Y-WY, ST X-WX, 1, WRT
3	OT	R	0	OT L-WL, OR R-WR, 0, WRT
4	ST	R	0	ST X-WX, OR R-WR, 0, WRT
5	OT	Y	0	OT L-WL, AN Y-WY, 0, WRT
6	TM	X	0	TM T-SV, ST X-WX, 0, ENT
		K	30	(BIN) K/H, 3, 0, WRT
9	ST	T	0	ST X-WX, TM T-SV, 0, WRT
10	OT	Y	1	OT L-WL, AN Y-WY, 1, WRT
11	ED			SHIFT SC, 1, 0, SHIFT SC, WRT

Procedure

1. Connect FP Programmer Ⅱ and the FP1 programmable controller using the FP1 Peripheral Cable.
2. Set the mode selector of the FP1 to PROG.
3. Press the keys on the FP Programmer Ⅱ, as shown on the right, to clear all the data stored in the FP1 programmable controller.

   ACLR, (–) OP, 0, ENT, SHIFT SC, (DELT) INST
   ACLR, 0, READ ▼
4. Enter the address from where you want to enter instructions. Use the alphanumeric keys to enter the address. In the example, instructions are entered from address 0, therefore, press 0 to read its contents then press READ ▼ .
5. Download the program (addresses and instructions) to the programmable controller.

Notes:

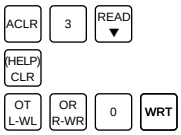
- An alarm will sound if you try to download a program while in RUN mode or if you press the wrong keys. If an alarm sounds, press the ACLR key and redo the download operation from the beginning.
- The first time you input a program, be sure to execute the program clear procedure (step 3, above) before starting input.

■ Key Operations for Correcting Input Errors

• Correcting the contents of the program

Procedure example

1. Read the contents of address 3.
2. Clear the display for address 3.
3. Rewrite with the correct instructions.



• Adding/inserting instructions

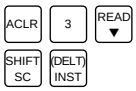
Procedure example

1. Read the contents of address 3.
2. Insert the new instruction.

• Deleting instructions

Procedure example

1. Read the contents of address 3.
2. Delete.



■ Inputting Instructions That Are Not on the Key Display

There are two ways to input instructions such as the **ED** (END) instruction and the **DF** (Leading edge differential) instruction, which are not on the key display.

• Using the HELP function

Procedure example

1. Press the keys shown on the right.

2. Next, press READ ▼ to look for the desired instruction.
3. Input the number for the instruction.
   Example:
   The **ED** instruction.

• Direct input of the instruction code

Example:
The **ED** instruction.

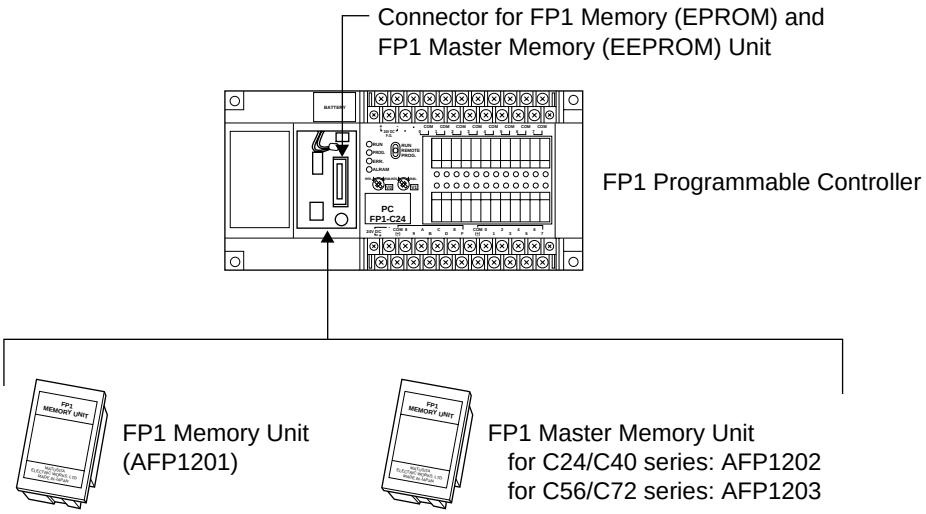
4-5. Memory Unit Creation and ROM Operation

1. Memory Unit

- The program may be downloaded to a memory unit and saved only for the C24, C40, C56, and C72 series. Using memory units makes it easy to rewrite and transfer programs.
- The contents of the program and system registers are written to the memory unit. When the contents of the memory unit are transferred to internal RAM, the existing contents of the memory and system registers will be overwritten.

Note:

- The contents of memory for operand, such as internal relays and data registers are not overwritten.



■ Memory Type (for C24, C40, C56, and C72 series)

Type		Part number	Writing method	Description
FP1 Memory Unit (EPROM)		AFP1201	Commercially available ROM programmer or FP ROM Writer.	Suitable for program storage or ROM-based operation when installed in the Control Unit.
FP1 Master Memory Unit (EEPROM)	for C24/C40 series	AFP1202	FP1 Control Unit. A ROM programmer is not required.	You can write data without using a ROM programmer. Suitable for copying and transmitting the master program.
	for C56/C72 series	AFP1203		

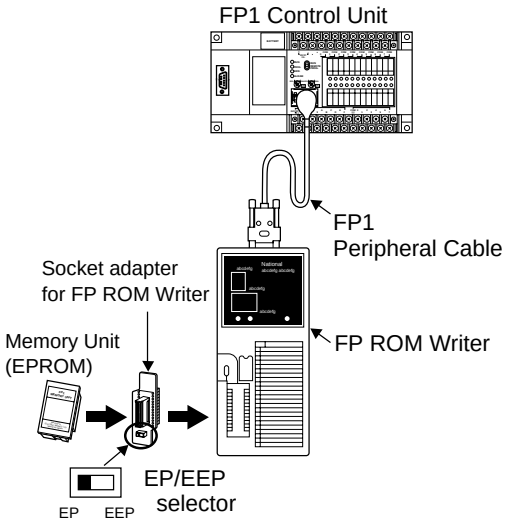
2. How to Program ROM

- Using an FP ROM Writer or a commercially available ROM programmer, the contents of the FP1's internal RAM can be written to the memory (ROM).
- The following types of memory (ROM) are available:
  - Memory Unit (EPROM): AFP1201
    Memory for storing programs. Writing is done with an FP ROM Writer or a commercially available ROM programmer.
  - Master Memory Unit (EEPROM): AFP1202 (for C24 and C40 series), AFP1203 (for C56 and C72 series)
    Memory for copying programs. Writing is done by attaching a master memory to the FP1 Control Unit.

■ Writing a program to the memory unit (EPROM) with an FP ROM Writer

[FP1's internal RAM Memory]

The content of the FP1's internal RAM is written directly to the memory unit (EPROM).



Necessary tools

- FP1 Peripheral Cable:
  0.5 m / 1.640 ft.: AFP15205
  3 m / 9.843 ft.: AFP1523
- FP ROM Writer: AFP5651
- Socket adapter for FP ROM Writer: AFP1810
- Memory Unit (EPROM): AFP1201

■ Writing a program to the memory unit (EPROM) with NPST-GR Software and a commercially available ROM programmer

[Program with NPST-GR Software → ROM programmer memory → memory (EPROM)]

Procedure:

① Transfer the program from the personal computer to the commercially available ROM programmer's internal memory with the NPST-GR Software.

② Attach the memory unit (EPROM) to the ROM programmer, and write the program.

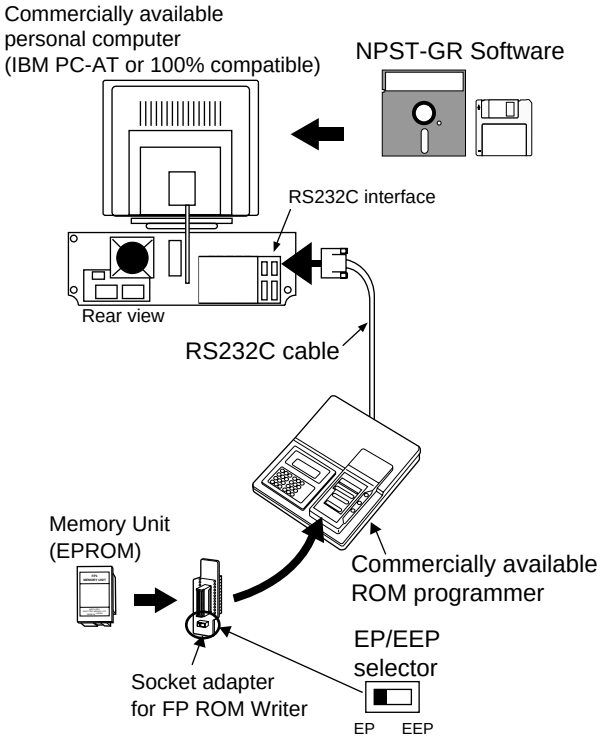
Necessary tools

- Computer: Commercially available personal computer (IBM PC-AT or 100% compatible machine)
  Main Memory: 550 KB or more free
  EMS: 800 KB or more free
  Hard disk space: 2 MB or more required
  Operating System: MS-DOS Ver. 3.30 or later
  Video mode (display mode): EGA or VGA
- NPST-GR Software Ver. 3: AFP266538

Note:

> • The .EXE files are compressed in the system disks. When installing the NPST-GR, you will have to expand them.

- RS232C cable:
  Select in accordance with the specifications of the commercially available ROM writer.
- Commercially available ROM programmer:
  We recommend Aval Data Corporation's PECKER 11.
- Socket adapter for FP ROM Writer: AFP1810
- Memory Unit (EPROM): AFP1201



■ Writing a program to the memory (EPROM) via the master memory (EEPROM) with a commercially available ROM programmer

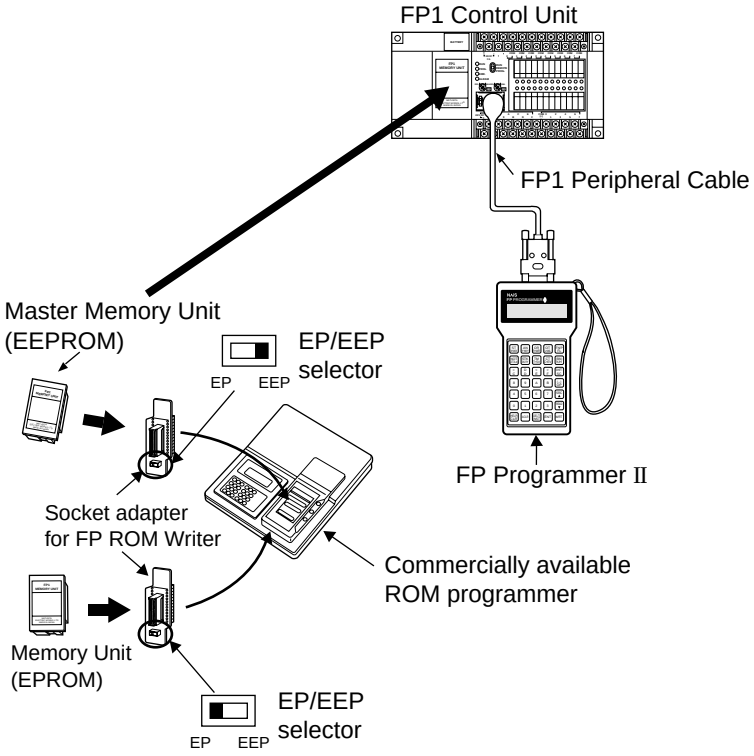
[FP1's internal RAM → master memory unit (EEPROM) → ROM programmer memory → memory (EPROM)]

Procedure:

① Attach master memory unit (EEPROM) to the FP1 Control Unit. Transfer to master memory unit (EEPROM) using FP Programmer Ⅱ in FP1's internal RAM. Remove master memory unit (EEPROM) from FP1, and attach to commercially available ROM programmer.

② Transfer contents of that master memory unit (EEPROM) to the internal memory of the ROM programmer. Replace the ROM programmer's master memory (EEPROM) with the memory (EPROM).

③ Write the contents of the ROM writer's internal memory to the memory unit (EPROM).



Necessary tools

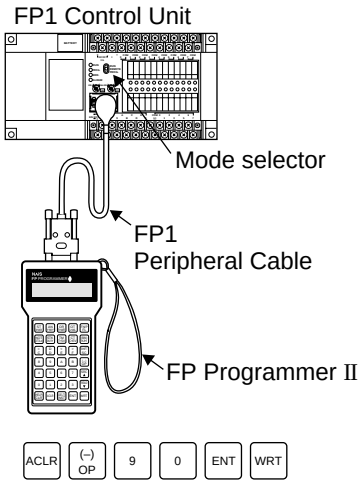
- FP1 Peripheral Cable:
  - 0.5 m / 1.640 ft.: AFP15205
  - 3 m / 9.843 ft.: AFP1523
- FP Programmer Ⅱ: AFP1114
- Socket adapter for FP ROM Writer: AFP1810
- Master Memory Unit (EEPROM): AFP1202 (for C24 and C40 series)
  AFP1203 (for C56 and C72 series)
- Memory Unit (EPROM): AFP1201
- Commercially available ROM programmer: We recommend Aval Data Corporation's PECKER 11.

3. Operation with Installed Memory Unit (ROM Operation)

When the FP1 is operated with the installed memory unit (ROM), the mode selector causes the following operational changes to occur.

■ When the Power is Turned ON in PROG. Mode

- In the PROG. mode, even if the memory unit (ROM) is installed, the programming tools (NPST-GR Software or FP Programmer Ⅱ) read the contents of the RAM on the FP1 Control Unit.
- Accordingly, to verify the contents of the memory unit (ROM) while in the the PROG. mode, you can transmit the contents to RAM using the following procedure.



Procedure

- Using FP Programmer Ⅱ

1. Press the keys in the sequence shown on the right.
2. The contents of the memory unit (ROM) will automatically be loaded into the internal RAM when the Mode Selector is set to RUN.

■ When the Power is Turned ON in RUN Mode

The contents of the memory unit (ROM) are automatically loaded (overwritten) into the internal RAM when the power is turned ON. Note that the previous contents of the RAM will be erased.

Notes:

- If you want to save the contents of the FP1 internal RAM onto a Master Memory Unit, be sure to set the Mode Selector to PROG. before turning ON the power.
- Turn OFF the power to the FP1 before installing or removing the memory unit.
- Even when using ROM-based operation, be sure the battery is connected for backup and retaining the data. The battery backs up retained data such as internal relays and data registers. Be sure to connect the battery even when using ROM-based operation if the program runs using retained data. If the internal relays and data registers have been set as non-retained data, it is not necessary to connect the battery. However, the ERR. LED will continue to be lit during operation.

CHAPTER 5

BASIC INSTRUCTIONS

5-1. Configuration of Basic Instructions

1. Types of Basic Instructions

Basic Sequence Instructions:

These basic instructions perform bit unit logic operations and are the basis of the relay sequence circuit.

Basic Function Instructions:

These are the timer, counter and shift register instructions.

Control Instructions:

These instructions determine the order and flow of program execution.

Compare Instructions:

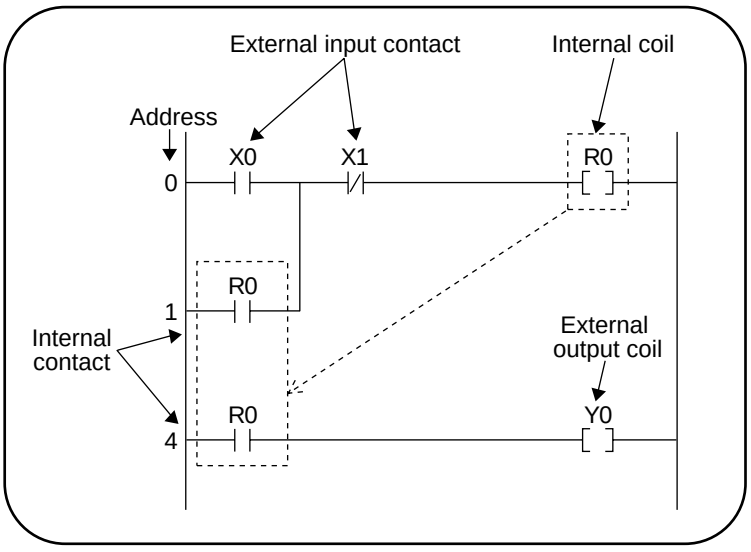
These instructions compare data.

2. Configuration of Basic Instructions

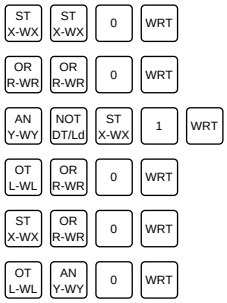
• Since most of the basic instructions form the basis of the relay sequence circuit, they are expressed as relay coils and contacts, as shown below.

Example:
Self-hold circuit by basic sequence instructions

Screen of NPST-GR Software in Boolean ladder mode



Key operation of FP Programmer Ⅱ



• Relay types are given on the following page. Note that the relays that can be specified depend upon the instruction. Refer to each instruction for details.

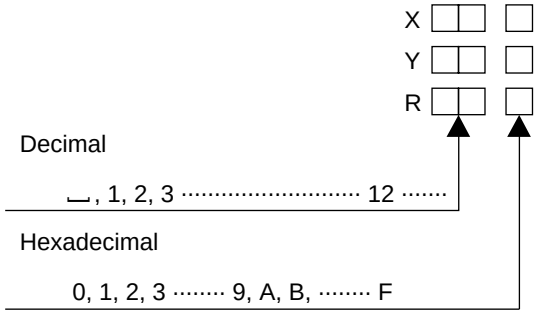
3. Operands for Basic Instructions

1) Description of Operands

Item		Function	Number of points	
			C14 and C16 series	C24, C40, C56, and C72 series
Relay	External input relay (X)	This relay feeds signals to the Programmable Controller from an external device such as a limit switch or photoelectric sensor.	208 points (X0 to X12F)	
	External output relay (Y)	This relay outputs the program execution result of the Programmable Controller and activates an external device such as a solenoid or motor.	208 points (Y0 to Y12F)	
	Internal relay (R)	This relay does not provide an external output and can be used only within the Programmable Controller.	256 points (R0 to R15F)	1,008 points (R0 to R62F)
	Special internal relay (R)	This relay is a special internal relay which has specific applications. This relay cannot be used for output. Use it only as contact. Refer to page 223, “8-3. Table of Special Internal Relays”.	64 points (R900 to R903F)	
Timer/ Counter contact	Timer contact (T)	This contact is the output of a timer instruction (TM). If a timer instruction is timed out, the contact with same number turns ON.	100 points (T0 to T99)	
	Counter contact (C)	This contact is the output of a counter instruction (CT). If a counter instruction is counted up, the contact with same number turns ON.	28 points (C100 to C127)	44 points (C100 to C143)

■ External input relay (X), external output relay (Y), internal relay (R)

- The lowest digit for these relay’s X, Y, and R numbers is expressed in hexadecimal and the second and higher digits are expressed in decimal to enable both bit and word processing.



Example:

Internal relay number

X0, X1, X2, X3, X4, X5, X6, X7, X8, X9, XA, XB, XC, XD, XE, XF
X10, ····· X1F
X20, ····· X2F
. .
. .
. .
. .
. .
. .
. .
. .
X90, ····· X9F
X100, ····· X10F
X110, ····· X11F
X120, ····· X12F

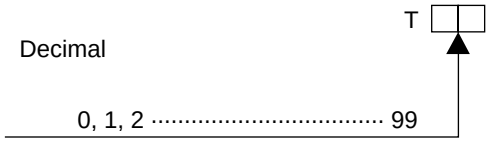
Notes:

- Refer to page 65, “3. I/O Allocation in the FP1”, for details about relay numbers.
- Any external output relay (Y) which is not used as an external output can be assigned as an internal relay (R).

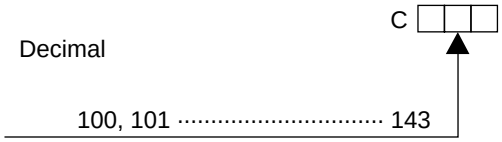
■ Timer contact (T), counter contact (C)

• The timer contact (T) and counter contact (C) numbers are expressed in decimal.

Timer contact (T)



Counter contact (C)



Notes:

- When the number of timers or counters is insufficient, the number can be changed by setting the system register.
- Refer to page 230, “8-5. System Registers”, for details about system register setting.
- In C56 and C72 series, the timer functions can be increased beyond this using the auxiliary timer instruction. Refer to “FP-M/FP1 Programming Manual” for details about the auxiliary timer instruction.

■ Hold type and non-hold type of the internal relay (R), timer contact (T), and counter contact (C)

• Setting is possible so that the state of the internal relay (R), timer (T) and counter (C), immediately after turning the power OFF or switching from RUN to PROG. mode, is either held (hold type) or reset (non-hold type).

• Selection of hold type and non-hold type is performed in the system register.
Refer to page 230, “8-5. System Registers”, for details about selection of hold and non-hold types.

• The default value of hold and non-hold areas is organized as follows.

Internal relay (R) .....R0 to R9F: Non-hold area
After R100: Hold area

Timer contact (T) and counter contact (C) .....0 to 99: Non-hold area
After 100: Hold area

5-2. Table of Basic Instructions

1. Basic Sequence Instructions

	Name	Boolean	Description	Step	Availability			Page
					C14/ C16	C24/ C40	C56/ C72	
*	Start	**ST**	Begins a logic operation with a Form A (normally open) contact.	1	A	A	A	101
*	Start Not	**ST/**	Begins a logic operation with a Form B (normally closed) contact.	1	A	A	A	101
*	Out	**OT**	Outputs the operated result to the specified output.	1	A	A	A	101
*	Not	**/**	Inverts the operated result up to this instruction.	1	A	A	A	102
*	AND	**AN**	Connects a Form A (normally open) contact serially.	1	A	A	A	103
*	AND Not	**AN/**	Connects a Form B (normally closed) contact serially.	1	A	A	A	103
*	OR	**OR**	Connects a Form A (normally open) contact in parallel.	1	A	A	A	104
*	OR Not	**OR/**	Connects a Form B (normally closed) contact in parallel.	1	A	A	A	104
*	AND stack	**ANS**	Performs an AND operation on multiple instruction blocks.	1	A	A	A	105
*	OR stack	**ORS**	Performs an OR operation on multiple instruction blocks.	1	A	A	A	106
*	Push stack	**PSHS**	Stores the operated result up to this instruction.	1	A	A	A	107
*	Read stack	**RDS**	Reads the operated result stored by the **PSHS** instruction.	1	A	A	A	107
*	Pop stack	**POPS**	Reads and clears the operated result stored by the **PSHS** instruction.	1	A	A	A	107
*	Leading edge differential	**DF**	Turns ON the contact for only one scan when the leading edge of the trigger is detected.	1	A	A	A	109
*	Trailing edge differential	**DF/**	Turns ON the contact for only one scan when the trailing edge of the trigger is detected.	1	A	A	A	109
*	Set	**SET**	Holds the contact (in bit) ON.	3	A	A	A	111
*	Reset	**RST**	Holds the contact (in bit) OFF.	3	A	A	A	111
*	Keep	**KP**	Turns ON the output and maintains its condition.	1	A	A	A	113
*	No operation	**NOP**	No operation.	1	A	A	A	114

- A: Available, N/A: Not available
- Details about the instructions with a * mark are described in this manual. Refer to the pages in the far right column of the above table.

2. Basic Function Instructions

	Name	Boolean	Description	Step	Availability			Page
					C14/ C16	C24/ C40	C56/ C72	
*	0.01 s units timer	**TMR**	Sets the ON-delay timer for 0.01 s units (0 to 327.67 s).	3	A	A	A	115
*	0.1 s units timer	**TMX**	Sets the ON-delay timer for 0.1 s units (0 to 3276.7 s).	3	A	A	A	115
*	1 s units timer	**TMY**	Sets the ON-delay timer for 1 s units (0 to 32767 s).	4	A	A	A	115
	Auxiliary timer	**F137 (STMR)**	Sets the ON-delay timer for 0.01 s units (0.01 to 327.67 s).	5	N/A	N/A	A	—
*	Counter	**CT**	Subtracts the preset counter.	3	A	A	A	119
	UP/DOWN counter	**F118 (UDC)**	Sets the UP/DOWN counter.	5	A	A	A	—
*	Shift register	**SR**	Shifts one bit of 16-bit [word internal relay (WR)] data to the left.	1	A	A	A	122
	Left/right shift register	**F119 (LRSR)**	Shifts one bit of the 16-bit data range to the left or to the right.	5	A	A	A	—

3. Control Instructions

	Name	Boolean	Description	Step	Availability			Page
					C14/ C16	C24/ C40	C56/ C72	
*	Master control relay	**MC**	Executes the instructions from **MC** to **MCE** when the predetermined trigger (I/O) turns ON.	2	A	A	A	124
*	Master control relay end	**MCE**		2	A	A	A	124
	Jump	**JP**	Skips to the **LBL** instruction that has the same number as the **JP** instruction when the predetermined trigger turns ON.	2	A	A	A	—
	Label	**LBL**	Label used for execution of **JP** and **LOOP** instructions.	1	A	A	A	—
	Loop	**LOOP**	Skips to the **LBL** instruction that has the same number as the **LOOP** instruction and executes what follows it repeatedly until the data of a specified operand becomes “0”.	4	A	A	A	—
*	End	**ED**	Indicates the end of a main program.	1	A	A	A	126
	Conditional end	**CNDE**	Ends one scan when the predetermined trigger turns ON.	1	A	A	A	—

- A: Available, N/A: Not available
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For other instructions without a * mark, refer to “FP-M/FP1 Programming Manual”.

Name	Boolean	Description	Step	Availability			Page
				C14/ C16	C24/ C40	C56/ C72	
Start step	**SSTP**	Indicates the start of the step ladder process.	3	A	A	A	—
Next step (pulse execution type)	**NSTP**	Opens the process of the step ladder and resets the process including the instruction itself. **NSTP** is executed when the leading edge of its trigger is detected.	3	A	A	A	—
Next step (scan execution type)	**NSTL**	Opens the process of the step ladder and resets the process including the instruction itself. **NSTL** is executed every scan if its trigger is ON.	3	A	A	A	—
Clear step	**CSTP**	Resets the specified process.	3	A	A	A	—
Step end	**STPE**	Closes the step ladder operations and returns to normal ladder operation.	1	A	A	A	—
Subroutine call	**CALL**	Executes the specified subroutine.	2	A	A	A	—
Subroutine entry	**SUB**	Indicates the start of the subroutine program.	1	A	A	A	—
Subroutine return	**RET**	Ends the subroutine program and returns to the main program.	1	A	A	A	—
Interrupt control	**ICTL**	Specifies the condition of the interrupt.	5	N/A	A	A	—
Interrupt	**INT**	Starts an interrupt program.	1	N/A	A	A	—
Interrupt return	**IRET**	Ends the interrupt program and returns instruction control to the main program.	1	N/A	A	A	—

4. Compare Instructions

	Name	Boolean	Operand	Description	Step	Availability			Page
						C14/ C16	C24/ C40	C56/ C72	
*	Word compare: Start equal	**ST =**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 = S2 OFF: when S1 ≠ S2	5	N/A	A	A	127
*	Word compare: AND equal	**AN =**	S1, S2		5	N/A	A	A	129
*	Word compare: OR equal	**OR =**	S1, S2		5	N/A	A	A	131

- A: Available, N/A: Not available
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For other instructions without a * mark, refer to “FP-M/FP1 Programming Manual”.

	Name	Boolean	Operand	Description	Step	Availability			Page
						C14/ C16	C24/ C40	C56/ C72	
*	Word compare: Start equal not	**ST <>**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 ≠ S2 OFF: when S1 = S2	5	N/A	A	A	127
*	Word compare: AND equal not	**AN <>**	S1, S2		5	N/A	A	A	129
*	Word compare: OR equal not	**OR <>**	S1, S2		5	N/A	A	A	131
*	Word compare: Start larger	**ST >**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 > S2 OFF: when S1 ≦ S2	5	N/A	A	A	127
*	Word compare: AND larger	**AN >**	S1, S2		5	N/A	A	A	129
*	Word compare: OR larger	**OR >**	S1, S2		5	N/A	A	A	131
*	Word compare: Start equal or larger	**ST >=**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 ≧ S2 OFF: when S1 < S2	5	N/A	A	A	127
*	Word compare: AND equal or larger	**AN >=**	S1, S2		5	N/A	A	A	129
*	Word compare: OR equal or larger	**OR >=**	S1, S2		5	N/A	A	A	131
*	Word compare: Start smaller	**ST <**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 < S2 OFF: when S1 ≧ S2	5	N/A	A	A	127
*	Word compare: AND smaller	**AN <**	S1, S2		5	N/A	A	A	129
*	Word compare: OR smaller	**OR <**	S1, S2		5	N/A	A	A	131
*	Word compare: Start equal or smaller	**ST <=**	S1, S2	Performs Start, AND or OR operation by comparing two word data in the following conditions. ON: when S1 ≦ S2 OFF: when S1 > S2	5	N/A	A	A	127
*	Word compare: AND equal or smaller	**AN <=**	S1, S2		5	N/A	A	A	129
*	Word compare: OR equal or smaller	**OR <=**	S1, S2		5	N/A	A	A	131
*	Double word compare: Start equal	**STD =**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) = (S2+1, S2) OFF: when (S1+1, S1) ≠ (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND equal	**AND =**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR equal	**ORD =**	S1, S2		9	N/A	A	A	137
*	Double word compare: Start equal not	**STD <>**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) ≠ (S2+1, S2) OFF: when (S1+1, S1) = (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND equal not	**AND <>**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR equal not	**ORD <>**	S1, S2		9	N/A	A	A	137

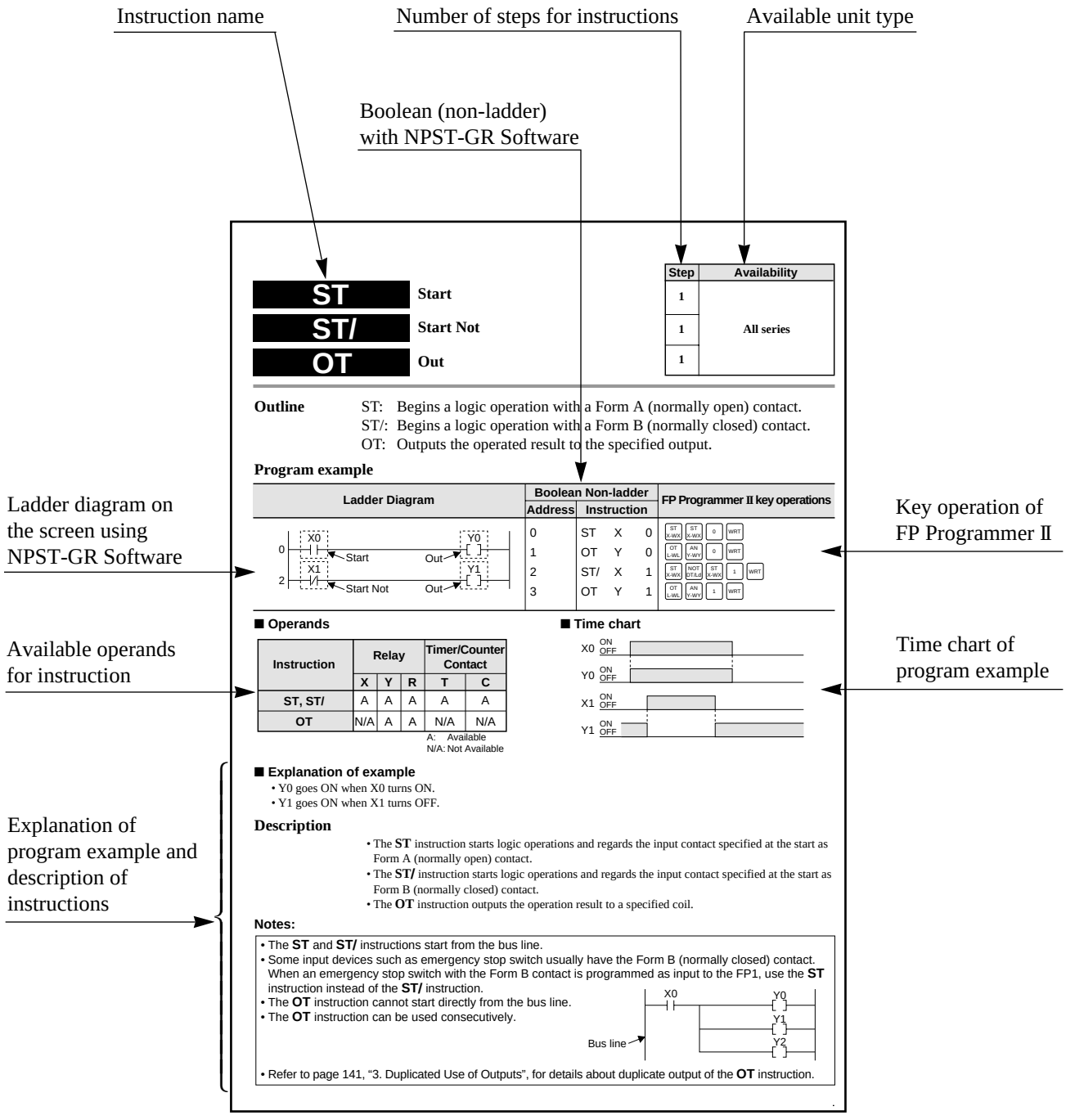
- A: Available, N/A: Not available
- Details about the instructions with a * mark are described in this manual. Refer to the pages in the far right column of the above tables.

	Name	Boolean	Operand	Description	Step	Availability			Page
						C14/ C16	C24/ C40	C56/ C72	
*	Double word compare: Start larger	**STD >**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) > (S2+1, S2) OFF: when (S1+1, S1) ≦ (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND larger	**AND >**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR larger	**ORD >**	S1, S2		9	N/A	A	A	137
*	Double word compare: Start equal or larger	**STD >=**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) ≧ (S2+1, S2) OFF: when (S1+1, S1) < (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND equal or larger	**AND >=**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR equal or larger	**ORD >=**	S1, S2		9	N/A	A	A	137
*	Double word compare: Start smaller	**STD <**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) < (S2+1, S2) OFF: when (S1+1, S1) ≧ (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND smaller	**AND <**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR smaller	**ORD <**	S1, S2		9	N/A	A	A	137
*	Double word compare: Start equal or smaller	**STD <=**	S1, S2	Performs Start, AND or OR operation by comparing two double word data in the following conditions. ON: when (S1+1, S1) ≦ (S2+1, S2) OFF: when (S1+1, S1) > (S2+1, S2)	9	N/A	A	A	133
*	Double word compare: AND equal or smaller	**AND <=**	S1, S2		9	N/A	A	A	135
*	Double word compare: OR equal or smaller	**ORD <=**	S1, S2		9	N/A	A	A	137

- A: Available, N/A: Not available
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.

5-3. Description of Basic Instructions

Basic Instruction Reference



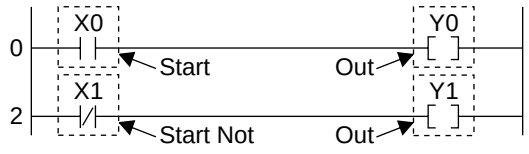
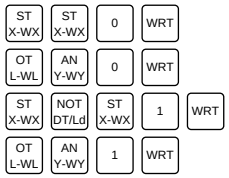
ST Start
ST/ Start Not
OT Out

Step	Availability
1	All series
1	
1	

Outline

ST: Begins a logic operation with a Form A (normally open) contact.
ST/: Begins a logic operation with a Form B (normally closed) contact.
OT: Outputs the operated result to the specified output.

Program example

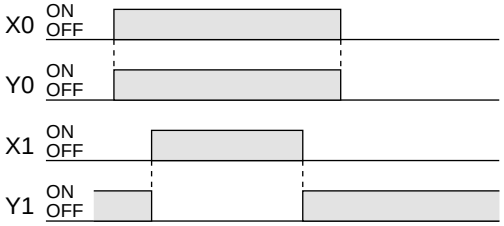
Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	
	1	OT	Y 0	
	2	ST/	X 1	
	3	OT	Y 1	

■ Operands

Instruction	Relay			Timer/Counter Contact	
	X	Y	R	T	C
ST, ST/	A	A	A	A	A
OT	N/A	A	A	N/A	N/A

A: Available
N/A: Not Available

■ Time chart



■ Explanation of example

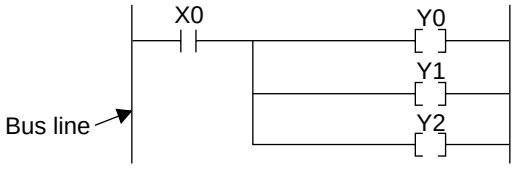
- Y0 goes ON when X0 turns ON.
- Y1 goes ON when X1 turns OFF.

Description

- The **ST** instruction starts logic operations and regards the input contact specified at the start as Form A (normally open) contact.
- The **ST/** instruction starts logic operations and regards the input contact specified at the start as Form B (normally closed) contact.
- The **OT** instruction outputs the operation result to a specified coil.

Notes:

- The **ST** and **ST/** instructions start from the bus line.
- Some input devices such as emergency stop switch usually have the Form B (normally closed) contact. When an emergency stop switch with the Form B contact is programmed as input to the FP1, use the **ST** instruction instead of the **ST/** instruction.
- The **OT** instruction cannot start directly from the bus line.
- The **OT** instruction can be used consecutively.



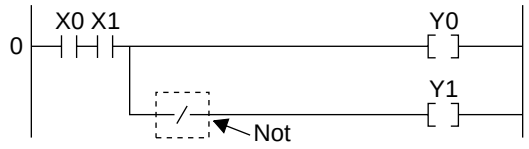
- Refer to page 141, “3. Duplicated Use of Outputs”, for details about duplicate output of the **OT** instruction.

/ Not

Step	Availability
1	All series

Outline Inverts the operated result up to this instruction.

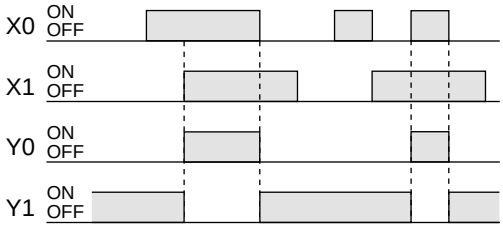
Program example

Ladder Diagram	Boolean Non-ladder				FP Programmer II key operations
	Address	Instruction			
	0	ST	X	0	ST X-WX ST X-WX 0 WRT
	1	AN	X	1	AN Y-WY ST X-WX 1 WRT
	2	OT	Y	0	OT L-WL AN Y-WY 0 WRT
	3	/			NOT DT/Ld WRT
	4	OT	Y	1	OT L-WL AN Y-WY 1 WRT

■ Explanation of example

- Y0 goes ON when both X0 and X1 turn ON.
- Y1 goes ON when X0 or X1 turns OFF.

■ Time chart



Description

- The **/** instruction inverts the operated result up to this instruction.

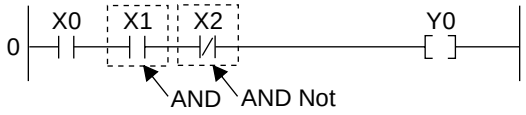
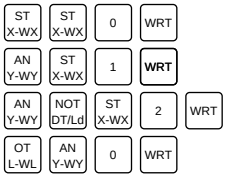
Step	Availability
1	All series
1	

AN AND

AN/ AND Not

Outline AN: Connects a Form A (normally open) contact serially.
AN/: Connects a Form B (normally closed) contact serially.

Program example

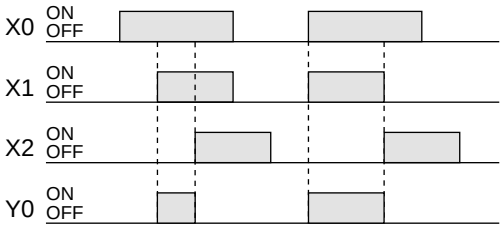
Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	
	1	AN	X 1	
	2	AN/	X 2	
	3	OT	Y 0	

■ Operands

Instruction	Relay			Timer/Counter Contact	
	X	Y	R	T	C
AN, AN/	A	A	A	A	A

A: Available
N/A: Not Available

■ Time chart



■ Explanation of example

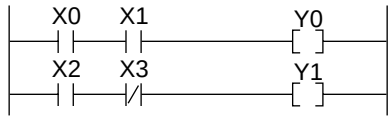
- Y0 goes ON when both X0 and X1 turn ON and also X2 turns OFF.

Description

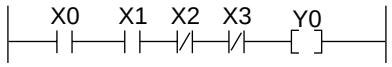
- Performs a logical AND operation with the results of the immediately preceding serially connected operation.

Notes:

- Use the **AN** instruction when the normally open contact (Form A contact) is serially connected. Use the **AN/** instruction when the normally closed contact (Form B contact) is serially connected.



- The **AN** and **AN/** instructions can be used consecutively.

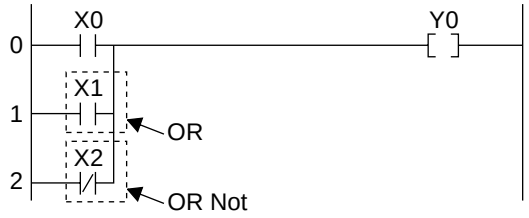


OR OR
OR/ OR Not

Step	Availability
1	All series
1	

Outline OR: Connects a Form A (normally open) contact in parallel.
OR/: Connects a Form B (normally closed) contact in parallel.

Program example

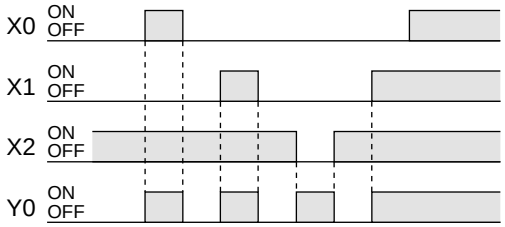
Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	OR	X 1	OR R-WR, ST X-WX, 1, WRT
	2	OR/	X 2	OR R-WR, NOT DT/Ld, ST X-WX, 2, WRT
	3	OT	Y 0	OT L-WL, AN Y-WY, 0, WRT

■ Operands

Instruction	Relay			Timer/Counter Contact	
	X	Y	R	T	C
OR, OR/	A	A	A	A	A

A: Available
N/A: Not Available

■ Time chart



■ Explanation of example

• Y0 goes ON when either X0 or X1 turns ON or X2 turns OFF.

Description

• Performs a logical OR operation with the results of the immediately preceding operation connected in parallel.

Notes:

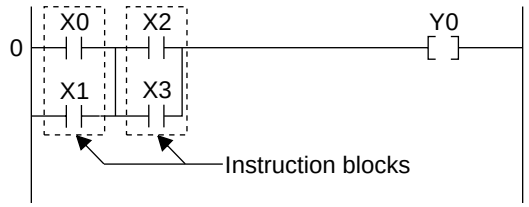
- Use the **OR** instruction when the normally open contact (Form A contact) is connected in parallel. Use the **OR/** instruction when the normally closed contact (Form B contact) is connected in parallel.
- The **OR** instruction starts from the bus line.
- The **OR** and **OR/** instructions can be used consecutively.

ANS AND stack

Step	Availability
1	All series

Outline Performs an AND operation on multiple instruction blocks.

Program example

Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	OR	X 1	OR R-WR, ST X-WX, 1, WRT
	2	ST	X 2	ST X-WX, ST X-WX, 2, WRT
	3	OR	X 3	OR R-WR, ST X-WX, 3, WRT
	4	ANS		AN Y-WY, STK IX/IY, WRT
	5	OT	Y 0	OT L-WL, AN Y-WY, 0, WRT

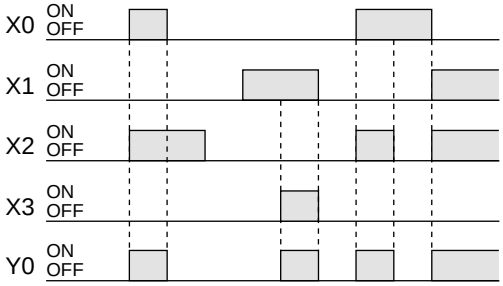
■ Explanation of example

• Y0 goes ON when X0 or X1 and X2 or X3 turn ON.

(X0 OR X1) AND (X2 OR X3) → Y0

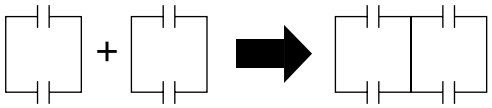
block 1 block 2

■ Time chart



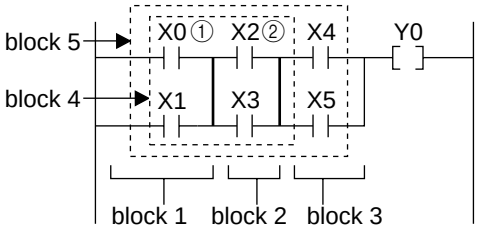
Description

• The **ANS** instruction is used to connect blocks in series.



• A block begins with the **ST** instruction.

• When two or more instruction blocks are programmed in series, make a program as follows.



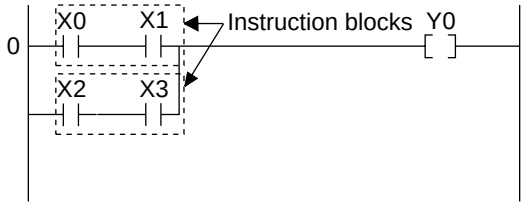

```
block 5
  block 4
    block 1   ST   X  0
              OR   X  1
    block 2   ST   X  2
              OR   X  3
              ANS ····· ①
  block 3     ST   X  4
              OR   X  5
              ANS ····· ②
              OUT  Y  0
```

ORS OR stack

Step	Availability
1	All series

Outline Performs an OR operation on multiple instruction blocks.

Program example

Ladder Diagram	Boolean Non-ladder				FP Programmer II key operations
	Address	Instruction			
	0	ST	X	0	ST X-WX, ST X-WX, 0, WRT
	1	AN	X	1	AN Y-WY, ST X-WX, 1, WRT
	2	ST	X	2	ST X-WX, ST X-WX, 2, WRT
	3	AN	X	3	AN Y-WY, ST X-WX, 3, WRT
	4	ORS			OR R-WR, STK IX/IY, WRT
	5	OT	Y	0	OT L-WL, AN Y-WY, 0, WRT

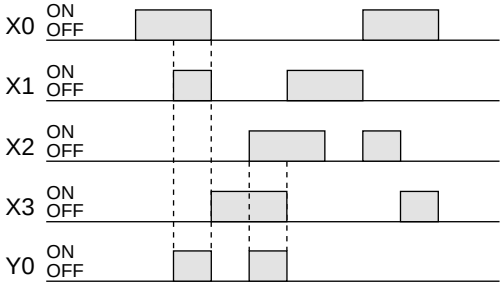
■ Explanation of example

• Y0 goes ON when both X0 and X1 or both X2 and X3 turn ON.

(X0 AND X1) OR (X2 AND X3) → Y0

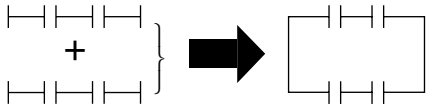
block 1 block 2

■ Time chart

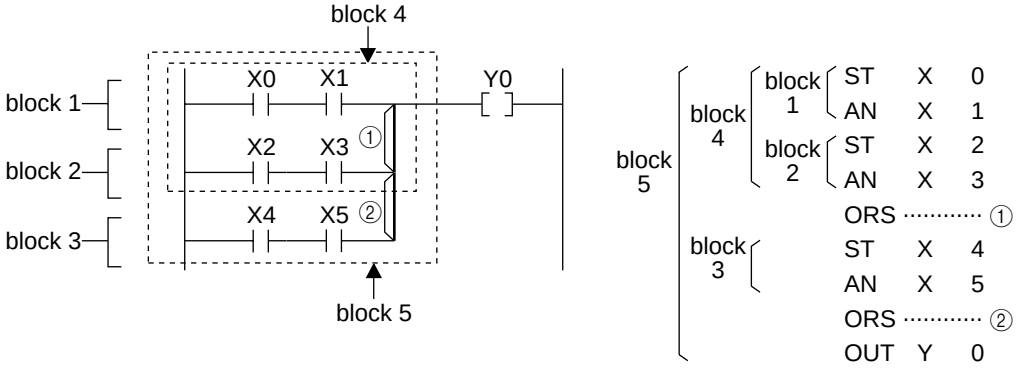


Description

• The **ORS** instruction is used to connect blocks in parallel.



• A block begins with the **ST** instruction.
• When two or more instruction blocks are programmed in parallel, make a program as follows.



PSHS Push stack
RDS Read stack
POPS Pop stack

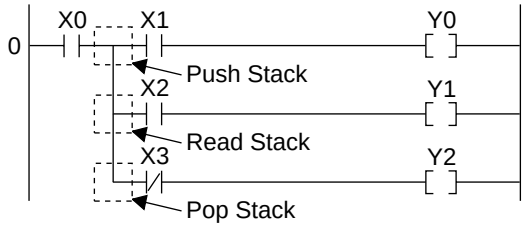
Step	Availability
1	All series
1	
1	

Outline

PSHS: Stores the operated result up to this instruction.
RDS: Reads the operated result stored by the **PSHS** instruction.
POPS: Reads and clears the operated result stored by the **PSHS** instruction.

Program example

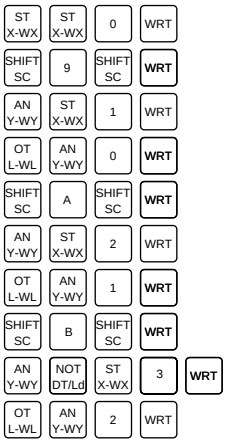
Ladder Diagram



Boolean Non-ladder

Address	Instruction
0	ST X 0
1	PSHS
2	AN X 1
3	OT Y 0
4	RDS
5	AN X 2
6	OT Y 1
7	POPS
8	AN/ X 3
9	OT Y 2

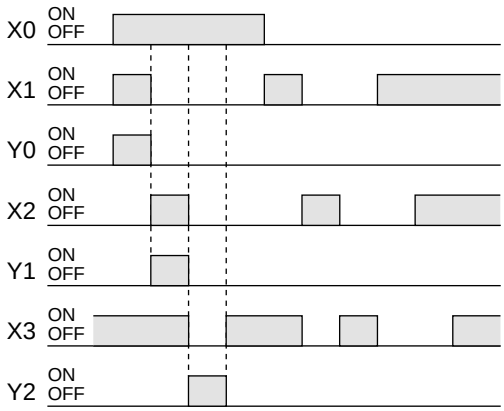
FP Programmer Ⅱ key operations



■ Explanation of example

- When X0 turns ON:
  1) Stores the operated result up to the **PSHS** instruction and Y0 goes ON when X1 turns ON.
  2) Reads the stored result by the **RDS** instruction and Y1 goes ON when X2 turns ON.
  3) Reads the stored result by the **POPS** instruction and Y2 goes ON when X3 turns OFF. Also clears the stored result by the **PSHS** instruction.

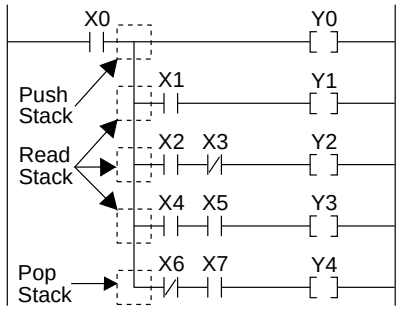
■ Time chart



Description

- **PSHS:** Stores the operated result up to this instruction and executes operation from the next step.
- **RDS:** Reads the operated result stored by the **PSHS** instruction and, using its contents, continues operation from the next step.
- **POPS:** Reads the operated result stored by the **PSHS** instruction and, using its contents, continues operation from the next step. Also clears the operated result stored by the **PSHS** instruction.

- You can continue to use the same operation result several times by successively using the **RDS** instruction. When you are finished, be sure to issue the **POPS** instruction.



Note:

- Refer to page 139, “5-4. Hints for Programming Basic Instructions”, for details about basic instructions, such as the **PSHS**, **RDS**, **POPS** instructions, which are not displayed on the FP Programmer Ⅱ key.

DF Leading edge differential

DF/ Trailing edge differential

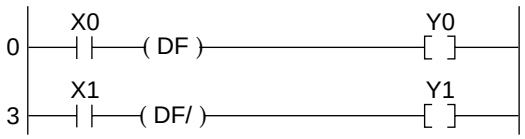
Step	Availability
1	All series
1	

Outline

DF: Turns ON the contact for only one scan when the leading edge of the trigger is detected.

DF/: Turns ON the contact for only one scan when the trailing edge of the trigger is detected.

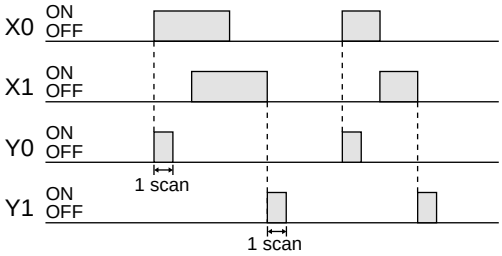
Program example

Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	DF		SHIFT SC, 0, SHIFT SC, WRT
	2	OT	Y 0	OT L-WL, AN Y-WY, 0, WRT
	3	ST	X 1	ST X-WX, ST X-WX, 1, WRT
	4	DF/		SHIFT SC, 0, SHIFT SC, NOT DT/Ld, WRT
	5	OT	Y 1	OT L-WL, AN Y-WY, 1, WRT

■ Explanation of example

- Y0 goes ON for only one scan when the leading edge of X0 is detected.
- Y1 goes ON for only one scan when the trailing edge of X1 is detected.

■ Time chart

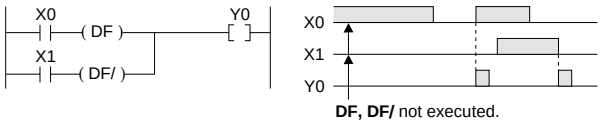


Description

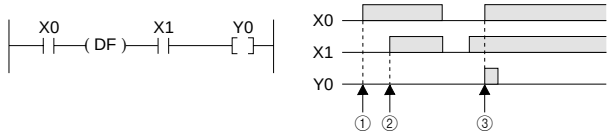
- The **DF** instruction executes and turns ON output for only one scan duration when the trigger changes from an OFF to an ON state.
- The **DF/** instruction executes and turns ON output for only one scan duration when the trigger changes from an ON to an OFF state.
- There is no limit on the number of times the **DF** instruction and **DF/** instruction can be used.

Notes:

- The **DF** and **DF/** instructions detect only the changes in the ON/OFF state of the contact comparing the state in the scan before. Therefore, if its trigger is already set to ON at the first scan of the FP1's operation, there will be no execution of the **DF** instruction. And if its trigger is set to OFF, there will be no execution of the **DF/** instruction.



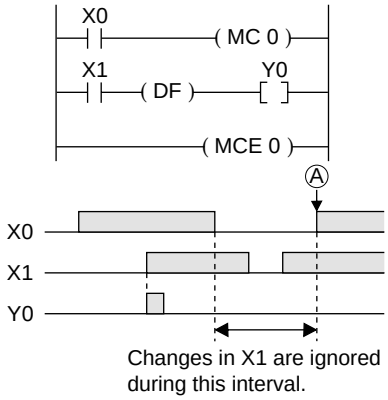
- With a circuit such as the one in the figure below, operation will be as follows.



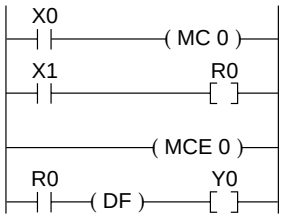
① When X1 is OFF, even if X0 rises, Y0 remains OFF.
② Even if X1 rises when X0 is ON, Y0 remains OFF.
③ If X0 rises when X1 is ON, then Y0 will go ON for one scan.

Notes:

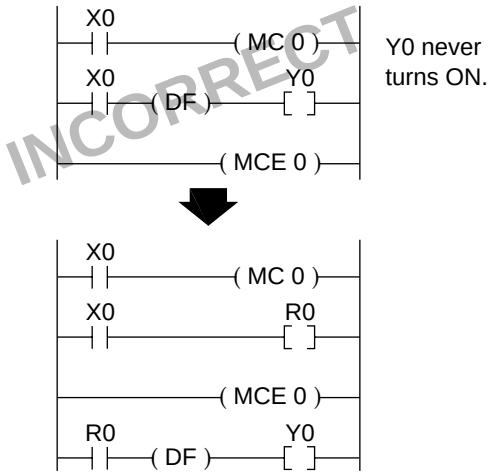
- Trigger to the **DF** instructions between the **MC** and **MCE** instruction set are ignored while the **MC** execution condition is OFF.



- If, in the example above, output is required at point Ⓐ, place the **DF** instruction outside the **MC** and **MCE** instruction set.



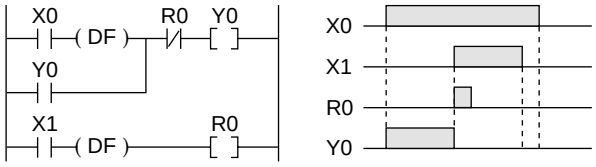
- If the same trigger is set for the **MC** and for the **DF** instruction, there will be no output. Place the **DF** instruction outside the **MC** and **MCE** instruction set when output is required.



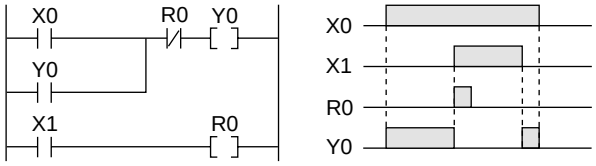
■ Application examples

- Self-hold circuits when the output is controlled by a long input signal.

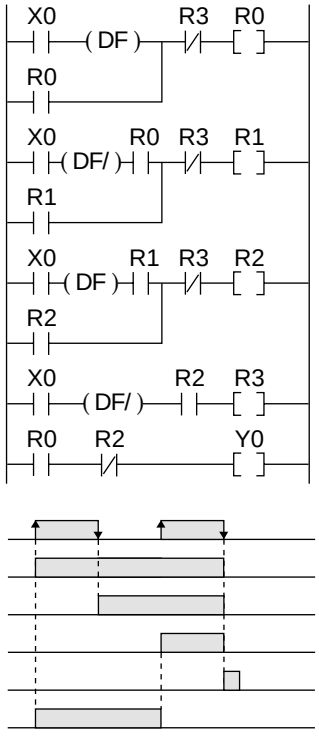
A program with a **DF** instruction



A program without a **DF** instruction



- Alternating circuit using a single signal to hold and release a circuit.

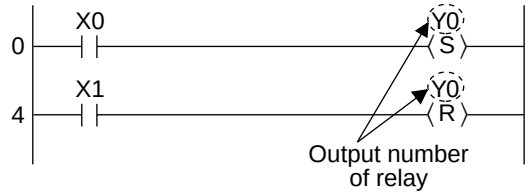


SET Set
RST Reset

Step	Availability
3	All series
3	

Outline SET: Holds the contact (in bit) ON.
RST: Holds the contact (in bit) OFF.

Program example

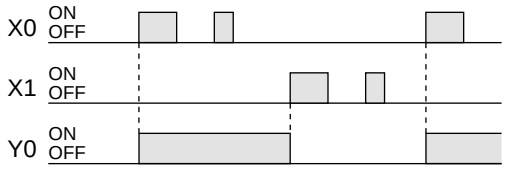
Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX ST X-WX 0 WRT
	1	SET	Y 0	SHIFT SC 1 9 SHIFT SC AN Y-WY 0 WRT
	4	ST	X 1	ST X-WX ST X-WX 1 WRT
	5	RST	Y 0	SHIFT SC 1 A SHIFT SC AN Y-WY 0 WRT

■ Operands

Instruction	Relay			Timer/Counter Contact	
	X	Y	R	T	C
SET, RST	N/A	A	A	N/A	N/A

A: Available
N/A: Not Available

■ Time chart

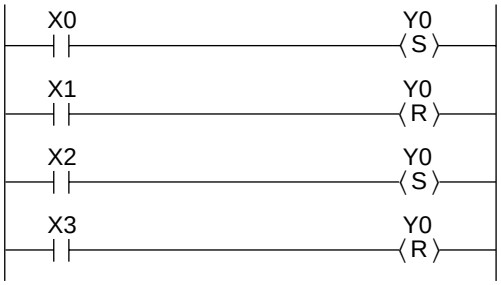


■ Explanation of example

- When X0 turns ON, Y0 goes ON and holds the contact (in bit) ON.
- When X1 turns ON, Y0 goes OFF and holds the contact (in bit) OFF.

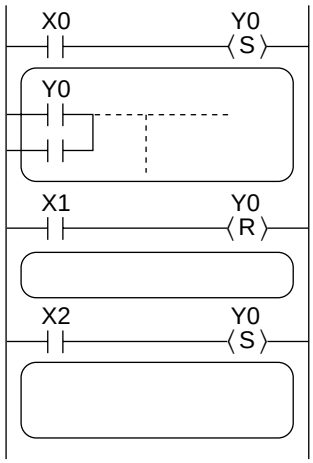
Description

- The **SET** instruction executes when the trigger is turned ON. Output turns ON and holds the contact (in bit) ON regardless of the trigger's state changes.
- The **RST** instruction executes when trigger is turned ON. Output turns OFF and holds the contact (in bit) OFF regardless of the trigger's state changes.
- You can use the same number for relays (Y and R) with the **SET** and **RST** instructions as many times as you like.



• When the **SET** and **RST** instructions are used, the contents of the output changes with each step during the processing of the operation.

Example: When X0, X1, and X2 are turned ON



This portion of the program is processed as if Y0 were ON.

This portion is processed as if Y0 were OFF.

This portion is processed as if Y0 were ON.

The external output at the I/O update depends on the final results of the operation.

• Place a **DF** instruction before the **SET** and **RST** instructions to make program development and refinement easier.

Note:

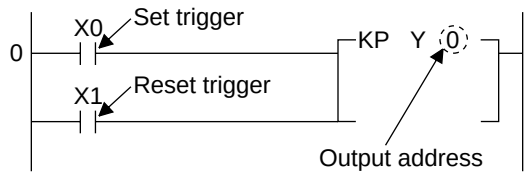
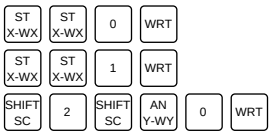
• Refer to page 139, “5-4. Hints for Programming Basic Instructions”, for details about basic instructions, such as the **SET**, **RST** instructions, which are not displayed on the FP Programmer Ⅱ keys.

Step	Availability
1	All series

KP Keep

Outline Turns ON the output and maintains its condition.

Program example

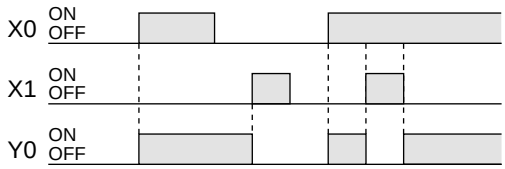
Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	
	1	ST	X 1	
	2	KP	Y 0	

■ Operands

Instruction	Relay			Timer/Counter Contact	
	X	Y	R	T	C
KP	N/A	A	A	N/A	N/A

A: Available
N/A: Not Available

■ Time chart



■ Explanation of example

- When X0 turns ON, output relay Y0 goes ON and maintains its condition.
- Y0 goes OFF when X1 turns ON.

Description

- When the set trigger turns ON, output of the specified relay goes ON and maintains its condition.
- Output relay goes OFF when the reset trigger turns ON.
- The output relay's ON state is maintained until a reset trigger turns ON regardless of the ON or OFF states of the set trigger.
- If the set trigger and reset trigger turns ON simultaneously, the reset trigger has priority.

Notes:

- The output relay maintains its condition even during operation of the **MC** instruction.
- The state of the **KP** instruction is not maintained when the mode of the programmable controller is switched from RUN to PROG. or when the power is turned OFF.
  (Use the hold-type internal relay if you want to also maintain the output state when the mode of the programmable controller is switched from RUN to PROG. or when turning OFF the power.)
- Refer to page 139, "5-4. Hints for Programming Basic Instructions", for details about basic instructions, such as the **KP** instruction, which are not displayed on the FP Programmer II keys.
- Refer to page 141, "3. Duplicated Use of Outputs", for details about duplicate output of the **KP** instruction.

NOP No operation

Step	Availability
1	All series

Outline No operation

Program example

Ladder Diagram	Boolean Non-ladder		FP1-Programmer Ⅱ key operations
	Address	Instruction	
	0	ST X 1	ST X-WX, ST X-WX, 1, WRT
	1	NOP	SHIFT SC, 1, SHIFT SC, (DELT) INST
	2	OT Y 0	OT L-WL, AN Y-WY, 0, WRT

■ Explanation of example

• Y0 outputs when X1 turns ON.

Description

• The **NOP** instruction can be used to make the program easier to read when checking or correcting.
• When the **NOP** instruction is inserted, the size of the program will increase slightly, however, there will be no effect on the results of the arithmetic operations.

Example:

• To move the starting point of a program block from address 39 to address 40, insert a **NOP** instruction to address 39.
This moves the starting point to address 40.

Address		Address	
36	ST X0	36	ST X0
•	OR X1	•	OR X1
•	OT Y1	•	OT Y1
39	ST X2	39	NOP ← Insert a **NOP** instruction.
40	AN X3	40	ST X2
•	OT R20	41	AN X3
•	ST R2	•	OT R20
•	DF	•	ST R2
44	ST X3	•	DF
		45	ST X3

Notes:

• To delete the **NOP** instruction after editing in the PROG. mode, use the programming tools (NPST-GR: DELETE ALL NOPS, FP Programmer Ⅱ: OP1).
Operation procedure of FP Programmer Ⅱ ACLR, (–) OP, 1, ENT, SHIFT SC, (DELT) INST
• Refer to page 139, “5-4. Hints for Programming Basic Instructions”, for details about basic instructions, such as the **NOP** instruction, which are not displayed on the FP Programmer Ⅱ keys.

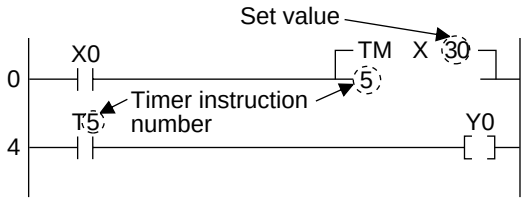
TMR 0.01s units timer
TMX 0.1s units timer
TMY 1s units timer

Step	Availability
3	All series
3	
4	

Outline

TMR: Sets the ON-delay timer for 0.01 s units (0 to 327.67 s)
TMX: Sets the ON-delay timer for 0.1 s units (0 to 3276.7 s)
TMY: Sets the ON-delay timer for 1 s units (0 to 32767 s)

Program example

Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	TM	X 5	TM T-SV, ST X-WX, 5, ENT
			K 30	(BIN) K/H, 3, 0, WRT
	4	ST	T 5	ST X-WX, TM T-SV, 5, WRT
	5	OT	Y 0	OT L-WL, AN Y-WY, 0, WRT

Timer instruction number	C14 and C16 series: up to 128 C24, C40, C56, and C72 series: up to 144 The number of the **TM** instructions is shared with that of the **CT** instructions. You can change the sharing of **TM** and **CT** instructions through the system registers. The default value of the **TM** and **CT** instruction is, for C14 and C16 series: **TM** instruction: 0 to 99, **CT** instruction: 100 to 127 for C24, C40, C56, and C72 series: **TM** instruction: 0 to 99, **CT** instruction: 100 to 143
Set value	Range: K0 to K32767 Decimal constant or timer set value area (SVn)* whose number is same as its timer instruction number (n) ***"SVn" can be specified only when the version of the CPU is 2.7 or later.**

■ Operands

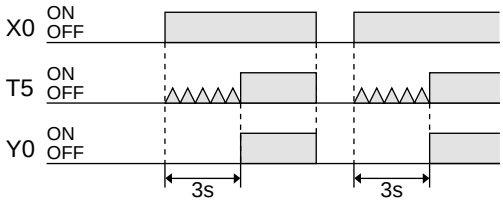
Instruction	Relay			Timer/Counter area		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
Set value	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	A	N/A	N/A

A: Available
N/A: Not Available

■ Explanation of example

• Three seconds after X0 turns ON, timer contact T5 turns ON. Then Y0 goes ON.

■ Time chart



Description

- The **TM** instruction is a down type preset timer.
- If there are not enough **TM** instruction numbers, you can increase the number by changing the setting of system register 5. Refer to page 230, “8-5. System Registers”, for details on how to change the number of timer instructions.

■ Timer set time

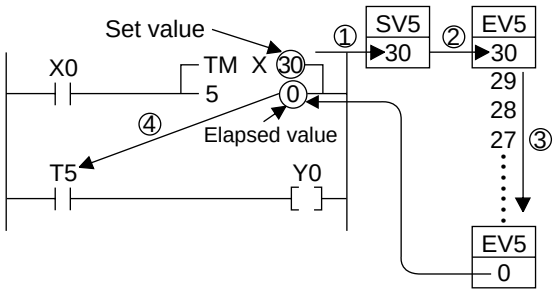
The formula of the timer set time is [the time unit] × [set value]
Example: TMX5 K30 (0.1 s × 30 = 3 s)

■ Timer operation

• When the decimal constant “K” is specified as a set value:

Procedure:

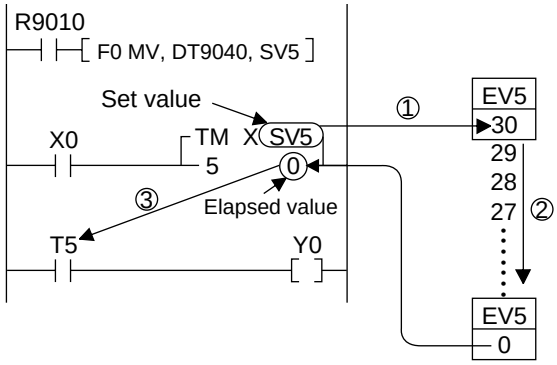
① When the mode of the programmable controller is set to RUN, K30 (decimal) is transferred to set value area SV5.
② When the leading edge of trigger X0 is detected (OFF → ON), set value K30 is transferred from the SV5 to the elapsed value area EV5.
③ The passed time is subtracted from the EV5 every scan while trigger X0 is in the ON state.
④ When the data in the elapsed value area EV5 becomes 0, timer contact T5 turns ON and then the Y0 goes ON.



• When the “SVn” is specified as a set value:

Procedure:

① When the leading edge of trigger X0 is detected (OFF → ON), the value in set value area SV5 is transferred to the elapsed value area EV5.
② The passed time is subtracted from the EV5 every scan while trigger X0 is in the ON state.
③ When the data in elapsed value area EV5 becomes 0, timer contact T5 turns ON and then Y0 goes ON.



Notes:

- If you turn OFF timer operation trigger X0 in the middle of an operation, the operation will be interrupted and the elapsed time will be reset to 0.
- Timer set value area SV is a memory area for the timer’s time setting.
- The timer contact goes ON when the value in timer elapsed value area EV becomes 0. However, the value in timer elapsed value area EV will also become 0 in a reset condition.
- For each **TM** instruction, one SV and EV set and one contact T are supported as follows:

Timer instruction number	Set value area SV	Elapsed value area EV	Timer contact T
TM0	SV0	EV0	T0
⋮	⋮	⋮	⋮
TM99	SV99	EV99	T99

- The timer is reset whenever the power is turned OFF, or the mode is changed from RUN to PROG. Set system register 6 to retain the run status.
  Refer to page 232, “2. Table of System Registers”, for details about system registers.
- Since the timing operation is executed during the scan of the timer instruction, program timer instructions so that the **TM** instruction is executed once per scan.
  Be sure that the **TM** instruction is executed once per scan when the **INT**, **JP**, **LOOP** instructions and others are programmed.

■ Changing the value in the Set Value Area (SV)

All control units can change the value in the set value area (SV), even during RUN mode, using the high-level instruction **F0 (MV)** or the programming tool (FP Programmer Ⅱ or NPST-GR).

The range of values that can be specified in the set value area (SV) are:

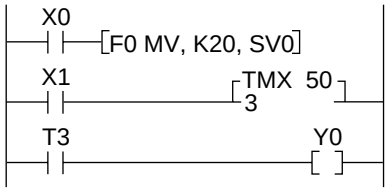
C14 and C16 series: SV0 to SV127
C24, C40, C56, and C72 series: SV0 to SV143

• High-level Instruction F0 (MV):

Use the high-level instruction **F0 (MV)** as described on the right in order to change the timer setting according to the input conditions.

Example: Change the setting from 5 seconds to 2 seconds when input X0 goes ON.

Refer to page 158, "**F0 (MV)** 16-bit data move" for details on the high-level instruction **F0 (MV)**.



• FP Programmer Ⅱ:

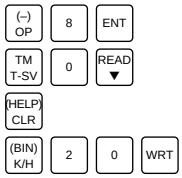
Example: Change the value of SV0 from K50 to K20.

Steps:

1) Monitor the status of the word data.
2) Search for SV0.
3) Clear the contents of SV0.
4) Write the new value.

Refer to the FP Programmer Ⅱ Operation Manual for details.

Key operations



• NPST-GR Software:

Select [MONITOR LIST RELAYS] in the on-line menu, read the relevant SV, and rewrite.
Refer to the NPST-GR Software Ver. 3 Manual for details.

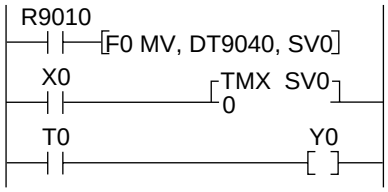
Notes:

- Even if the SV value is changed, the setting in the program will not be rewritten. The setting from the program is sent to the SV and changed only when the mode is changed back to RUN mode, or the next time the power is turned ON.
- When the SV value is rewritten, the currently operating timer will continue operating as-is. The EV value will not be changed until the next input ON condition.
- The value in elapsed value area EV can be changed in the same way.

• Example:

When fine-tuning the timing during trial operation, you can change the values of the special data registers DT9040 to DT9043, in the 0 to 255 range, using the potentiometers on the front of the main unit.

R9010: Always ON relay
DT9040: Manual dial-set register for V0.



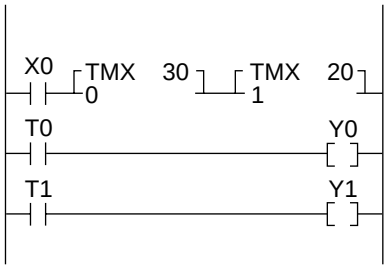
Note:

- Note that the timers are non-retentive. They will all be reset (set to 0) if the power is turned OFF, or the mode is changed from RUN to PROG. Set system register 6 to retain the run status.

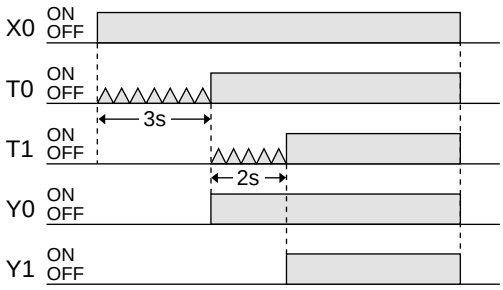
■ Application example

When using two timer instructions

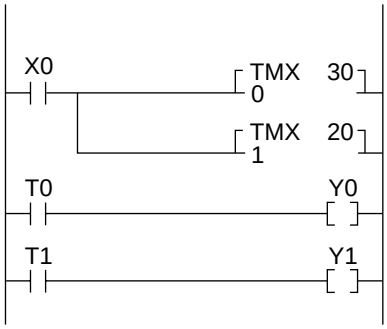
Program example 1



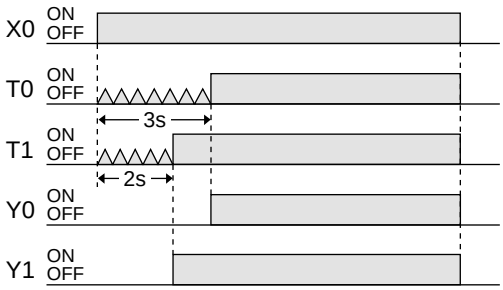

```
ST    X    0
TM    X    0
  K        30
TM    X    1
  K        20
ST    T    0
OT    Y    0
ST    T    1
OT    Y    1
```



Program example 2




```
ST    X    0
PSHS
TM    X    0
  K        30
POPS
TM    X    1
  K        20
ST    T    0
OT    Y    0
ST    T    1
OT    Y    1
```

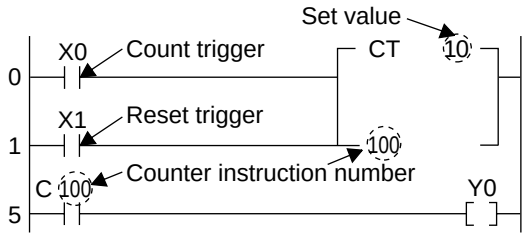


Step	Availability
3	All series

CT Counter

Outline Subtracts the preset counter.

Program example

Ladder Diagram	Boolean Non-ladder				FP Programmer II key operations
	Address	Instruction			
	0	ST	X	0	ST X-WX, ST X-WX, 0, WRT
	1	ST	X	1	ST X-WX, ST X-WX, 1, WRT
	2	CT		100	CT C-EV, 1, 0, 0, ENT
			K	10	(BIN) K/H, 1, 0, WRT
	5	ST	C	100	ST X-WX, CT C-EV, 1, 0, 0, WRT
	6	OT	Y	0	OT L-WL, AN Y-WY, 0, WRT

Counter instruction number	C14 and C16 series: up to 128 C24, C40, C56, and C72 series: up to 144 The number of the **CT** instructions is shared with that of the **TM** instructions. You can change the sharing of **TM** and **CT** instructions through the system registers. The default value of the **TM** and **CT** instructions is, for C14 and C16 series: **TM** instruction: 0 to 99, **CT** instruction: 100 to 127 for C24, C40, C56, and C72 series: **TM** instruction: 0 to 99, **CT** instruction: 100 to 143
Preset (Set) value	All series: K0 to K32767 Decimal constant or counter set value area (SVn)* whose number is the same as its timer instruction number (n) ***"SVn" can be specified only when the version of the CPU is 2.7 or later.**

■ Operands

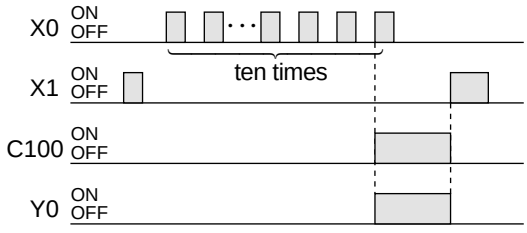
Instruction	Relay			Timer/Counter area		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
Preset (Set) value	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	A	N/A	N/A

A: Available
N/A: Not Available

■ Explanation of example

- In order to reset the counter, turns reset trigger X1 ON and then OFF.
- When the leading edge of the X0 is detected ten times, counter contact C100 turns ON and then Y0 goes ON.
- The elapsed value EV100 is reset when X1 turns ON.

■ Time chart



Description

- The **CT** instruction is a down type preset counter.
- If there are not enough **CT** instruction numbers, you can increase the number by changing the setting of system register 5. Refer to page 230, "8-5. System Registers", for details on how to change the number of contact numbers.
- When programming the **CT** instruction, be sure to program the count and reset triggers.
  Count trigger: subtract one count from elapsed value area EV each time its leading edge is detected.
  (trigger X0 in the example)
  Reset trigger: reset the counter when this is ON.
  (trigger X1 in the example)

■ Counter operation

• When the decimal constant "K" is specified as a set value:

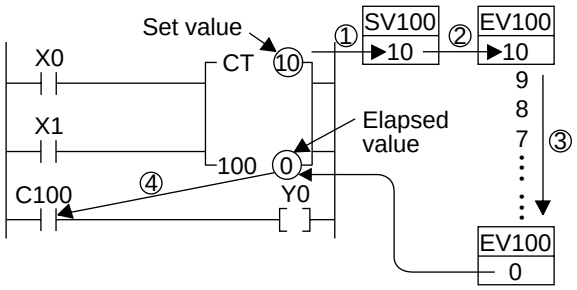
Procedure:

① When the mode of the programmable controller is set to RUN, K10 (decimal) is transferred to the set value area SV100.

② When reset trigger X1 turns ON, elapsed value area EV100 is reset. The value in the SV100 is transferred to the EV100 when the trailing edge of X1 is detected (ON → OFF).

③ Each time the leading edge of count trigger X0 is detected, one count is subtracted from the value in the elapsed value area EV100.

④ When the elapsed value area EV100 becomes 0, counter contact C100 turns ON and then Y0 goes ON.



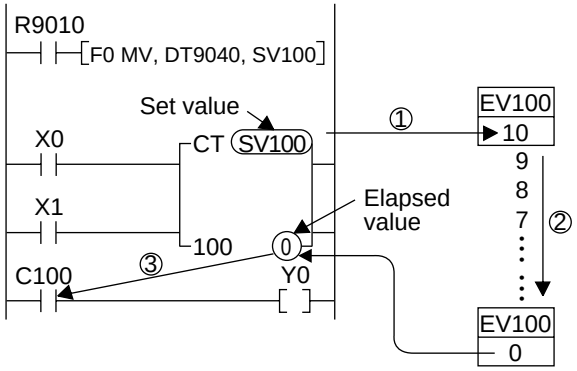
• When the "SVn" is specified as a preset value:

Procedure:

① When reset trigger X1 turns ON, elapsed value area EV100 is reset. The value in SV100 is transferred to the EV100 when the trailing edge of X1 is detected (ON → OFF).

② Each time the leading edge of count trigger X0 is detected, one count is subtracted from the value in the elapsed value area EV100.

③ When the elapsed value area EV100 becomes 0, counter contact C100 turns ON and then Y0 goes ON.



Notes:

- Even if the mode of the programmable controller is changed from PROG. to RUN, the set value is not set to the elapsed value area. If you need to preset the counter elapsed value area, be sure to turn the reset trigger ON and then OFF once before use.
- Counter set value area SV is a memory area for the counter setting.
- The counter contact goes ON when the value in the counter elapsed value area (EV) becomes 0. However, the value in the elapsed value area for the counter will also become 0 in a reset condition.

Continued

Notes:

- For each **CT** instruction, one SV and EV set and one contact C are supported as follows:

Counter instruction number	Set value area SV	Elapsed value area EV	Counter contact C
CT100	SV100	EV100	C100
⋮	⋮	⋮	⋮

- The counter is not reset even if the power is turned OFF, or the mode is changed from RUN to PROG. Set system register 6 if you need to set the counter non-hold type. Refer to page 232, "2. Table of System Registers", for details about system registers.
- When the count trigger and the reset trigger are detected simultaneously, the reset trigger has priority.

■ Changing the value in the Set Value Area (SV)

All the control units can change the value in the set value area (SV), even during RUN mode, using the high-level instruction **F0 (MV)** or the programming tool (FP Programmer Ⅱ or NPST-GR).

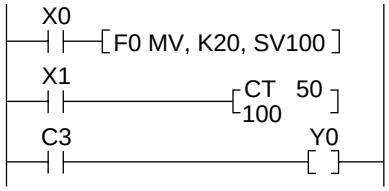
The range of values that can be specified in the set value area (SV) are:

C14 and C16 series: SV0 to SV127
C24, C40, C56, and C72 series: SV0 to SV143

• High-level Instruction F0 (MV):

Use the high-level instruction **F0 (MV)** as described below in order to change the counter setting according to the input conditions.

Example: Change the setting from 50 (K50) to 20 (K20) when input X0 goes ON.



Refer to page 158, "**F0 (MV)** 16-bit data move" for details on the high-level instruction **F0 (MV)**.

• FP Programmer Ⅱ:

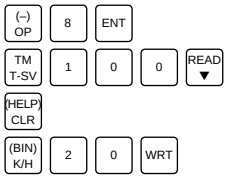
Example: Change the value of SV100 from K50 to K20.

Steps:

1) Monitor the status of the word data.
2) Search for SV100.
3) Clear the contents of SV100.
4) Write the new value.

Refer to the FP Programmer Ⅱ Operation Manual for details.

Key operations



• NPST-GR Software:

Select "MONITOR LIST RELAYS" in the on-line menu, read the relevant SV, and rewrite.
Refer to the NPST-GR Software Ver. 3 Manual for details.

Notes:

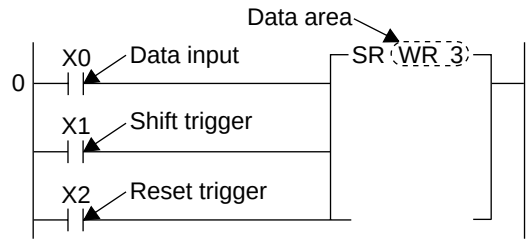
- Even if the SV value is changed, the setting in the program will not be rewritten. The setting from the program is sent to the SV and changed only when the mode is changed back to RUN, or the next time the power is turned ON.
- When the SV value is rewritten, the currently operating counter will continue operating as-is. The EV value will not be changed until the next time the reset trigger goes from ON to OFF.
- If the power is turned OFF, or the mode is switched from RUN to PROG., the counter status will be retained.
- The value in the elapsed value area (EV) can be changed in the same way.

SR Shift register

Step	Availability
1	All series

Outline Shifts one bit of 16-bit [word internal relay (WR)] data to the left.

Program example

Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	ST	X 1	ST X-WX, ST X-WX, 1, WRT
	2	ST	X 2	ST X-WX, ST X-WX, 2, WRT
	3	SR	WR 3	SHIFT SC, 3, SHIFT SC, OR R-WR, 3, WRT

Data area	16-bit data area (WR) whose one bit is shifted to the left

■ Operands

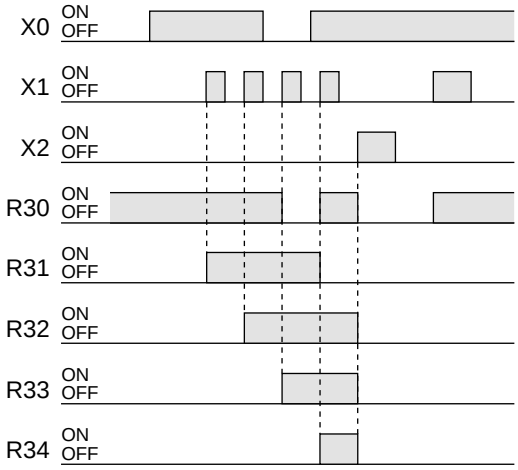
Operand	Relay			Timer/Counter area		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
SR	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

A: Available
N/A: Not Available

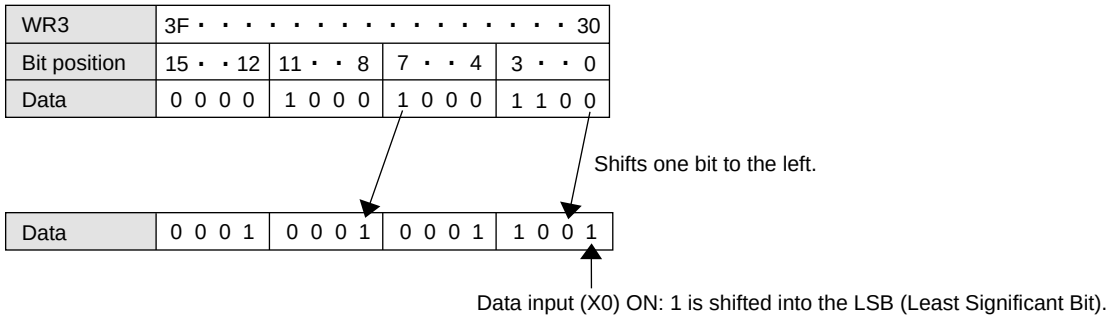
■ Explanation of example

- If shift trigger X1 turns ON when X2 is in the OFF state, the contents of the internal relay WR3 (internal relays R30 to R3F), are shifted one bit to the left.
- "1" is shifted in R30 if X0 is ON, and "0" is shifted in R30 if X0 is OFF.
- If reset trigger X2 turns ON (leading edge), the contents of WR3 are cleared (all bits in the WR3 become "0").

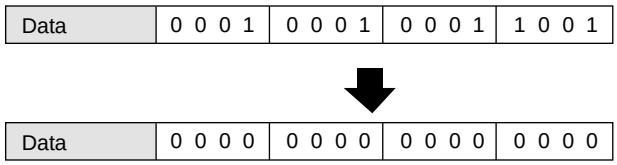
■ Time chart



When shift trigger (X1) is turned ON:



When reset trigger (X2) is turned ON:



Notes:

- Refer to page 6, “1-2. Explanation of Memory Areas”, for details about word internal relay (WR).
- Refer to page 146, “3. Operands for High-level Instructions”, for details about word internal relay (WR).
- Refer to page 139, “5-4. Hints for Programming Basic Instructions”, for details about basic instruction, such as the **SR** instruction, which are not displayed on the FP Programmer Ⅱ key.

Description

- Shifts one bit of the specified data area (WR) to the left (to the higher bit position).
- When programming the **SR** instruction, be sure to program the data input, shift and reset triggers.
  - Data input: specifies the state of new shift-in data
    - new shift-in data 1: when the input is ON
    - 0: when the input is OFF
  - Shift trigger: shifts one bit to the left when the leading edge of the trigger is detected
  - Reset trigger: turns all the bits of the data area to 0 when the trigger turns ON
- The area available for this instruction is only the word internal relay (WR).
  - Word internal relay (WR) number range:
  - C14 and C16 series: WR0 to WR15
  - C24, C40, C56, and C72 series: WR0 to WR62

Notes:

- The **SR** instruction needs data input, shift trigger, and reset trigger.
- When the reset trigger and the shift trigger are detected simultaneously, the reset trigger has priority.
- If the area is specified as the hold type, the data in the area is not reset (become “0”) when the mode is set to the RUN mode. If you need to reset the data, turn ON the reset trigger before use or change the settings of the system register 7.
- Refer to page 232, “2. Table of System Registers”, for details about system registers.
- **F119 (LRSR)**, **F100 (SHR)**, **F101 (SHL)**, **F120 (ROR)**, **F121 (ROL)**, **F122 (RCR)** and **F123 (RCL)** can also be used as shift register instructions.

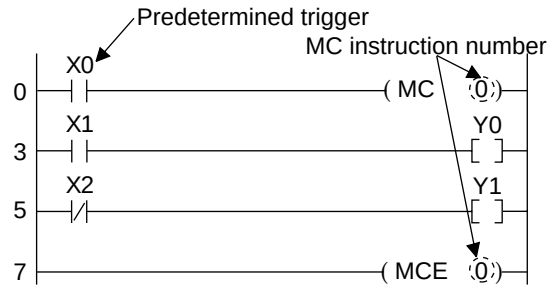
MC Master control relay

MCE Master control relay end

Step	Availability
2	All series
2	

Outline Executes the instructions from **MC** to **MCE** when the predetermined trigger (I/O) turns ON.

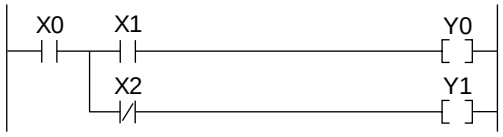
Program example

Ladder Diagram	Boolean Non-ladder			FP Programmer II key operations
	Address	Instruction		
	0	ST	X 0	ST X-WX, ST X-WX, 0, WRT
	1	MC	0	SHIFT SC, 4, SHIFT SC, 0, WRT
	3	ST	X 1	ST X-WX, ST X-WX, 1, WRT
	4	OT	Y 0	OT L-WL, AN Y-WY, 0, WRT
	5	ST/	X 2	ST X-WX, NOT DT/Ld, ST X-WX, 2, WRT
	6	OT	Y 1	OT L-WL, AN Y-WY, 1, WRT
	7	MCE	0	SHIFT SC, 5, SHIFT SC, 0, WRT

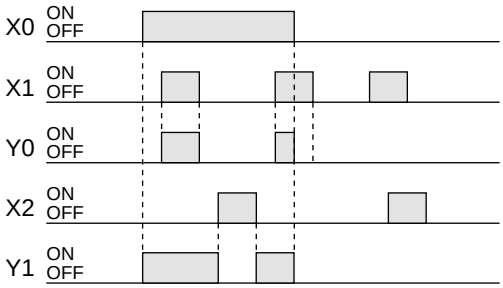
MC instruction number	C14 and C16 series: 0 to 15 (16 points) C24, C40, C56, and C72 series: 0 to 31 (32 points)

■ Explanation of example

- Executes the programs from the **MC** instruction to the **MCE** instruction when predetermined trigger X0 turns ON.
- The example program executes in the same way as the program below.



■ Time chart

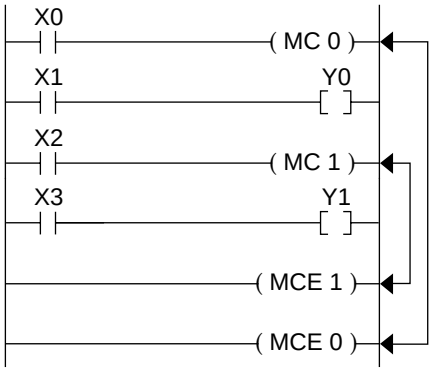


Description

- Executes programs from **MC** to **MCE** when the predetermined trigger turns ON.
- When the predetermined trigger is in the OFF state, the instructions between the **MC** and **MCE** instruction set operate as follows.

Instruction	I/O Condition
OT	All OFF
KP	Holds the state at the time just before the trigger turns OFF.
SET	
RST	
TM and **F137 (STMR)**	Reset
CT and **F118 (UDC)**	Holds the elapsed value at the time just before the trigger turns OFF.
SR and **F119 (LRSR)**	
Other instructions	Not executed

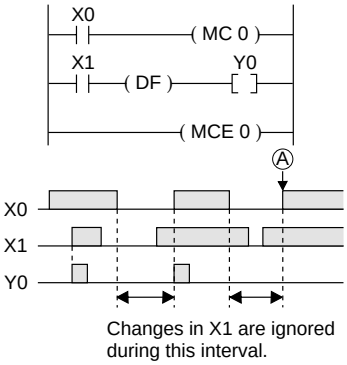
• Another master control instruction (**MC**, **MCE**) set can be programmed between one master control instruction set as shown on the right. This construction is called “nesting”.



Notes:

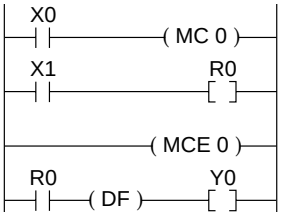
1. When programming **DF** and **DF/** instructions in the master control instruction set:
   The **DF** and **DF/** instructions remember their trigger state (ON or OFF) just before the trigger of the **MC** instruction turns OFF while the master control instruction set is in the OFF state.
   Be sure to pay attention to the following when the **DF** and **DF/** instructions are programmed.

   • Trigger to the **DF** or **DF/** instruction between the **MC** and **MCE** instruction set is ignored while the **MC** trigger is OFF.

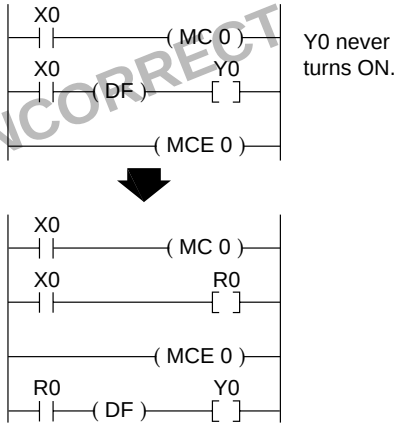


Changes in X1 are ignored during this interval.

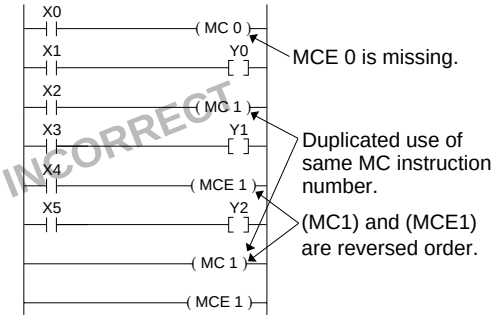
   • If, in the example above, output is required at point Ⓐ, place the **DF** or **DF/** instruction outside the **MC** and **MCE** instruction set.



   • If the same trigger is set for the **MC** and for the **DF** or **DF/** instruction, there will be no output. Place the **DF** or **DF/** instruction outside the **MC** and **MCE** instruction set when output is required.



2. The **MC** instruction cannot be started directly from the bus line. Be sure to include a contact input before the **MC** instruction in your program.
3. The program cannot be executed in the following conditions:
   - The trigger of the **MC** instruction is missing.
   - There are two or more master control instruction sets with the same number.
   - The order of the **MC** and **MCE** instructions are reversed.

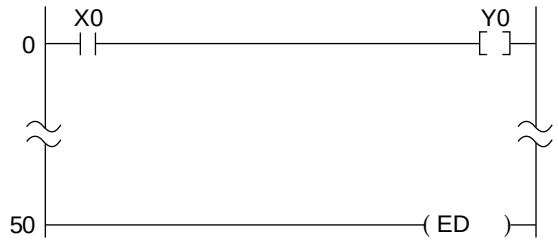
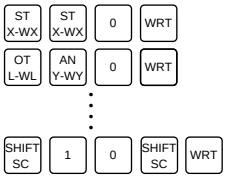


ED End

Step	Availability
1	All series

Outline Indicates the end of a main program.

Program example

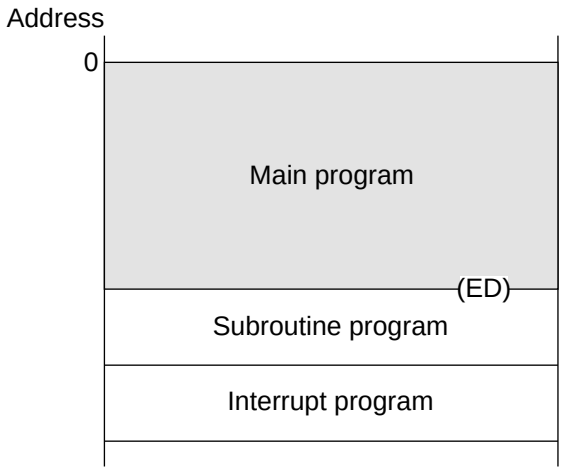
Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
	0 1 ⋮ 50	ST X 0 OT Y 0 ⋮ ED	

■ Explanation of example

• Step 50 is the end of the main program area.

Description

• Indicates the end of a main program.



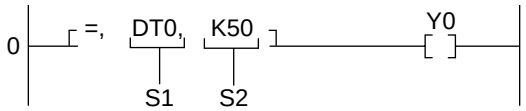
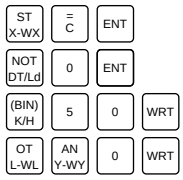
Notes:

- Place any subroutine programs and interrupt programs after the **ED** instruction.
- Use the **CNDE** instruction if end processing is necessary within the main program. Refer to FP-M/FP1 Programming Manual, for details about the **CNDE** instruction.
- Refer to page 139, “5-4. Hints for Programming Basic Instructions”, for details about basic instructions, such as the **ED** instruction, which are not displayed on the FP Programmer II keys.

		Step	Availability
ST =	**Word compare: Start equal**	5	**C24, C40, C56, and C72 series (CPU version 2.7 or later)**
ST <>	**Word compare: Start equal not**	5	
ST >	**Word compare: Start larger**	5	
ST >=	**Word compare: Start equal or larger**	5	
ST <	**Word compare: Start smaller**	5	
ST <=	**Word compare: Start equal or smaller**	5	

Outline Performs Start operation by comparing two word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
	0 5	ST = DT 0 K 50 OT Y 0	

S1	16-bit equivalent constant 16-bit area to be compared
S2	16-bit equivalent constant or 16-bit area to be compared

■ Operands

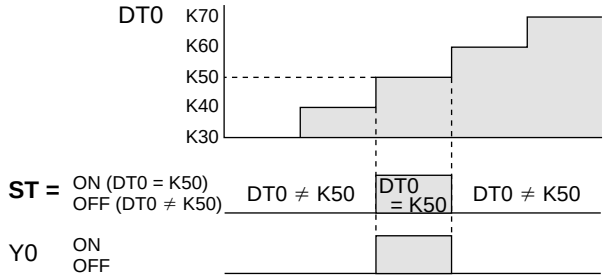
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

- Compares the contents of data register DT0 with the constant K50. If DT0 = K50, the external output relay Y0 goes ON.

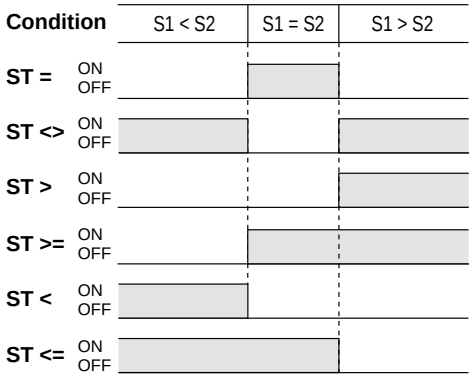
■ Time chart



Description

- Compares the word data specified by S1 with the word data specified by S2 according to the comparative conditions.
  The contact goes ON/OFF depending on the result of the comparison.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
ST =	S1 = S2	ON
	S1 ≠ S2	OFF
ST <>	S1 ≠ S2	ON
	S1 = S2	OFF
ST >	S1 > S2	ON
	S1 ≦ S2	OFF
ST >=	S1 ≧ S2	ON
	S1 < S2	OFF
ST <	S1 < S2	ON
	S1 ≧ S2	OFF
ST <=	S1 ≦ S2	ON
	S1 > S2	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

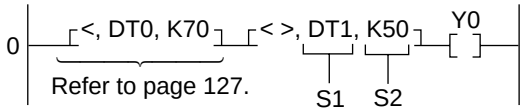
Notes:

- The Start comparison instructions **ST =**, **ST <>**, **ST >**, **ST >=**, **ST <**, and **ST <=** are programmed from the bus line.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.

		Step	Availability
AN =	**Word compare: AND equal**	5	**C24, C40, C56, and C72 series (CPU version 2.7 or later)**
AN <>	**Word compare: AND equal not**	5	
AN >	**Word compare: AND larger**	5	
AN >=	**Word compare: AND equal or larger**	5	
AN <	**Word compare: AND smaller**	5	
AN <=	**Word compare: AND equal or smaller**	5	

Outline Performs AND operation by comparing two word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison. The contacts are connected serially.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
	0	ST <	ST X-WX, ≤ E, ENT
		DT 0	NOT DT/Ld, 0, ENT
		K 70	(BIN) K/H, 7, 0, WRT
	5	AN <>	AN Y-WY, ≤ E, > F, ENT
		DT 1	NOT DT/Ld, 1, ENT
		K 50	(BIN) K/H, 5, 0, WRT
	10	OT Y 0	OT L-WL, AN Y-WY, 0, WRT

S1	16-bit equivalent constant or 16-bit area to be compared
S2	16-bit equivalent constant or 16-bit area to be compared

■ Operands

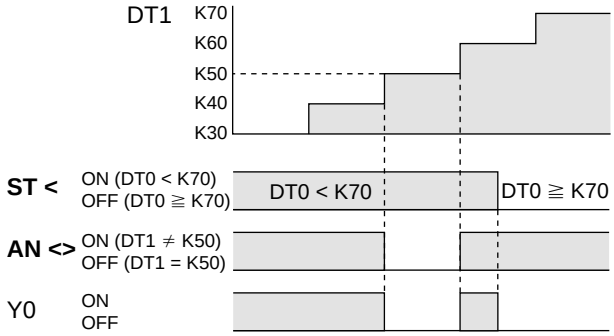
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

• Compares the contents of data register DT0 with the constant K70 and compares the contents of data register DT1 with the constant K50. If DT0 < K70 and DT1≠K50, the external output relay Y0 goes ON.

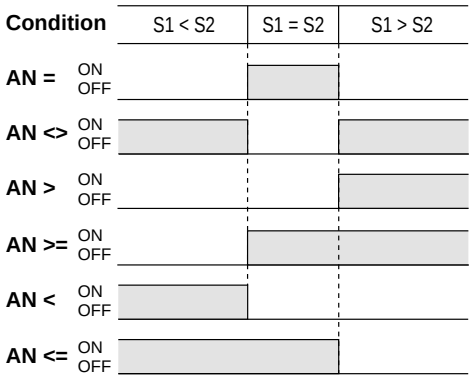
■ Time chart



Description

- Compares the word data specified by S1 with the word data specified by S2 according to the comparative conditions.
  The contact goes ON/OFF depending on the result of the comparison.
  The contacts are connected serially.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
AN =	S1 = S2	ON
	S1 ≠ S2	OFF
AN <>	S1 ≠ S2	ON
	S1 = S2	OFF
AN >	S1 > S2	ON
	S1 ≦ S2	OFF
AN >=	S1 ≧ S2	ON
	S1 < S2	OFF
AN <	S1 < S2	ON
	S1 ≧ S2	OFF
AN <=	S1 ≦ S2	ON
	S1 > S2	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

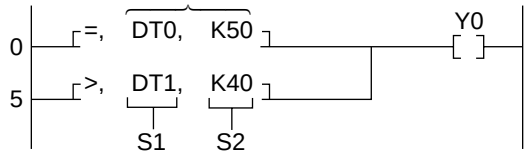
Notes:

- Multiple AND comparison instructions **AN =**, **AN <>**, **AN >**, **AN >=**, **AN <**, and **AN <=** can be used consecutively.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.

		Step	Availability
OR =	**Word compare: OR equal**	5	**C24, C40, C56, and C72 series (CPU version 2.7 or later)**
OR <>	**Word compare: OR equal not**	5	
OR >	**Word compare: OR larger**	5	
OR >=	**Word compare: OR equal or larger**	5	
OR <	**Word compare: OR smaller**	5	
OR <=	**Word compare: OR equal or smaller**	5	

Outline Performs OR operation by comparing two word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison. The contacts are connected in parallel.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
Refer to page 127. 	0	ST =	ST X-WX, = C, ENT
		DT 0	NOT DT/Ld, 0, ENT
		K 50	(BIN) K/H, 5, 0, WRT
	5	OR >	OR R-WR, > F, ENT
		DT 1	NOT DT/Ld, 1, ENT
		K 40	(BIN) K/H, 4, 0, WRT
	10	OT Y 0	OT L-WL, AN Y-WY, 0, WRT

S1	16-bit equivalent constant or 16-bit area to be compared
S2	16-bit equivalent constant or 16-bit area to be compared

■ Operands

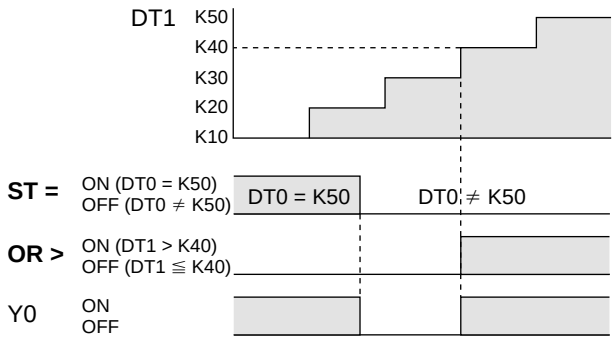
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

- Compares the contents of data register DT0 with the constant K50 and compares the contents of data register DT1 with the constant K40. If either DT0 = K50 or DT1 > K40, the external output relay Y0 goes ON.

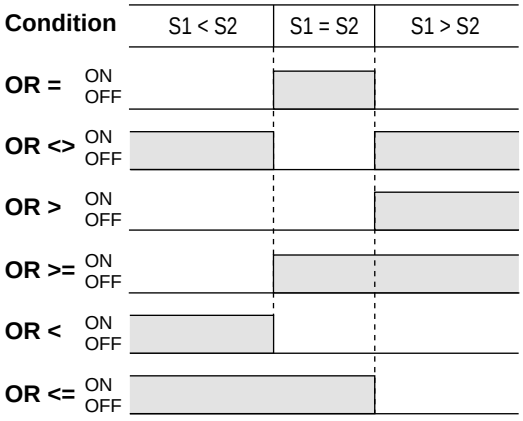
■ Time chart



Description

- The contact goes ON/OFF depending on the result of the comparison. The contacts are connected in parallel.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
OR =	S1 = S2	ON
	S1 ≠ S2	OFF
OR <>	S1 ≠ S2	ON
	S1 = S2	OFF
OR >	S1 > S2	ON
	S1 ≦ S2	OFF
OR >=	S1 ≧ S2	ON
	S1 < S2	OFF
OR <	S1 < S2	ON
	S1 ≧ S2	OFF
OR <=	S1 ≦ S2	ON
	S1 > S2	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

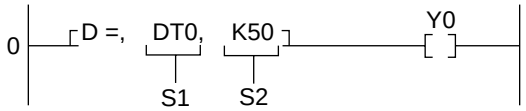
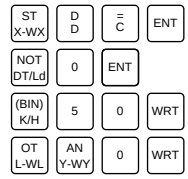
Notes:

- The OR comparison instructions **OR =**, **OR <>**, **OR >**, **OR >=**, **OR <**, and **OR <=** are programmed from the bus line.
- Multiple OR comparison instructions **OR =**, **OR <>**, **OR >**, **OR >=**, **OR <**, **OR <=** can be used consecutively.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.

		Step	Availability
STD =	**Double word compare: Start equal**	9	**C24, C40, C56, and C72 series (CPU version 2.7 or later)**
STD <>	**Double word compare: Start equal not**	9	
STD >	**Double word compare: Start larger**	9	
STD >=	**Double word compare: Start equal or larger**	9	
STD <	**Double word compare: Start smaller**	9	
STD <=	**Double word compare: Start equal or smaller**	9	

Outline Performs Start operation by comparing two double word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
	0 9	STD = DT 0 K 50 OT Y 0	

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared

■ Operands

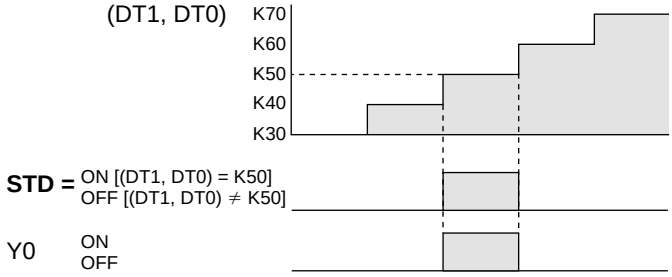
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

- Compares the contents of data registers (DT1, DT0) with the constant K50. If (DT1, DT0) = K50, the external output relay Y0 goes ON.

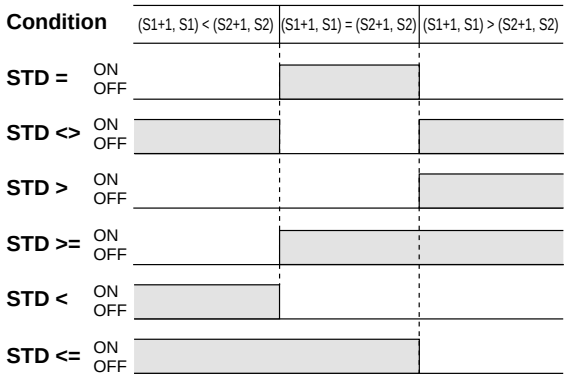
■ Time chart



Description

- Compares the double word data specified by S1 and S1+1, with the double word data specified by S2 and S2+1, according to the comparative conditions.
  The contact goes ON/OFF depending on the result of the comparison.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
STD =	(S1+1, S1) = (S2+1, S2)	ON
	(S1+1, S1) ≠ (S2+1, S2)	OFF
STD <>	(S1+1, S1) ≠ (S2+1, S2)	ON
	(S1+1, S1) = (S2+1, S2)	OFF
STD >	(S1+1, S1) > (S2+1, S2)	ON
	(S1+1, S1) ≦ (S2+1, S2)	OFF
STD >=	(S1+1, S1) ≧ (S2+1, S2)	ON
	(S1+1, S1) < (S2+1, S2)	OFF
STD <	(S1+1, S1) < (S2+1, S2)	ON
	(S1+1, S1) ≧ (S2+1, S2)	OFF
STD <=	(S1+1, S1) ≦ (S2+1, S2)	ON
	(S1+1, S1) > (S2+1, S2)	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

Notes:

- The Start comparison instructions **STD =**, **STD <>**, **STD >**, **STD >=**, **STD <**, and **STD <=** are programmed from the bus line.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.
- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1) are automatically decided if the lower 16-bit areas (S1, S2) are specified.

		Step	Availability
AND =	**Double word compare: AND equal**	9	**C24, C40, C56, and C72 series (CPU version 2.7 or later)**
AND <>	**Double word compare: AND equal not**	9	
AND >	**Double word compare: AND larger**	9	
AND >=	**Double word compare: AND equal or larger**	9	
AND <	**Double word compare: AND smaller**	9	
AND <=	**Double word compare: AND equal or smaller**	9	

Outline Performs AND operation by comparing two double word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison. The contacts are connected serially.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
0 D <, DT0, K70 D < >, DT10, K50 Y0	0	STD <	ST X-WX, D D, < E, ENT
Refer to page 133. S1 S2		DT 0	NOT DT/Ld, 0, ENT
		K 70	(BIN) K/H, 7, 0, WRT
	9	AND <>	AN Y-WY, D D, < E, > F, ENT
		DT 10	NOT DT/Ld, 1, 0, ENT
		K 50	(BIN) K/H, 5, 0, WRT
	18	OT Y 0	OT L-WL, AN Y-WY, 0, WRT

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared

■ Operands

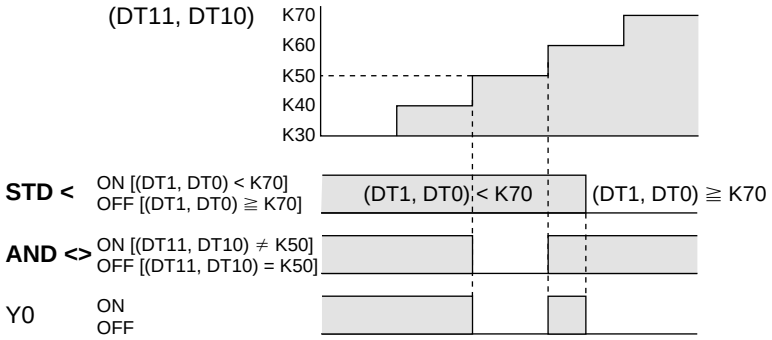
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

- Compares the contents of data registers (DT1, DT0) with the constant K70 and compares the contents of data registers (DT11, DT10) with the constant K50. If (DT1, DT0) < K70 and (DT11, DT10) ≠ K50, the external output relay Y0 goes ON.

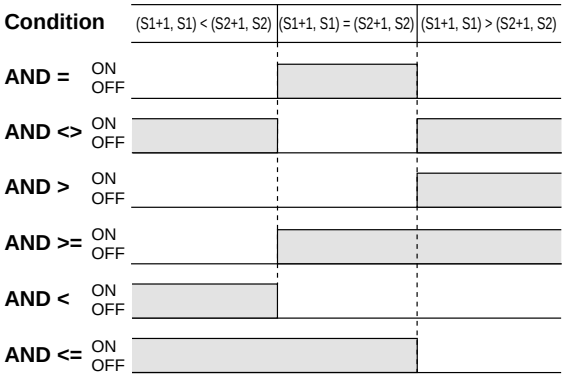
■ Time chart



Description

- Compares the double word data specified by S1 and S1+1, with the double word data specified by S2 and S2+1, according to the comparative conditions. The contact goes ON/OFF depending on the result of the comparison. The contacts are connected serially.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
AND =	(S1+1, S1) = (S2+1, S2)	ON
	(S1+1, S1) ≠ (S2+1, S2)	OFF
AND <>	(S1+1, S1) ≠ (S2+1, S2)	ON
	(S1+1, S1) = (S2+1, S2)	OFF
AND >	(S1+1, S1) > (S2+1, S2)	ON
	(S1+1, S1) ≦ (S2+1, S2)	OFF
AND >=	(S1+1, S1) ≧ (S2+1, S2)	ON
	(S1+1, S1) < (S2+1, S2)	OFF
AND <	(S1+1, S1) < (S2+1, S2)	ON
	(S1+1, S1) ≧ (S2+1, S2)	OFF
AND <=	(S1+1, S1) ≦ (S2+1, S2)	ON
	(S1+1, S1) > (S2+1, S2)	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

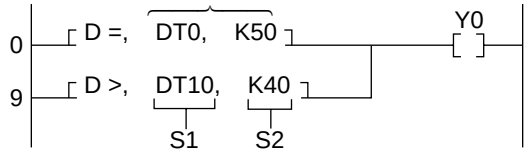
Notes:

- Multiple AND comparison instructions **AND =**, **AND <>**, **AND >**, **AND >=**, **AND <**, and **AND <=** can be used consecutively.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.
- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1) are automatically decided if the lower 16-bit areas (S1, S2) are specified.

		Step	Availability
ORD =	Double word compare: OR equal	9	C24, C40, C56, and C72 series (CPU version 2.7 or later)
ORD <>	Double word compare: OR equal not	9	
ORD >	Double word compare: OR larger	9	
ORD >=	Double word compare: OR equal or larger	9	
ORD <	Double word compare: OR smaller	9	
ORD <=	Double word compare: OR equal or smaller	9	

Outline Performs OR operation by comparing two double word data in the comparative conditions. The contact goes ON/OFF depending on the result of the comparison. The contacts are connected in parallel.

Program example

Ladder Diagram	Boolean Non-ladder		FP Programmer II key operations
	Address	Instruction	
Refer to page 133. 	0	STD =	ST X-WX, D D, = C, ENT
		DT 0	NOT DT/Ld, 0, ENT
		K 50	(BIN) K/H, 5, 0, WRT
	9	ORD >	OR R-WR, D D, > F, ENT
		DT 10	NOT DT/Ld, 1, 0, ENT
		K 40	(BIN) K/H, 4, 0, WRT
	18	OT Y 0	OT L-WL, AN Y-WY, 0, WRT

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared

■ Operands

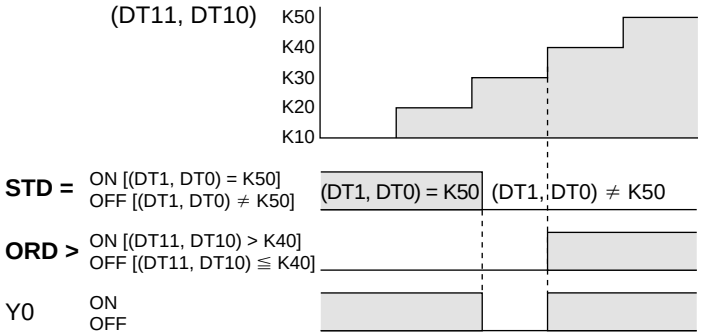
Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

- Compares the contents of data registers (DT1, DT0) with the constant K50 and compares the contents of data registers (DT11, DT10) with the constant K40. If either (DT1, DT0) = K50 or (DT11, DT10) > K40, the external output relay Y0 goes ON.

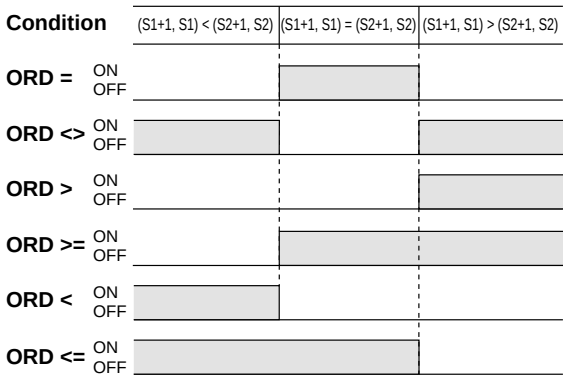
■ Time chart



Description

- Compares the double word data specified by S1 and S1+1, with the double word data specified by S2 and S2+1, according to the comparative conditions. The contact is connected in parallel depending on the results of the comparative conditions.
- The result of the comparison operation is as follows:

Comparative instruction	Comparative condition	Contact operation
ORD =	(S1+1, S1) = (S2+1, S2)	ON
	(S1+1, S1) ≠ (S2+1, S2)	OFF
ORD <>	(S1+1, S1) ≠ (S2+1, S2)	ON
	(S1+1, S1) = (S2+1, S2)	OFF
ORD >	(S1+1, S1) > (S2+1, S2)	ON
	(S1+1, S1) ≦ (S2+1, S2)	OFF
ORD >=	(S1+1, S1) ≧ (S2+1, S2)	ON
	(S1+1, S1) < (S2+1, S2)	OFF
ORD <	(S1+1, S1) < (S2+1, S2)	ON
	(S1+1, S1) ≧ (S2+1, S2)	OFF
ORD <=	(S1+1, S1) ≦ (S2+1, S2)	ON
	(S1+1, S1) > (S2+1, S2)	OFF



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

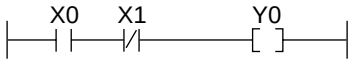
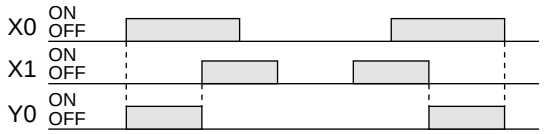
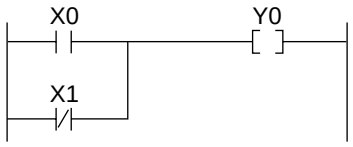
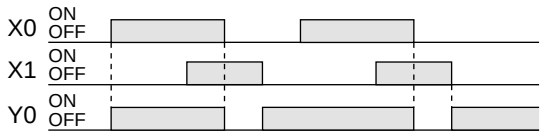
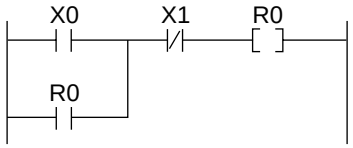
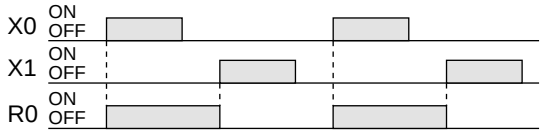
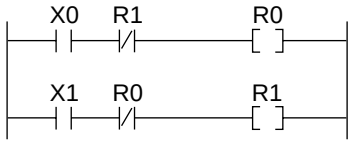
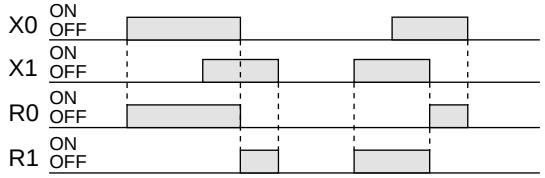
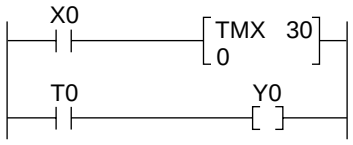
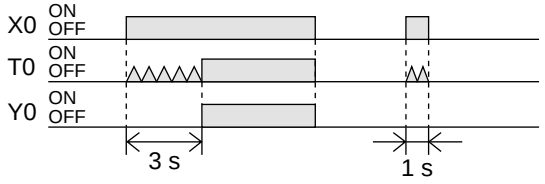
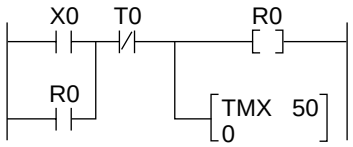
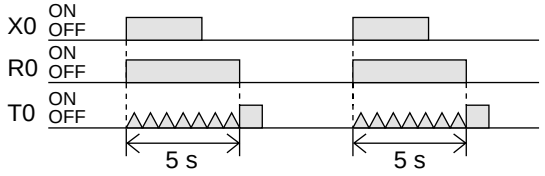
- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

Notes:

- The OR comparison instructions **ORD =**, **ORD <>**, **ORD >**, **ORD >=**, **ORD <**, and **ORD <=** are programmed from the bus line.
- Multiple OR comparison instructions **ORD =**, **ORD <>**, **ORD >**, **ORD >=**, **ORD <**, **ORD <=** can be used consecutively.
- This instruction can be input only with FP Programmer Ⅱ or NPST-GR version 3.1 or later.
- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1) are automatically decided if the lower 16-bit areas (S1, S2) are specified.

5-4. Hints for Programming Basic Instructions

1. Basic Circuit with Basic Instructions

Item	Ladder Diagram	Time Chart
AND & AND Not operation		
OR & OR Not operation		
Self-hold circuit		
Interlock circuit		
ON-delay timer circuit		
One shot circuit		

2. Basic Instructions not Displayed on the Keys of FP Programmer II

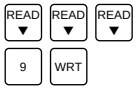
1) When You do not Know the Basic Instruction Codes for the FP Programmer II

Procedure:

1. The instruction code list is appeared on the screen when press the SHIFT SC (HELP) CLR keys as follows.

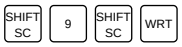
0 = DF	1 = NOP
2 = KP	3 = SR

2. Press the READ ▼ or SRC ▲ to find desired instruction code.
3. Press the desired instruction code (For example, press “9” as “**PSHS**” instruction.) and WRT key.



2) When You Know the Basic Instruction Codes for the FP Programmer II

- Press the desired instruction code (For example, press “9” as instruction code of “**PSHS**” instruction.) directly.
- Refer to “FP Programmer II Operation Manual”, for details about key operation.



3) Table of Instruction Codes for the FP Programmer II

Instruction Name	Boolean	Instruction Code
Leading edge differential	DF	0
No operation	NOP	1
Keep	KP	2
Shift register	SR	3
Leading edge differential	MC	4
Leading edge differential	MCE	5
Jump	JP	6
Label	LBL	7
Loop	LOOP	8
Push stack	PSHS	9
Read stack	RDS	A
Pop stack	POPS	B
Start step	SSTP	C

Instruction Name	Boolean	Instruction Code
Next step	NSTP	D
Clear step	CSTP	E
Step end	STPE	F
End	ED	10
Conditional end	CNDE	11
Subroutine call	CALL	12
Subroutine entry	SUB	13
Subroutine return	RET	14
Interrupt control	ICTL	15
Interrupt	INT	16
Interrupt return	IRET	17
Break	BRK	18
Set	SET	19
Reset	RST	1A
Next step level type	NSTL	1B

3. Duplicated Use of Outputs

1) Duplicated Output

- Duplicate use of same number designation in the **KP** and **OT** instructions is prohibited.
  Even if the same output is used for multiple application instructions, such as the **SET** or **RST** instruction, or a data transfer instruction, it is not regarded as duplicated output.
- If you enter RUN mode while the duplicated output condition exists, under normal conditions, it will be flagged as an error, the ERR LED will light and the special internal relay R9000 (self-diagnostic flag) will go ON.

2) How to Check for Duplicated Use

You can check for duplicated outputs in the program using the programming tool (FP Programmer II or NPST-GR), by the following method:

- FP Programmer Ⅱ:
  Operate the OP function “OP-9 TOTAL CHECK”.
  (Key operation: (–) OP, 9, ENT, READ ▼)
  If there are any duplicated outputs, an error message (DUP USE) and the address number will be displayed.
  Refer to “FP Programmer Ⅱ Operation Manual”, for details about OP function.
- NPST-GR:
  Select the “PROGRAM CHECK” on NPST FUNCTION MENU.
  If there are any duplicated outputs, an error message (DUPLICATE USE ERROR) and the address numbers will be displayed. If you execute <SRCH ERROR ADRS>, the error message will be displayed, and the first address number will be displayed.
  Refer to “NPST-GR Manual”, for details about program check.

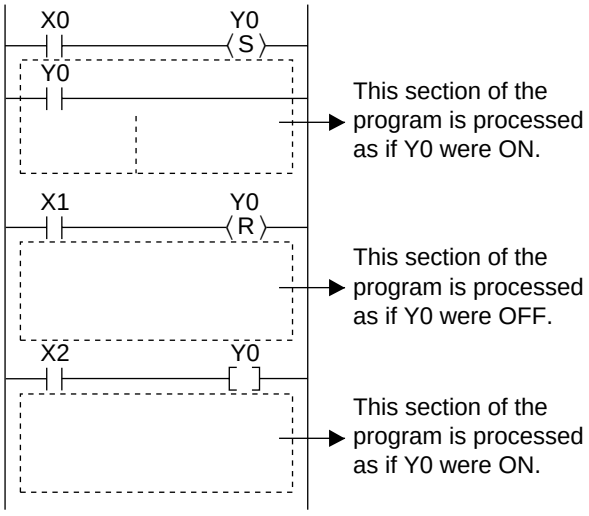
3) Enabling Duplicated Output

- If the duplicate output is set to “enable (K1)” in system register 20, the error does not occur.
- Refer to page 230, “8-5. System Registers”, for details about duplicate output.

4) Output State in One Scan

- If the same output is used by multiple instructions such as the **OT**, **KP**, **SET**, **RST**, or data transfer instructions, the output obtained at the I/O update is determined by the results of the operation at the greatest program address.

Example:
The contents of the output at each step when X0 to X2 are all ON and the output from the **SET**, **RST** and **OT** instructions overlap.



When X0 to X2 are all ON, Y0 is output as ON at I/O update according to the result of X2 trigger.

CHAPTER 6

HIGH-LEVEL INSTRUCTIONS

6-1. Configuration of High-level Instructions

1. Types of High-level Instructions

• In the FP1 Control Unit, the following high-level instructions are available:

Data Transfer Instructions:
These instructions copy or exchange the 16-bit or 32-bit data.

BIN Arithmetic Instructions:
These instructions add, subtract, multiply, or divide the 16-bit or 32-bit data.

BCD Arithmetic Instructions:
These instructions add, subtract, multiply, or divide the BCD data.

Data Comparison Instructions:
These instructions compare the 16-bit or 32-bit data.

Logic Operation Instructions:
These instructions perform the logic operations (AND, OR, Exclusive OR, Exclusive NOR).

Data Conversion Instructions:
These instructions convert the 16-bit or 32-bit data to the specific format.

Data Shift Instructions:
These instructions shift the data in units of words or of hexadecimal digits.

Up/Down Counter and Left/Right Shift Register Instructions:
These are the up/down counter and left/right shift register instructions.

Data Rotate Instructions:
These instructions rotate the data to right or left.

Bit Manipulation Instructions:
These instructions handle the data in units of bits.

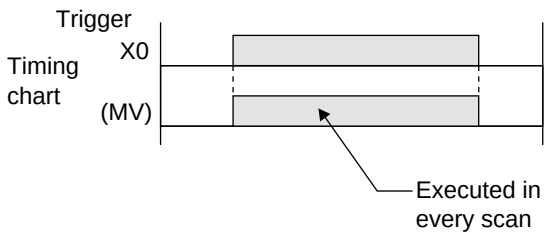
Auxiliary Timer Instruction:
This is the auxiliary timer instruction (0.01 s unit ON-delay timer).

Special Instructions:
These instructions perform the special functions to control FP1 operation.

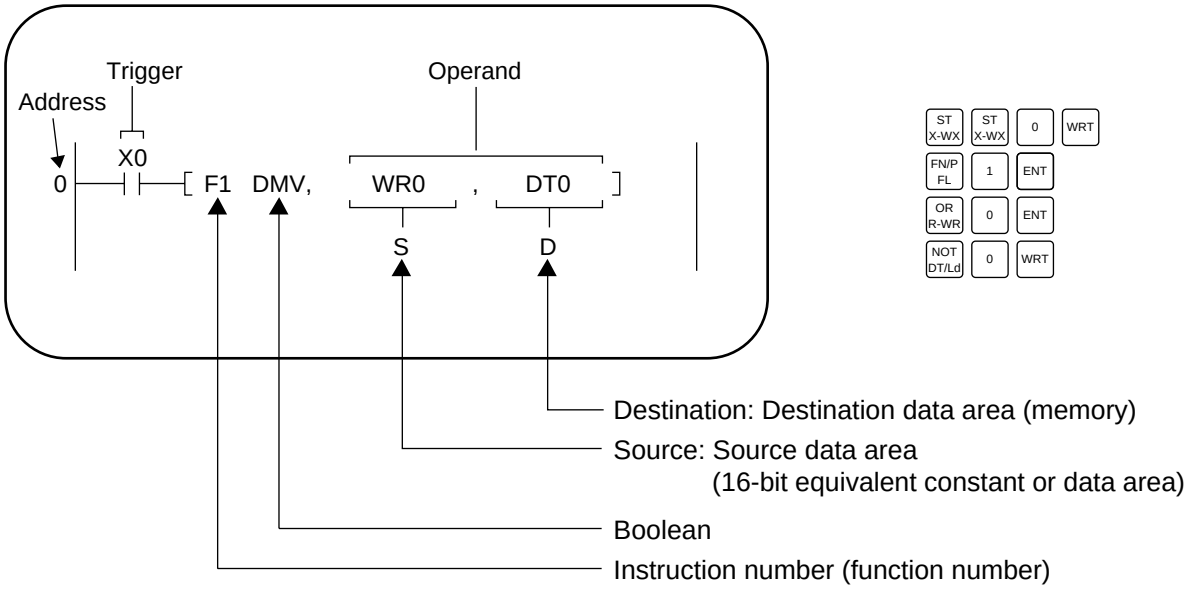
High-speed Counter Special Instructions:
These instructions perform the special high-speed counter functions.

2. Configuration of High-level Instructions

- The high-level instructions are expressed as high-level instruction numbers, boolean and operands.
- The high-level instruction numbers (**F0** to **F165**) are used for inputting high-level instructions.
- The high-level instructions should be programmed with the trigger.
- Note that the number and the type of operands [source (S) and destination (D)] specified in the high-level instruction depend upon the instruction. Refer to each high-level instruction for details.



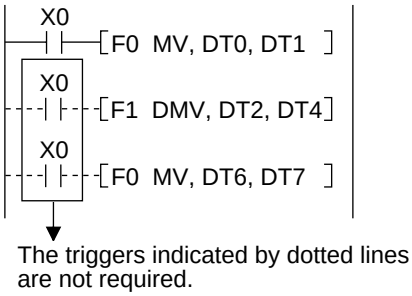
Screen of NPST-GR Software in Boolean ladder mode



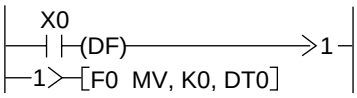
Key operation of FP Programmer II

Notes:

- There is no need to program the same triggers many times when two or more high-level instructions are programmed consecutively with the same trigger.
  In the program example shown right, the X0 for second and third instructions can be omitted.



- Program a **DF** instruction when the instruction should be executed once at the leading edge of the trigger.

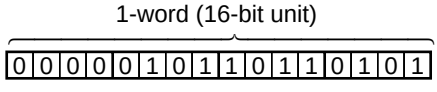


3. Operands for High-level Instructions

<table>
<tr><th colspan="2" rowspan="2">Item</th><th rowspan="2">Function</th><th colspan="3">Numbering</th></tr>
<tr><th>C14/C16</th><th>C24/C40</th><th>C56/C72</th></tr>
<tr><td rowspan="3">Relay</td><td>Word external input relay (WX)</td><td>“WX” expresses an external input relay “X”.
“WX” handles the external input relays “X” in units of words (1 word = 16 bits).
Therefore, “WX0” means 16 bits from “X0” to “XF”.</td><td colspan="3">WX0 to WX12
(= X0 to X12F)</td></tr>
<tr><td>Word external output relay (WY)</td><td>“WY” expresses an external output relay “Y”.
“WY” handles the external output relays “Y” in units of words (1 word = 16 bits).
Therefore, “WY1” means 16 bits from “Y10” to “Y1F”.</td><td colspan="3">WY0 to WY12
(= Y0 to Y12F)</td></tr>
<tr><td>Word internal relay (WR)</td><td>“WR” expresses an internal relay “R”.
“WR” handles the internal relays in units of words (1 word = 16 bits).
Therefore, “WR2” means 16 bits from “R20” to “R2F”.</td><td>WR0
to
WR15
(= R0 to R15F)</td><td colspan="2">WR0 to WR62
(= R0 to R62F)</td></tr>
<tr><td rowspan="2">Timer/ Counter area</td><td>Timer/Counter set value area (SV)</td><td>“SV” is a memory area where the preset (set) value of the TM/CT instructions is stored.
Each “SV” consists of 16 bits.
The address of this memory area corresponds to the TM/CT instruction number.</td><td>SV0
to
SV127</td><td colspan="2">SV0 to SV143</td></tr>
<tr><td>Timer/Counter elapsed value area (EV)</td><td>“EV” is a memory area where the count (elapsed) value of the TM/CT instructions is stored.
Each “EV” consists of 16 bits.
The address of this memory area corresponds to the TM/CT instruction number.</td><td>EV0
to
EV127</td><td colspan="2">EV0 to EV143</td></tr>
<tr><td rowspan="2">Register</td><td>Data register (DT)</td><td>“DT” is a memory area for data processed within the programmable controllers and each “DT” consists of 16 bits.</td><td>DT0
to
DT255</td><td>DT0
to
DT1659</td><td>DT0
to
DT6143</td></tr>
<tr><td>Special data register (DT)</td><td>The special data register is a memory area that has special applications. Refer to page 226, “8-4. Table of Special Data Registers” for details about the special data register.</td><td colspan="3">DT9000 to DT9069</td></tr>
<tr><td>Index register</td><td>Index register (IX, IY)</td><td>The index register can be used as an address modifier for WX, WY, WR, SV, EV, DT, K and H. Refer to page 193, “2. How to Use Index Registers (IX, IY)”.</td><td colspan="3">IX, IY</td></tr>
<tr><td rowspan="4">Constant</td><td rowspan="2">Decimal constant (K)</td><td rowspan="2">Decimal constants</td><td colspan="3">16-bit constant (word):
K-32768 to K32767</td></tr>
<tr><td colspan="3">32-bit constant (double word):
K-2147483648 to K2147483647</td></tr>
<tr><td rowspan="2">Hexadecimal constant (H)</td><td rowspan="2">Hexadecimal constants</td><td colspan="3">16-bit constant (word):
H0 to HFFFF</td></tr>
<tr><td colspan="3">32-bit constant (double word):
H0 to HFFFFFFFF</td></tr>
</table>

■ Registers and Constants

- The word relays (WX, WY, WR), timer/counter area (SV, EV), register (DT), index registers (IX, IY) and constants (K, H) consist of 1 word (16 bits) and are handled as word units.

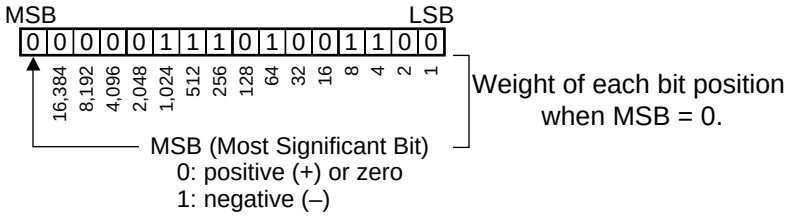


- The word addresses are expressed in decimals.

■ Data Handled in the FP1 Programmable Controller

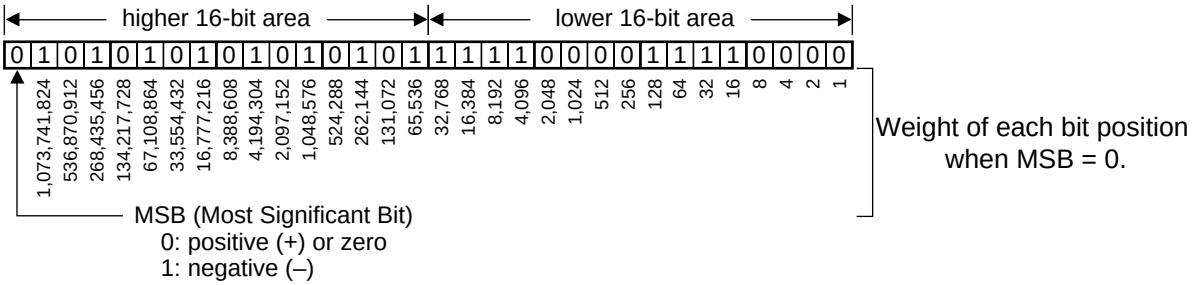
• The FP1 Programmable Controller can handle data in 16-bit units (word) or 32-bit units (double word).

<16-bit data>



16-bit binary data	Decimal constants	4-digit hexadecimal constants
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	K 32767	H 7 F F F
• • •	• • •	• • •
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1	K 1	H 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	K 0	H 0 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	K – 1	H F F F F
• • •	• • •	• • •
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	K – 32768	H 8 0 0 0

<32-bit data>

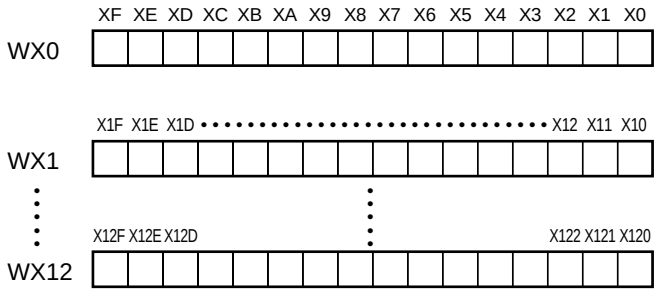


32-bit binary data	Decimal constants	4-digit hexadecimal constants
0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	K 2147483647	H 7 F F F F F F F
• • •	• • •	• • •
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1	K 1	H 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	K 0	H 0 0 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	K – 1	H F F F F F F F F
• • •	• • •	• • •
1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	K – 2147483648	H 8 0 0 0 0 0 0 0

■ Word external input relay (WX), Word external output relay (WY) and Word internal relay (WR)

- "WX", "WY" and "WR" express the relays (X, Y and R). This word format treats the 16-bit relay groupings as one word.
- The word relay addresses (WX, WY and WR) can also be expressed by bit addresses using X, Y, and R, as follows.

Example: Word external input relay (WX)



- The contents of the word relay correspond to the state of its relays (components).

When the data of WR0 is K0 (decimal), if R0 and R1 are turned ON, its data becomes K3 (decimal). In the same way, if the data of WR0 is changed from K0 to K3, this means that R0 and R1 are turned ON.

■ Hold and non-hold settings of the data register (DT)

- The terms "hold" and "non-hold" are specified as;

  Hold area: the memory area whose contents will not be lost or modified if the operating power is lost or if the mode of the programmable controller is changed from RUN to PROG.

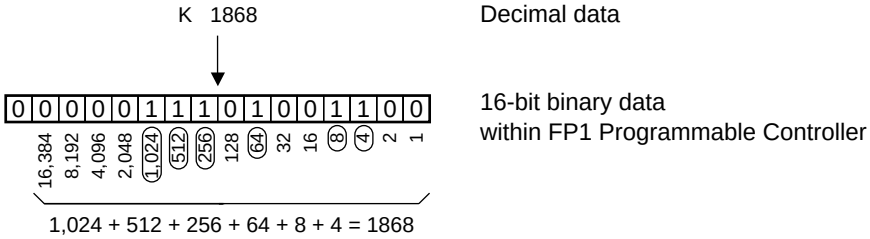
  Non-hold area: the memory area whose contents will be lost or modified if the operating power is lost or if the mode of the programmable controller is changed from RUN to PROG.
- Settings of "hold" or "non-hold" for the data register (DT) can be performed by changing the setting in system register 8.
  Refer to page 230, "8-5. System Registers", for details about the settings of hold type and non-hold types.
- The default value in system register 8 is "0" and all the data registers (DT) are set as hold type.

■ Constant (Decimal and Hexadecimal)

Decimal constant(K constant)

- Use of the decimal constant is most common and it is mainly used to input data to the programmable controllers. Some data such as the timer/counter set (preset) value should be programmed using this decimal constant. The decimal constant is expressed by adding the prefix "K" to the data.
- The decimal constant input to the FP1 is converted internally to binary and then processed.

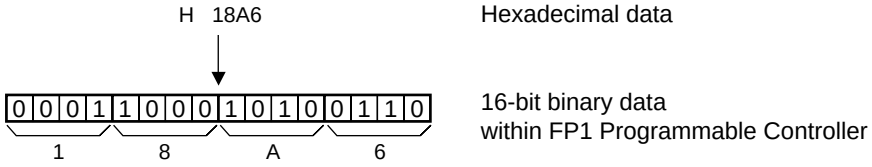
Example: When K1868 (decimal) is input to the FP1.



Hexadecimal constant (H constant)

• The hexadecimal constant is used to represent binary numbers with fewer digits. The hexadecimal number system uses one digit to represent four binary digits (bits). The hexadecimal constant is expressed by adding the prefix “H” to the data.

Example: When H18A6 (hexadecimal) is input to the FP1.



• The data processed in the programmable controllers can be monitored as binary (B), decimals (K), hexadecimals (H), or ASCII (A) using the FP Programmer Ⅱ or NPST-GR Software.

• Refer to the programming tool manual of the FP Programmer Ⅱ or NPST-GR Software, for details about the data monitoring method.

6-2. Table of High-level Instructions

1. Data Transfer Instructions

	Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
					> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
*	F0	MV	S, D	16-bit data move					↕	5	A	A	A	158
*	F1	DMV	S, D	32-bit data move					↕	7	A	A	A	160
	F2	MV/	S, D	16-bit data invert and move					↕	5	A	A	A	—
	F3	DMV/	S, D	32-bit data invert and move					↕	7	A	A	A	—
	F5	BTM	S, n, D	Bit data move					↕	7	A	A	A	—
*	F6	DGT	S, n, D	Hexadecimal digit move					↕	7	A	A	A	162
	F10	BKMV	S1, S2, D	Block move					↕	7	A	A	A	—
	F11	COPY	S, D1, D2	Block copy					↕	7	A	A	A	—
	F15	XCH	D1, D2	16-bit data exchange					↕	5	A	A	A	—
	F16	DXCH	D1, D2	32-bit data exchange					↕	5	A	A	A	—
	F17	SWAP	D	Higher/lower byte in 16-bit data exchange					↕	3	A	A	A	—

2. BIN Arithmetic Instructions

	Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
					> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
	F20	+	S, D	16-bit data [D + S → D]		↕		↕	↕	5	A	A	A	—
	F21	D+	S, D	32-bit data [(D + 1, D) + (S + 1, S) → (D + 1, D)]		↕		↕	↕	7	A	A	A	—
*	F22	+	S1, S2, D	16-bit data [S1 + S2 → D]		↕		↕	↕	7	A	A	A	165
*	F23	D+	S1, S2, D	32-bit data [(S1 + 1, S1) + (S2 + 1, S2) → (D + 1, D)]		↕		↕	↕	11	A	A	A	167
	F25	–	S, D	16-bit data [D – S → D]		↕		↕	↕	5	A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For high-level instructions without a * mark, refer to “FP-M/FP1 Programming Manual”.

	Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
					> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
	F26	D–	S, D	32-bit data [(D + 1, D) – (S + 1, S) → (D + 1, D)]		↕		↕	↕	7	A	A	A	—
*	F27	–	S1, S2, D	16-bit data [S1 – S2 → D]		↕		↕	↕	7	A	A	A	169
*	F28	D–	S1, S2, D	32-bit data [(S1 + 1, S1) – (S2 + 1, S2) → (D + 1, D)]		↕		↕	↕	11	A	A	A	171
*	F30	*	S1, S2, D	16-bit data [S1 × S2 → (D + 1, D)]		↕			↕	7	A	A	A	173
*	F31	D*	S1, S2, D	32-bit data [(S1 + 1, S1) × (S2 + 1, S2) → (D + 3, D + 2, D + 1, D)]		↕			↕	11	N/A	A	A	175
*	F32	%	S1, S2, D	16-bit data [S1/S2 → D...(DT9015)]		↕		↕	↕	7	A	A	A	177
*	F33	D%	S1, S2, D	32-bit data [(S1 + 1, S1)/(S2 + 1, S2) → (D + 1, D)...(DT9016, DT9015)]		↕		↕	↕	11	N/A	A	A	179
	F35	+1	D	16-bit data increment [D + 1 → D]		↕		↕	↕	3	A	A	A	—
	F36	D+1	D	32-bit data increment [(D + 1, D) + 1 → (D + 1, D)]		↕		↕	↕	3	A	A	A	—
	F37	–1	D	16-bit data decrement [D – 1 → D]		↕		↕	↕	3	A	A	A	—
	F38	D–1	D	32-bit data decrement [(D + 1, D) –1 → (D + 1, D)]		↕		↕	↕	3	A	A	A	—

3. BCD Arithmetic Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F40	B+	S, D	4-digit BCD data [D + S → D]		↕		↕	↕	5	A	A	A	—
F41	DB+	S, D	8-digit BCD data [(D + 1, D) + (S + 1, S) → (D + 1, D)]		↕		↕	↕	7	A	A	A	—
F42	B+	S1, S2, D	4-digit BCD data [S1 + S2 → D]		↕		↕	↕	7	A	A	A	—
F43	DB+	S1, S2, D	8-digit BCD data [(S1 + 1, S1) + (S2 + 1, S2) → (D + 1, D)]		↕		↕	↕	11	A	A	A	—
F45	B–	S, D	4-digit BCD data [D – S → D]		↕		↕	↕	5	A	A	A	—
F46	DB–	S, D	8-digit BCD data [(D + 1, D) – (S + 1, S) → (D + 1, D)]		↕		↕	↕	7	A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For high-level instructions without a * mark, refer to “FP-M/FP1 Programming Manual”.

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F47	B–	S1, S2, D	4-digit BCD data [S1 – S2 → D]		↕		↕	↕	7	A	A	A	—
F48	DB–	S1, S2, D	8-digit BCD data [(S1 + 1, S1) – (S2 + 1, S2) → (D + 1, D)]		↕		↕	↕	11	A	A	A	—
F50	B*	S1, S2, D	4-digit BCD data [S1 × S2 → (D + 1, D)]		↕			↕	7	A	A	A	—
F51	DB*	S1, S2, D	8-digit BCD data [(S1 + 1, S1) × (S2 + 1, S2) → (D + 3, D + 2, D + 1, D)]		↕			↕	11	N/A	A	A	—
F52	B%	S1, S2, D	4-digit BCD data [S1/S2 → D...(DT9015)]		↕			↕	7	A	A	A	—
F53	DB%	S1, S2, D	8-digit BCD data [(S1 + 1, S1)/(S2 + 1, S2) → (D + 1, D)...(DT9016, DT9015)]		↕			↕	11	N/A	A	A	—
F55	B+1	D	4-digit BCD data increment [D + 1 → D]		↕		↕	↕	3	A	A	A	—
F56	DB+1	D	8-digit BCD data increment [(D + 1, D) + 1 → (D + 1, D)]		↕		↕	↕	3	A	A	A	—
F57	B–1	D	4-digit BCD data decrement [D – 1 → D]		↕		↕	↕	3	A	A	A	—
F58	DB–1	D	8-digit BCD data decrement [(D + 1, D) – 1 → (D + 1, D)]		↕		↕	↕	3	A	A	A	—

4. Data Comparison Instructions

	Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
					> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
*	F60	CMP	S1, S2	16-bit data compare	↕	↕	↕	↕	↕	5	A	A	A	181
*	F61	DCMP	S1, S2	32-bit data compare	↕	↕	↕	↕	↕	9	A	A	A	184
	F62	WIN	S1, S2, S3	16-bit data band compare	↕	↕	↕		↕	7	A	A	A	—
	F63	DWIN	S1, S2, S3	32-bit data band compare	↕	↕	↕		↕	13	A	A	A	—
	F64	BCMP	S1, S2, S3	Block data compare		↕			↕	7	N/A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For high-level instructions without a * mark, refer to “FP-M/FP1 Programming Manual”.

5. Logic Operation Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F65	WAN	S1, S2, D	16-bit data AND		↕			↕	7	A	A	A	—
F66	WOR	S1, S2, D	16-bit data OR		↕			↕	7	A	A	A	—
F67	XOR	S1, S2, D	16-bit data exclusive OR		↕			↕	7	A	A	A	—
F68	XNR	S1, S2, D	16-bit data exclusive NOR		↕			↕	7	A	A	A	—

6. Data Conversion Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F70	BCC	S1, S2, S3, D	Block check code calculation					↕	9	N/A	A	A	—
F71	HEXA	S1, S2, D	Hexadecimal data → ASCII code					↕	7	N/A	A	A	—
F72	AHEX	S1, S2, D	ASCII code → Hexadecimal data					↕	7	N/A	A	A	—
F73	BCDA	S1, S2, D	BCD data → ASCII code					↕	7	N/A	A	A	—
F74	ABCD	S1, S2, D	ASCII code → BCD data					↕	9	N/A	A	A	—
F75	BINA	S1, S2, D	16-bit data → ASCII code					↕	7	N/A	A	A	—
F76	ABIN	S1, S2, D	ASCII code → 16-bit data					↕	7	N/A	A	A	—
F77	DBIA	S1, S2, D	32-bit data → ASCII code					↕	11	N/A	A	A	—
F78	DABI	S1, S2, D	ASCII code → 32-bit data					↕	11	N/A	A	A	—
* F80	BCD	S, D	16-bit data → 4-digit BCD data					↕	5	A	A	A	187
* F81	BIN	S, D	4-digit BCD data → 16-bit data					↕	5	A	A	A	189
F82	DBCD	S, D	32-bit data → 8-digit BCD data					↕	7	A	A	A	—
F83	DBIN	S, D	8-digit BCD data → 32-bit data					↕	7	A	A	A	—
F84	INV	D	16-bit data invert					↕	3	A	A	A	—
F85	NEG	D	16-bit data two's complement					↕	3	A	A	A	—
F86	DNEG	D	32-bit data two's complement					↕	3	A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- Details about the instructions with a * mark are described in this manual.
  Refer to the pages in the far right column of the above tables.
  For high-level instructions without a * mark, refer to "FP-M/FP1 Programming Manual".

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F87	ABS	D	16-bit data absolute				↕	↕	3	A	A	A	—
F88	DABS	D	32-bit data absolute				↕	↕	3	A	A	A	—
F89	EXT	D	16-bit data sign extension					↕	3	A	A	A	—
F90	DECO	S, n, D	Decode					↕	7	A	A	A	—
F91	SEGT	S, D	16-bit data 7-segment decode					↕	5	A	A	A	—
F92	ENCO	S, n, D	Encode					↕	7	A	A	A	—
F93	UNIT	S, n, D	16-bit data combine					↕	7	A	A	A	—
F94	DIST	S, n, D	16-bit data distribute					↕	7	A	A	A	—
F95	ASC	S, D	Character → ASCII code					↕	15	N/A	A	A	—
F96	SRC	S1, S2, S3	Table data search					↕	7	A	A	A	—

7. Data Shift Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F100	SHR	D, n	Right shift of 16-bit data in bit units				↕	↕	5	A	A	A	—
F101	SHL	D, n	Left shift of 16-bit data in bit units				↕	↕	5	A	A	A	—
F105	BSR	D	Right shift of one hexadecimal digit (4 bits) of 16-bit data					↕	3	A	A	A	—
F106	BSL	D	Left shift of one hexadecimal digit (4 bits) of 16-bit data					↕	3	A	A	A	—
F110	WSHR	D1, D2	Right shift of one word (16 bits) of 16-bit data range					↕	5	A	A	A	—
F111	WSHL	D1, D2	Left shift of one word (16 bits) of 16-bit data range					↕	5	A	A	A	—
F112	WBSR	D1, D2	Right shift of one hexadecimal digit (4 bits) of 16-bit data range					↕	5	A	A	A	—
F113	WBSL	D1, D2	Left shift of one hexadecimal digit (4 bits) of 16-bit data range					↕	5	A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- For above mentioned instructions, refer to “FP-M/FP1 Programming Manual”.

8. UP/DOWN Counter and LEFT/RIGHT Shift Register Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F118	UDC	S, D	UP/DOWN counter		↕		↕		5	A	A	A	—
F119	LRSR	D1, D2	Left/right shift register				↕	↕	5	A	A	A	—

9. Data Rotate Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F120	ROR	D, n	16-bit data right rotate				↕	↕	5	A	A	A	—
F121	ROL	D, n	16-bit data left rotate				↕	↕	5	A	A	A	—
F122	RCR	D, n	16-bit data right rotate with carry flag data				↕	↕	5	A	A	A	—
F123	RCL	D, n	16-bit data left rotate with carry flag data				↕	↕	5	A	A	A	—

10. Bit Manipulation Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F130	BTS	D, n	16-bit data bit set					↕	5	A	A	A	—
F131	BTR	D, n	16-bit data bit reset					↕	5	A	A	A	—
F132	BTI	D, n	16-bit data bit invert					↕	5	A	A	A	—
F133	BTT	D, n	16-bit data test		↕			↕	5	A	A	A	—
F135	BCU	S, D	Number of ON bits in 16-bit data					↕	5	A	A	A	—
F136	DBCU	S, D	Number of ON bits in 32-bit fata					↕	7	A	A	A	—

11. Auxiliary Timer Instruction

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F137	STMR	S, D	Auxiliary timer						5	N/A	N/A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- For above mentioned instructions, refer to “FP-M/FP1 Programming Manual”.

12. Special Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F138	HMSS	S, D	Hours, minutes, and seconds data to seconds data					↕	5	N/A	A	A	—
F139	SHMS	S, D	Seconds data to hours, minutes, and seconds data					↕	5	N/A	A	A	—
F140	STC	———	Carry flag (R9009) set				↕		1	N/A	A	A	—
F141	CLC	———	Carry flag (R9009) reset				↕		1	N/A	A	A	—
F143	IORF	D1, D2	Partial I/O update					↕	5	N/A	A	A	—
F144	TRNS	S, n	Serial communication					↕	5	N/A	A	A	—
F147	PR	S, D	Parallel printout					↕	5	N/A	A	A	—
F148	ERR	n	Self-diagnostic error set					↕	3	N/A	A	A	—
F149	MSG	S	Message display						13	N/A	A	A	—
F157	CADD	S1, S2, D	Time addition [(S1+2, S1+1, S1) + (S2+1, S2) → (D+2, D+1, D)]					↕	9	N/A	A	A	—
F158	CSUB	S1, S2, D	Time subtraction [(S1+2, S1+1, S1) – (S2+1, S2) → (D+2, D+1, D)]					↕	9	N/A	A	A	—

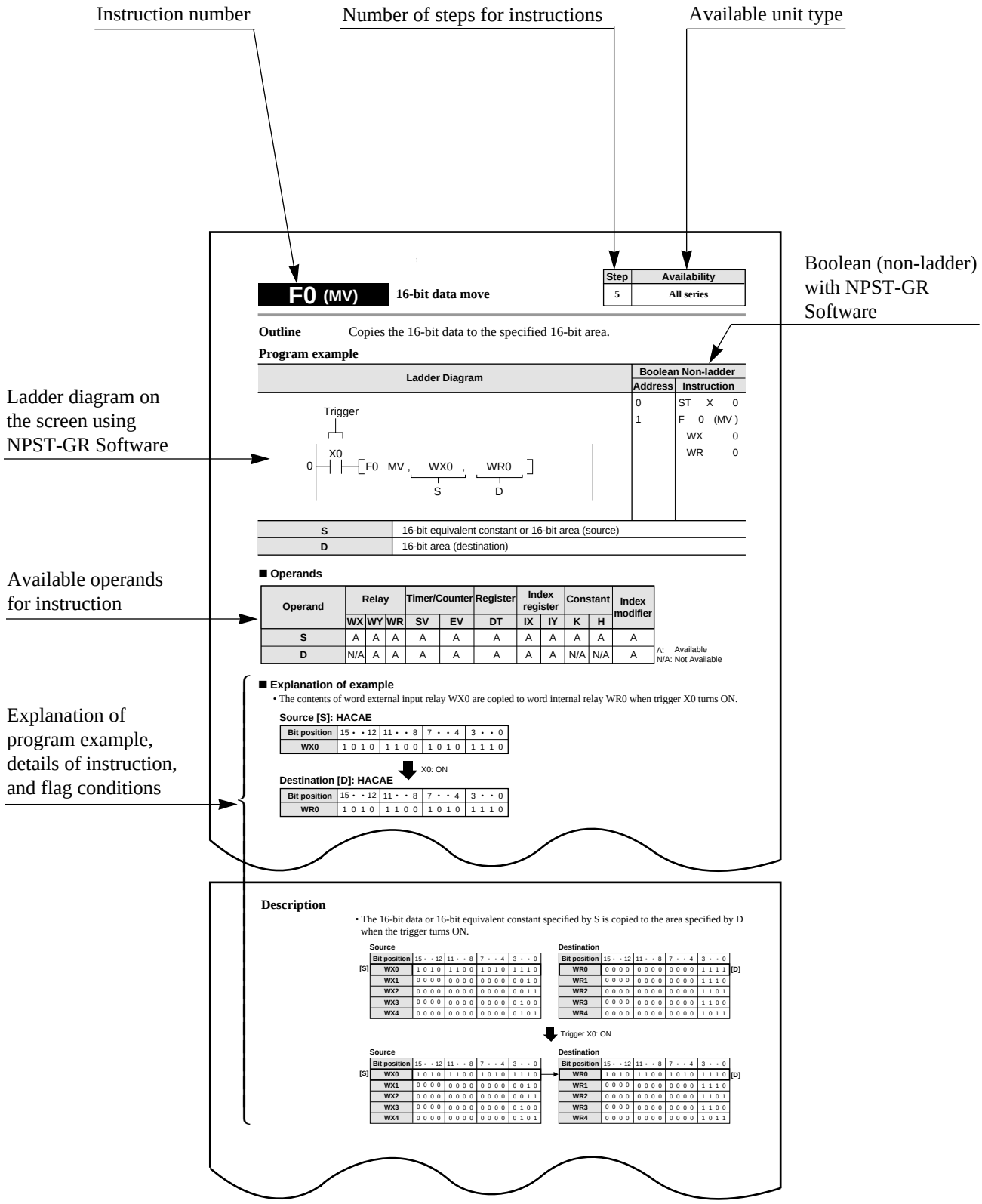
13. High-speed Counter Special Instructions

Number	Boolean	Operand	Description	Flag operation					Step	Availability			Page
				> R900A	= R900B	< R900C	CY R9009	ER R9007 R9008		C14/ C16	C24/ C40	C56/ C72	
F0	MV	S, DT9052	High-speed counter control					↕	5	A	A	A	—
F1	DMV	S, DT9044 or DT9044, D	Change and read of the elapsed value of high speed counter					↕	7	A	A	A	—
F162	HC0S	S, Yn	High-speed counter output set					↕	7	A	A	A	—
F163	HC0R	S, Yn	High-speed counter output reset					↕	7	A	A	A	—
F164	SPD0	S	Speed control					↕	3	A	A	A	—
F165	CAM0	S	Cam control					↕	3	A	A	A	—

- A: Available, N/A: Not available
- Specification of flag operation in the above tables:
  [↕] The flag (special relay) available for the instruction (turns ON/OFF according to the condition).
  [ ](blank) The flag (special relay) not available for the instruction (keeps the state regardless of the instruction).
- For above mentioned instructions, refer to “FP-M/FP1 Programming Manual”.

6-3. Description of High-level Instructions

High-level Instruction Reference



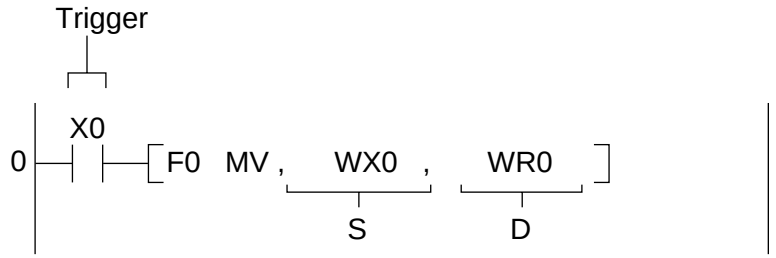
F0 (MV) 16-bit data move

Step	Availability
5	All series

Outline Copies the 16-bit data to the specified 16-bit area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
0	ST X 0
1	F 0 (MV)
	WX 0
	WR 0

S	16-bit equivalent constant or 16-bit area (source)
D	16-bit area (destination)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• The contents of word external input relay WX0 are copied to word internal relay WR0 when trigger X0 turns ON.

Source [S]: HACAE

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WX0	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0

X0: ON

Destination [D]: HACAE

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WR0	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0

Description

• The 16-bit data or 16-bit equivalent constant specified by S is copied to the area specified by D when the trigger turns ON.

Source

	Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
[S]	WX0	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0
	WX1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 0
	WX2	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 1
	WX3	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 0
	WX4	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 1

Destination

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0	
WR0	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1	[D]
WR1	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 0	
WR2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 0 1	
WR3	0 0 0 0	0 0 0 0	0 0 0 0	1 1 0 0	
WR4	0 0 0 0	0 0 0 0	0 0 0 0	1 0 1 1	

Trigger X0: ON

Source

	Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
[S]	WX0	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0
	WX1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 0
	WX2	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 1
	WX3	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 0
	WX4	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 1

Destination

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0	
WR0	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0	[D]
WR1	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 0	
WR2	0 0 0 0	0 0 0 0	0 0 0 0	1 1 0 1	
WR3	0 0 0 0	0 0 0 0	0 0 0 0	1 1 0 0	
WR4	0 0 0 0	0 0 0 0	0 0 0 0	1 0 1 1	

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

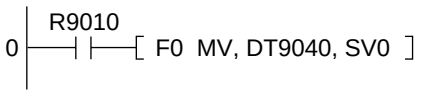
• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

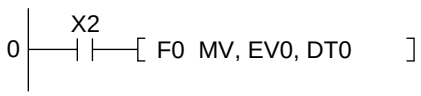
■ Application example

Example 1: Put the value of the dial set register in the timer set value area.



R9010: Always ON special internal relay
DT9040: Manual dial set register for "V0"

Example 2: Transfer the timer elapsed value EV0 to the data register DT0 when X2 turns ON.

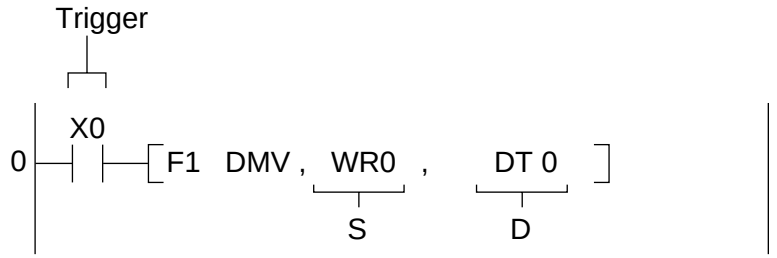


F1 (DMV) 32-bit data move

Step	Availability
7	All series

Outline Copies the 32-bit data to the specified 32-bit area.

Program example

Ladder Diagram	Boolean Non-ladder	
	Address	Instruction
	0	ST X 0
	1	F 1 (DMV)
		WR 0
		DT 0

S	32-bit equivalent constant or lower 16-bit area of 32-bit data (source)
D	Lower 16-bit area for 32-bit data (destination)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S	A	A	A	A	A	A	A	N/A	A	A	A
D	N/A	A	A	A	A	A	A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• The contents of word internal input relays WR1 and WR0 are copied to data registers DT1 and DT0 when trigger X0 turns ON.

Source [S+1, S]: HACAEE486

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WR1	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WR0	1 1 1 0	0 1 0 0	1 0 0 0	0 1 1 0

lower 16-bit area

X0: ON

Destination [D+1, D]: HACAEE486

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	1 0 1 0	1 1 0 0	1 0 1 0	1 1 1 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	1 1 1 0	0 1 0 0	1 0 0 0	0 1 1 0

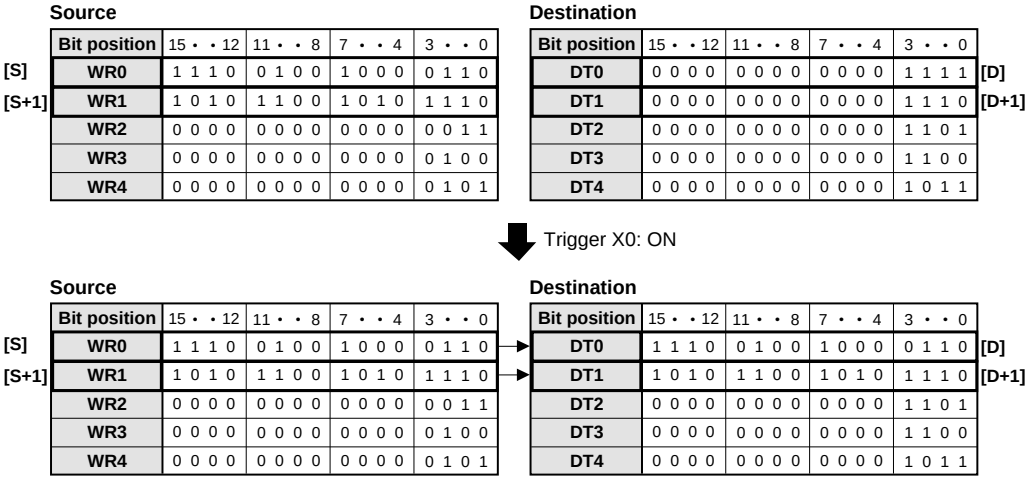
lower 16-bit area

Note:

• When processing 32-bit data, the higher 16-bit areas (S+1, D+1) are automatically decided if the lower 16-bit areas (S, D) are specified.
e.g., S+1 (higher) = WR1, S (lower) = WR0
D+1 (higher) = DT1, D (lower) = DT0

Description

• The 32-bit data or the 32-bit equivalent constant specified by S is copied to the 32-bit area specified by D when the trigger turns ON.



■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

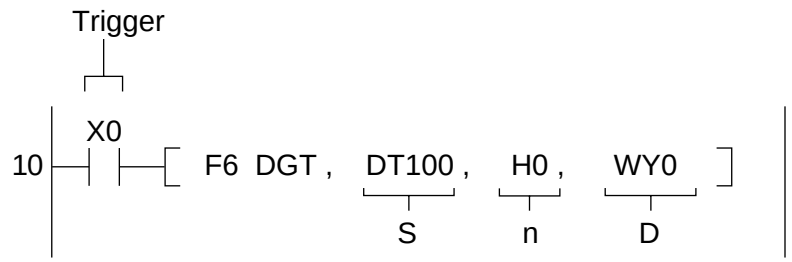
F6 (DGT) Hexadecimal digit move

Step	Availability
7	All series

Outline Copies the hexadecimal digits in one 16-bit area to the specified digit in another 16-bit area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
10	ST X 0
11	F 6 (DGT)
	DT 100
	H 0
	WY 0

S	16-bit equivalent constant or 16-bit area (source)
n	16-bit equivalent constant or 16-bit area (specifies source and destination hexadecimal digit position and number of hexadecimal digits)
D	16-bit area (destination)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S	A	A	A	A	A	A	A	A	A	A	A
n	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• The hexadecimal digit 0 of the data register DT100 is copied to hexadecimal digit 0 of word external output relay WY0 when trigger X0 turns ON.

n: H0

Source [S]: H149

Hexadecimal digit position	3	2	1	0
Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT100	0 0 0 0	0 0 0 1	0 1 0 0	1 0 0 1

X0: ON

Destination [D]: H8A9

Hexadecimal digit position	3	2	1	0
Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WY0	0 0 0 0	1 0 0 0	1 0 1 0	1 0 0 1

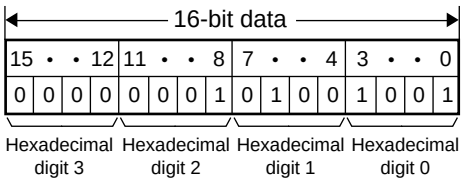
In this case, only the lower 4 bits of WY0 change value.

Description

• The hexadecimal digits in the 16-bit data or in the 16-bit equivalent constant specified by S are copied to the 16-bit area specified by D according to content specified by n when the trigger turns ON.

■ How to specify the n

• The hexadecimal digit position of 16-bit data is specified as shown on the right.



• The n specifies source and destination hexadecimal digit positions and number of digits to be copied using hexadecimal data as follows:

n : H 0 □ □ □

① Source: Starting hexadecimal digit position (H0 to H3)
H0: Hexadecimal digit 0
H1: Hexadecimal digit 1
H2: Hexadecimal digit 2
H3: Hexadecimal digit 3

② Number of hexadecimal digits to be copied (H0 to H3)
H0: Copies 1 hexadecimal digits (4 bits)
H1: Copies 2 hexadecimal digits (8 bits)
H2: Copies 3 hexadecimal digits (12 bits)
H3: Copies 4 hexadecimal digits (16 bits)

③ Destination: Starting hexadecimal digit position (H0 to H3)
H0: Hexadecimal digit 0
H1: Hexadecimal digit 1
H2: Hexadecimal digit 2
H3: Hexadecimal digit 3

Note:

• If the value for ①, ②, and ③ is 0, such as “H0000” in the example program on the previous page, use the short form, “H0”.

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

Notes:

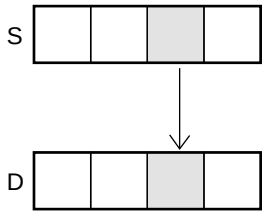
• Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
• When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
• Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

■ Examples of hexadecimal digit copy

(1) When hexadecimal digit 1 of the source is copied to hexadecimal digit 1 of the destination:

n: H 1 0 1

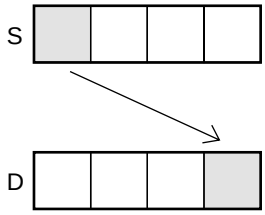
- Source: Starting hexadecimal digit 1
- Copies 1 hexadecimal digit (4 bits)
- Destination: Starting hexadecimal digit 1



(2) When hexadecimal digit 3 of the source is copied to hexadecimal digit 0 of the destination:

n: H 0 0 3

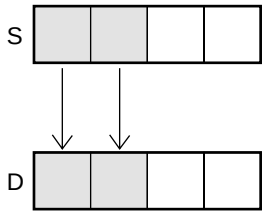
- Source: Starting hexadecimal digit 3
- Copies 1 hexadecimal digit (4 bits)
- Destination: Starting hexadecimal digit 0



(3) When multiple hexadecimal digits (hexadecimal digits 2 and 3) of the source are copied to multiple hexadecimal digits (hexadecimal digits 2 and 3) of the destination:

n: H 2 1 2

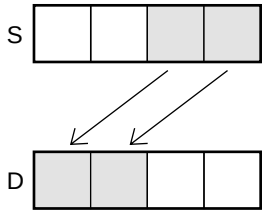
- Source: Starting hexadecimal digit 2
- Copies 2 hexadecimal digits (8 bits)
- Destination: Starting hexadecimal digit 2



(4) When multiple hexadecimal digits (hexadecimal digits 0 and 1) of the source are copied to multiple hexadecimal digits (hexadecimal digits 2 and 3) of the destination:

n: H 2 1 0

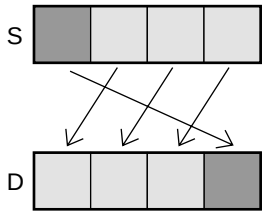
- Source: Starting hexadecimal digit 0
- Copies 2 hexadecimal digits (8 bits)
- Destination: Starting hexadecimal digit 2



(5) When 4 hexadecimal digits (hexadecimal digits 0 to 3) of the source are copied to 4 hexadecimal digits (hexadecimal digits 0 to 3) of the destination:

n: H 1 3 0

- Source: Starting hexadecimal digit 0
- Copies 4 hexadecimal digits (16 bits)
- Destination: Starting hexadecimal digit 1



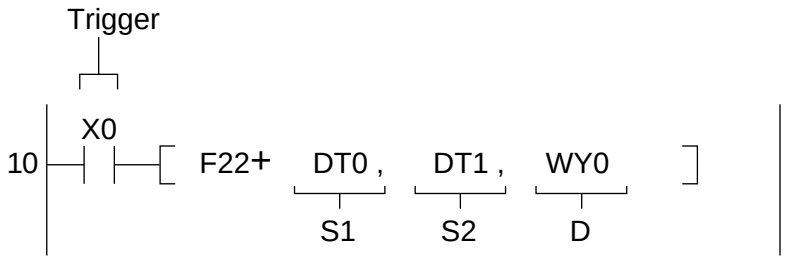
F22 (+) 16-bit data [S1 + S2 → D]

Step	Availability
7	All series

Outline Adds two 16-bit data and stores the result in the specified area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
10	ST X 0
11	F 22 (+)
	DT 0
	DT 1
	WY 0

S1	16-bit equivalent constant or 16-bit area (for augend)
S2	16-bit equivalent constant or 16-bit area (for addend)
D	16-bit area (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• The contents of data registers DT0 and DT1 are added when trigger X0 turns ON. The added result is stored in word external output relay WY0.

Augend [S1]: K123

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	0 0 0 0	0 1 1 1	1 0 1 1

+

Addend [S2]: K45

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	0 0 0 0	0 0 0 0	0 0 1 0	1 1 0 1

↓ X0: ON

Result [D]: K168

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WY0	0 0 0 0	0 0 0 0	1 0 1 0	1 0 0 0

Description

• The 16-bit data or 16-bit equivalent constant specified by S1 and S2 are added together when the trigger turns ON. The added result is stored in D.

Augend data		Addend data	Trigger turns ON	Result
S1	+	S2	⟶	D

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

• = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.

• Carry flag (R9009): Turns ON for an instant when the calculated result exceeds the range of 16-bit data (overflows or underflows).
*Range of 16-bit data: K-32768 to K32767 (H8000 to H7FFF)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.
- If the calculated result accidently overflows or underflows (if special internal relay R9009 turns ON), use of the **F23 (D+)** instruction (32-bit data addition) is recommended. When you use the **F23 (D+)** instruction instead of **F22 (+)**, be sure to convert the 16-bit addend and augend into 32-bit data using the **F89 (EXT)** instruction.

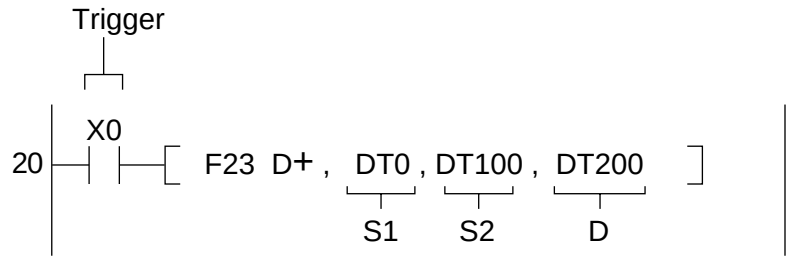
F23 (D+) 32-bit data [(S1+1, S1) + (S2+1, S2) → (D+1, D)]

Step	Availability
11	All series

Outline Adds two 32-bit data and stores the result in the specified area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
20	ST X 0
21	F 23 (D+)
	DT 0
	DT 100
	DT 200

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data (for augend)
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data (for addend)
D	Lower 16-bit area of 32-bit data (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A
D	N/A	A	A	A	A	A	A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• The contents of data registers DT1 and DT0 and the contents of data registers DT101 and DT100 are added when trigger X0 turns ON. The added result is stored in data registers DT201 and DT200.

Augend [S1+1, S1]: K1312896

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	0 0 0 0	0 0 0 0	0 0 0 1	0 1 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	1 0 0 0	1 0 0 0	0 0 0 0

lower 16-bit area

+

Addend [S2+1, S2]: K558144

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT101	0 0 0 0	0 0 0 0	0 0 0 0	1 0 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT100	1 0 0 0	0 1 0 0	0 1 0 0	0 0 0 0

lower 16-bit area

X0: ON

Result [D+1, D]: K1871040

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT201	0 0 0 0	0 0 0 0	0 0 0 1	1 1 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT200	1 0 0 0	1 1 0 0	1 1 0 0	0 0 0 0

lower 16-bit area

Note:

- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1, D+1) are automatically decided if the lower 16-bit areas (S1, S2, D) are specified.
  e.g., S1+1 (higher) = DT1, S1 (lower) = DT0
  S2+1 (higher) = DT101, S2 (lower) = DT100
  D+1 (higher) = DT201, D (lower) = DT200

Description

- The 32-bit data or 32-bit equivalent constant specified by S1 and S2 are added together when the trigger turns ON. The added result is stored in D+1 and D.

Augend data				Addend data			Trigger turns ON	Result		
S1	: lower	16-bit	+	S2	: lower	16-bit	⟶	D	: lower	16-bit
S1+1	: higher	16-bit		S2+1	: higher	16-bit		D+1	: higher	16-bit

■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)
- = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.
- Carry flag (R9009): Turns ON for an instant when the calculated result exceeds the range of 32-bit data (overflows or underflows).
  *Range of 32-bit data: K-2147483648 to K2147483647 (H80000000 to H7FFFFFFF)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.

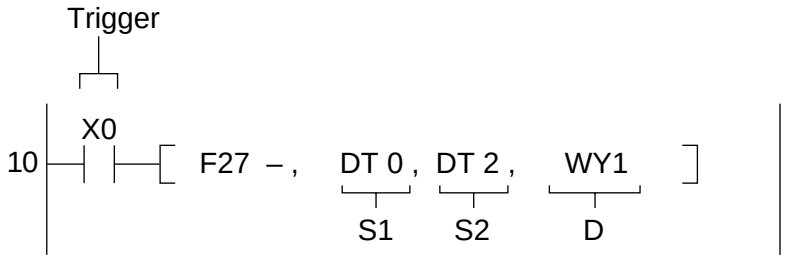
Step	Availability
7	All series

F27 (–) 16-bit data [S1 – S2 → D]

Outline Subtracts the 16-bit data from the minuend and stores the result in the specified area.

Program example

Ladder Diagram



Boolean Non-ladder	
Address	**Instruction**
10	ST X 0
11	F 27 (–)
	DT 0
	DT 2
	WY 1

S1	16-bit equivalent constant or 16-bit area (for minuend)
S2	16-bit equivalent constant or 16-bit area (for subtrahend)
D	16-bit area (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Subtracts the contents of data register DT2 from the contents of data register DT0 when trigger X0 turns ON. The subtracted result is stored in word external output relay WY1.

Minuend [S1]: K893

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	0 0 1 1	0 1 1 1	1 1 0 1

–

Subtrahend [S2]: K452

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT2	0 0 0 0	0 0 0 1	1 1 0 0	0 1 0 0

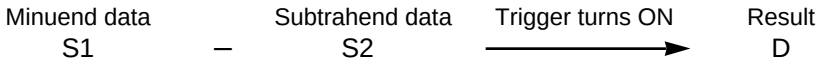
X0: ON

Result [D]: K441

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WY1	0 0 0 0	0 0 0 1	1 0 1 1	1 0 0 1

Description

• Subtracts the 16-bit data or 16-bit equivalent constant specified by S2 from the 16-bit data or 16-bit equivalent constant specified by S1 when the trigger turns ON. The subtracted result is stored in D.



■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

• = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.

• Carry flag (R9009): Turns ON for an instant when the calculated result exceeds the range of 16-bit data (overflows or underflows).
*Range of 16-bit data: K-32768 to K32767 (H8000 to H7FFF)

Notes:

• Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
• When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
• Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.
• If the calculated result accidently overflows or underflows (if special internal relay R9009 turns ON), use of the **F28 (D-)** instruction (32-bit data subtraction) is recommended. When you use the **F28 (D-)** instruction instead of **F27 (-)**, be sure to convert the 16-bit subtrahend and minuend into 32-bit data using the **F89 (EXT)** instruction.

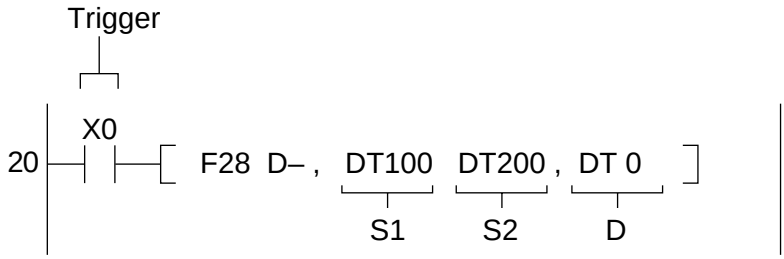
F28 (D–) 32-bit data [(S1+1, S1) – (S2+1, S2) → (D+1, D)]

Step	Availability
11	All series

Outline Subtracts the 32-bit data from the minuend and stores the result in the specified area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
20	ST X 0
21	F 28 (D–)
	DT 100
	DT 200
	DT 0

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data (for minuend)
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data (for subtrahend)
D	Lower 16-bit area of 32-bit data (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A
D	N/A	A	A	A	A	A	A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Subtracts the contents of data registers DT201 and DT200 from the contents of data registers DT101 and DT100 when trigger X0 turns ON. The subtracted result is stored in data registers DT1 and DT0.

Minuend [S1+1, S1]: K16809984

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT101	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT100	1 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

lower 16-bit area

–

Subtrahend [S2+1, S2]: K525312

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT201	0 0 0 0	0 0 0 0	0 0 0 0	1 0 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT200	0 0 0 0	0 1 0 0	0 0 0 0	0 0 0 0

lower 16-bit area

X0: ON

Result [D+1, D]: K16284672

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	0 0 0 0	0 0 0 0	1 1 1 1	1 0 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 1 1 1	1 1 0 0	0 0 0 0	0 0 0 0

lower 16-bit area

Note:

- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1, D+1) are automatically decided if the lower 16-bit areas (S1, S2, D) are specified.
  e.g., S1+1 (higher) = DT101, S1 (lower) = DT100
  S2+1 (higher) = DT201, S2 (lower) = DT200
  D+1 (higher) = DT1, D (lower) = DT0

Description

- Subtracts the 32-bit data or 32-bit equivalent constant specified by S2 from the 32-bit data or 32-bit equivalent constant specified by S1 when the trigger turns ON.
  The subtracted result is stored in D+1 and D.

Minuend data		Subtrahend data		Trigger turns ON	Result	
S1 : lower 16-bit	–	S2 : lower 16-bit	→		D : lower 16-bit	
S1+1 : higher 16-bit		S2+1 : higher 16-bit			D+1 : higher 16-bit	

■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)
- = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.
- Carry flag (R9009): Turns ON for an instant when the calculated result exceeds the range of 32-bit data (overflows or underflows).
  *Range of 32-bit data: K-2147483648 to K2147483647 (H80000000 to H7FFFFFFF)

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.

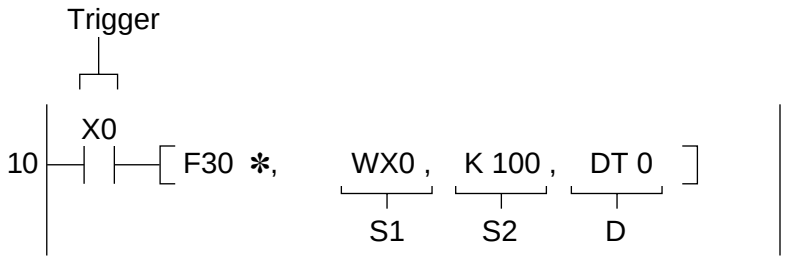
F30 (✻) 16-bit data [S1 × S2 → (D+1, D)]

Step	Availability
7	All series

Outline Multiplies two 16-bit data and stores the result in the specified 32-bit area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
10	ST X 0
11	F 30 (✻)
	WX 0
	K 100
	DT 0

S1	16-bit equivalent constant or 16-bit area (for multiplicand)
S2	16-bit equivalent constant or 16-bit area (for multiplier)
D	Lower 16-bit area of 32-bit data (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Multiplies the contents of word external input relay WX0 and decimal constant K100 when trigger X0 turns ON. The multiplied result is stored in data registers DT1 and DT0.

Multiplicand [S1]: K25

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WX0	0 0 0 0	0 0 0 0	0 0 0 1	1 0 0 1

✖

Multiplier [S2]: K100

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
K100	0 0 0 0	0 0 0 0	0 1 1 0	0 1 0 0

X0: ON

Result [D+1, D]: K2500

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

higher 16-bit area

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	1 0 0 1	1 1 0 0	0 1 0 0

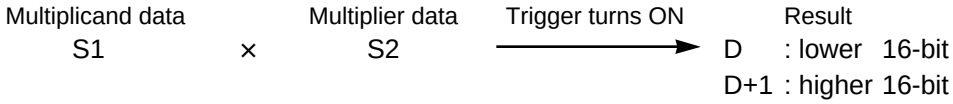
lower 16-bit area

Note:

- The multiplied result is stored in the 32-bit area.
  The higher 16-bit area (D+1) is automatically decided when the lower 16-bit area (D) is specified.
  e.g., D+1 (higher) = DT1, D (lower) = DT0

Description

- Multiplies the 16-bit data or 16-bit equivalent constant specified by S1 and the 16-bit data or 16-bit equivalent constant specified by S2 when the trigger turns ON.
  The multiplied result is stored in D+1 and D (32-bit area).



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)
- = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags and = flag.

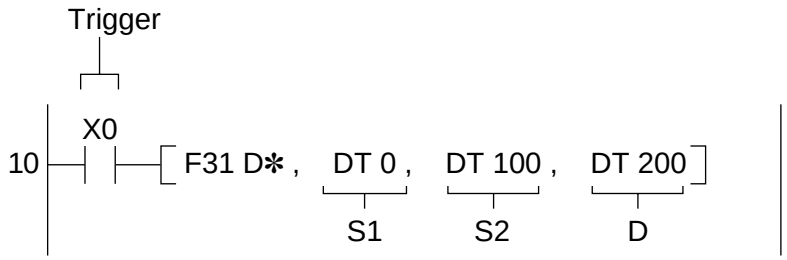
F31 (D✻) 32-bit data [(S1+1, S1) × (S2+1, S2) → (D+3, D+2, D+1, D)]

Step	Availability
11	C24, C40, C56, and C72 series

Outline Multiplies two 32-bit data and stores the result in the specified 64-bit area.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
10	ST X 0
11	F 31 (D✻)
	DT 0
	DT 100
	DT 200

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data (for multiplicand)
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data (for multiplier)
D	Lowest 16-bit area of 64-bit data (for result)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A
D	N/A	A	A	A	A	A	N/A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Multiplies the contents of data registers DT1 and DT0 and the contents of data registers DT101 and DT100 when trigger X0 turns ON. The multiplied result is stored in data registers DT203, DT202, DT201, and DT200.

Multiplicand [S1+1, S1]: K1638411

DT1	DT0

higher 16-bit area lower 16-bit area

✖

Multiplier [S2+1, S2]: K458761

DT101	DT100

higher 16-bit area lower 16-bit area

X0: ON

Result [D+3, D+2, D+1, D]: K751639068771

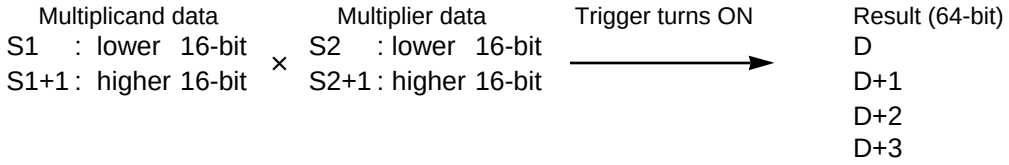
DT203	DT202	DT201	DT200

Notes:

- When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1) are automatically decided if the lower 16-bit areas (S1, S2) are specified.
  e.g., S1+1 (higher) = DT1, S1 (lower) = DT0
  S2+1 (higher) = DT101, S2 (lower) = DT100
- The multiplied result is stored in the 64-bit area.
  The areas (D+3, D+2, D+1) other than the lowest 16-bit area (D) are automatically decided when the lowest 16-bit area is specified.
  e.g., D = DT200
  D+1 = DT201
  D+2 = DT202
  D+3 = DT203

Description

- Multiplies the 32-bit data or 32-bit equivalent constant specified by S1 and the one specified by S2 when the trigger turns ON.
  The multiplied result is stored in D+3, D+2, D+1, and D (64-bit area).



■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)
- = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags and = flag.

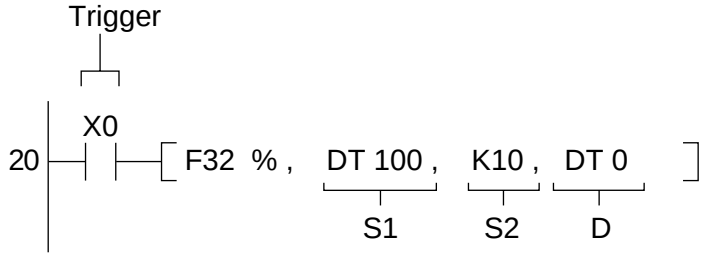
F32 (%) 16-bit data [S1/S2 → D... (DT9015)]

Step	Availability
7	All series

Outline Divides the 16-bit data by the divisor and stores the result in the specified area and the remainder in special data register DT9015.

Program example

Ladder Diagram



Boolean Non-ladder	
Address	**Instruction**
20	ST X 0
21	F 32 (%)
	DT 100
	K 10
	DT 0

S1	16-bit equivalent constant or 16-bit area (for dividend)
S2	16-bit equivalent constant or 16-bit area (for divisor)
D	16-bit area (for quotient), (remainder is stored in special data register DT9015)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Divides the contents of data register DT100 by decimal constant K10 when trigger X0 turns ON. The quotient is stored in data register DT0 and the remainder is stored in special data register DT9015.

Dividend [S1]: K183

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT100	0 0 0 0	0 0 0 0	1 0 1 1	0 1 1 1

÷

Divisor [S2]: K10

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
K10	0 0 0 0	0 0 0 0	0 0 0 0	1 0 1 0

X0: ON

Quotient [D]: K18

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	0 0 0 0	0 0 0 1	0 0 1 0

Remainder: K3

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT9015	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 1

Description

• The 16-bit data or 16-bit equivalent constant specified by S1 is divided by the 16-bit data or 16-bit equivalent constant specified by S2 when the trigger turns ON.
The quotient is stored in D and the remainder is stored in the special data register DT9015.

Dividend data		Divisor	Trigger turns ON	Quotient		Remainder
S1	÷	S2	⟶	D	....	DT9015

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state,
- when the area specified using the index modifier exceeds the limit.
- when the 16-bit equivalent constant or 16-bit data for the divisor specified by S2 is 0.

The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant,
- when the area specified using the index modifier exceeds the limit.
- when the 16-bit equivalent constant or 16-bit data for the divisor specified by S2 is 0.

The error address is transferred to DT9018. (See notes below.)

• = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.

• Carry flag (R9009): Turns ON for an instant when negative minimum value K-32768 (H8000) is divided by K-1 (HFFFF).

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.
- If the calculated result accidently overflows (if special internal relay R9009 turns ON), use of the **F33 (D%)** instruction (32-bit data division) is recommended. When you use the **F33 (D%)** instruction instead of **F32 (%)**, be sure to convert the 16-bit dividend and divisor into 32-bit data using the **F89 (EXT)** instruction.

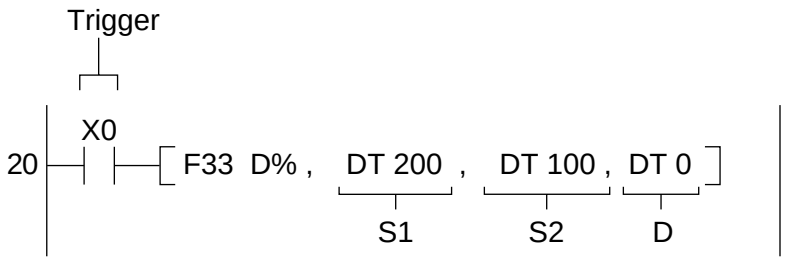
F33 (D%) 32-bit data [(S1+1, S1)/(S2+1, S2) → (D+1, D) ... (DT9016, DT9015)]

Step	Availability
11	C24, C40, C56, and C72 series

Outline Divides the 32-bit data by the divisor and stores the result in the specified area and the remainder in special data registers DT9016 and DT9015.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
20	ST X 0
21	F 33 (D%)
	DT 200
	DT 100
	DT 0

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data (for dividend)
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data (for divisor)
D	Lower 16-bit area of 32-bit data (for quotient) (remainder is stored in special data registers DT9016 and DT9015)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A
D	N/A	A	A	A	A	A	A	N/A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Divides the contents of data registers DT201 and DT200 by the contents of data registers DT101 and DT100 when trigger X0 turns ON. The quotient is stored in data registers DT1 and DT0 and the remainder is stored in special data registers DT9016 and DT9015.

Dividend [S1+1, S1]: K16908416

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT201	0 0 0 0	0 0 0 1	0 0 0 0	0 0 1 0
DT200	0 0 0 0	0 0 0 0	1 0 0 0	0 0 0 0

higher 16-bit area | lower 16-bit area

÷

Divisor [S2+1, S2]: K589828

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT101	0 0 0 0	0 0 0 0	0 0 0 0	1 0 0 1
DT100	0 0 0 0	0 0 0 0	0 0 0 0	0 1 0 0

higher 16-bit area | lower 16-bit area

X0: ON

Quotient [D+1, D]: K28

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
DT0	0 0 0 0	0 0 0 0	0 0 0 1	1 1 0 0

higher 16-bit area | lower 16-bit area

Remainder: K393232

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT9016	0 0 0 0	0 0 0 0	0 0 0 0	0 1 1 0
DT9015	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 0

higher 16-bit area | lower 16-bit area

Note:

- When processing 32-bit data, the higher 16-bit areas S1+1, S2+1, D+1 are automatically decided if the lower 16-bit areas S1, S2, D are specified.
  e.g., S1+1 (higher) = DT201, S1 (lower) = DT200
  S2+1 (higher) = DT101, S2 (lower) = DT100
  D+1 (higher) = DT1, D (lower) = DT0

Description

- The 32-bit data or 32-bit equivalent constant specified by S1 is divided by the 32-bit data or 32-bit equivalent constant specified by S2 when the trigger turns ON. The quotient is stored in D+1 and D and the remainder is stored in the special data registers DT9016 and DT9015.

Dividend data			Divisor			Trigger turns ON	Quotient			Remainder
S1	: lower	16-bit	S2	: lower	16-bit		D	: lower	16-bit	DT9015
S1+1	: higher	16-bit	S2+1	: higher	16-bit		D+1	: higher	16-bit	DT9016

■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state,
  - when the area specified using the index modifier exceeds the limit.
  - when the 32-bit equivalent constant or 32-bit data for the divisor specified by S2 is 0.

  The error address is transfeered to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant,
  - when the area specified using the index modifier exceeds the limit.
  - when the 32-bit equivalent constant or 32-bit data for the divisor specified by S2 is 0.

  The error address is transferred to DT9018. (See notes below.)
- = flag (R900B): Turns ON for an instant when the calculated result is recognized as “0”.
- Carry flag (R9009): Turns ON for an instant when negative minimum value K-2147483648 (H80000000) is divided by K-1 (HFFFFFFFF).

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relays R9008, R9009, and R900B as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags, = flag, and carry flag.

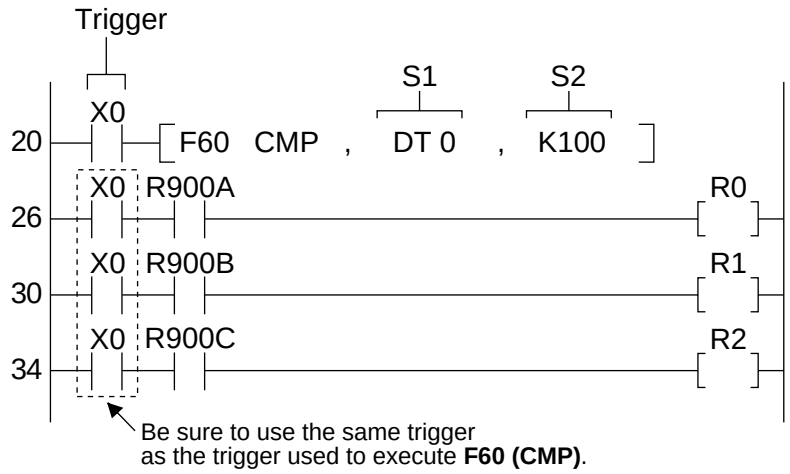
Step	Availability
5	All series

F60 (CMP) 16-bit data compare

Outline Compares one 16-bit data with another.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
20	ST X 0
21	F 60 (CMP)
	DT 0
	K 100
26	ST X 0
27	AN R 900A
29	OT R 0
30	ST X 0
31	AN R 900B
33	OT R 1
34	ST X 0
35	AN R 900C
37	OT R 2

S1	16-bit equivalent constant or 16-bit area to be compared
S2	16-bit equivalent constant or 16-bit area to be compared

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	A	A	A	A
S2	A	A	A	A	A	A	A	A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

• Compares decimal constant K100 with the contents of data register DT0 when trigger X0 turns ON. The compared result is stored in special internal relays R900A, R900B, and R900C.

When DT0 > K100, R900A turns ON and internal relay R0 turns ON.
When DT0 = K100, R900B turns ON and internal relay R1 turns ON.
When DT0 < K100, R900C turns ON and internal relay R2 turns ON.

In this program example, the comparison will be performed only when X0 turns ON.

Description

• Compares the 16-bit data specified by S1 with one specified by S2 when the trigger turns ON. The compared result is stored in special internal relays R9009, and R900A to R900C.

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See notes below.)

• The following table lists the conditions of carry flag (R9009), > flag (R900A), = flag (R900B), and < flag (R900C), depending on the relative sizes of S1 and S2.

Comparison between S1 and S2	Flag			
	R900A (> flag)	R900B (= flag)	R900C (< flag)	R9009 (carry flag)
S1 < S2	OFF	OFF	ON	↕
S1 = S2	OFF	ON	OFF	OFF
S1 > S2	ON	OFF	OFF	↕

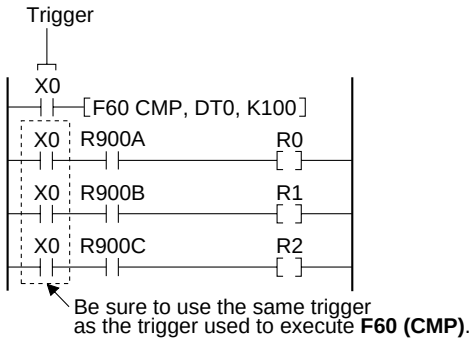
" ↕ ": turns ON or OFF according to the conditions

Notes:

• Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix "B" on the part number have this function.)
• When using special internal relays R9008, R9009, R900A, R900B and R900C as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
• Refer to page 223, "8-3. Table of Special Internal Relays", for details about error flags.

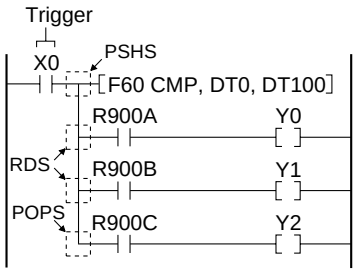
Notes:

• Do not forget to program the same trigger as the instruction to get the accurate comparison result. Even if special relays are also programmed in other parts of the program, the trigger prevents the result of the other instruction from affecting them.



• You can also program the above using the **PSHS**, **RDS**, and **POPS** instructions.

[Ladder diagram]

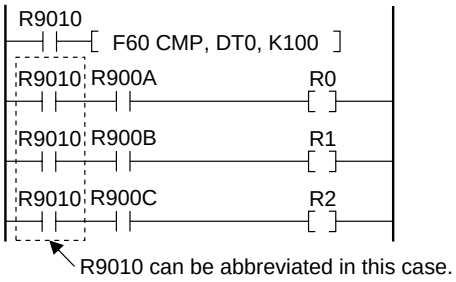


[Boolean Non-ladder]

```
ST    X      0
PSHS
F60         CMP
      DT     0
      DT     100
RDS
AN    R      900A
OT    Y      0
RDS
AN    R      900B
OT    Y      1
POPS
AN    R      900C
OT    Y      2
```

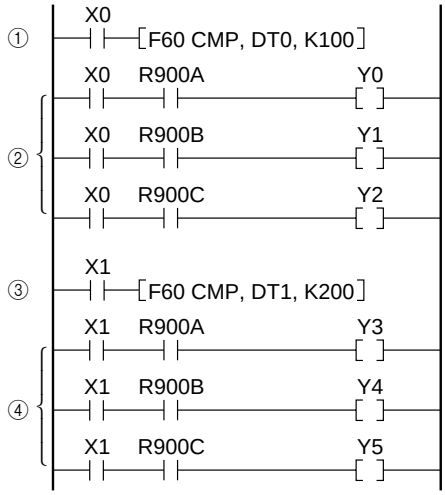
Notes:

- If you program the **F60 (CMP)** instruction using special internal relay R9010 (ON all the time), the same trigger as the instruction need not be programmed.



- The comparison instruction flags R900A to R900C are updated with each execution of the comparison instruction. If you use two or more comparison instructions in your program, be sure to use the flags immediately after each comparison instruction using the output relays or the internal relays.
  The compared result of ① is stored in the output relays (Y0, Y1, and Y2) of program ②.
  The compared result of ③ is stored in the output relays (Y3, Y4, and Y5) of program ④.

Program example:
Compares DT0 with K100 when X0 turns ON, and DT1 with K200 when X1 turns ON



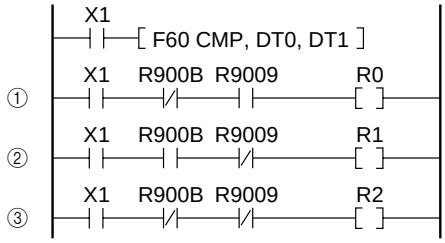
- When comparing special data, such as BCD or binary without signs, flags R9009, R900A, R900B, and R900C move as shown in the table below. In this case, construct your program as shown in the program example below, using special internal relays R900B and R9009.

Comparison between S1 and S2	Flag			
	R900A (> flag)	R900B (= flag)	R900C (< flag)	R9009 (carry flag)
S1 < S2	↕	OFF	↕	ON
S1 = S2	OFF	ON	OFF	OFF
S1 > S2	↕	OFF	↕	OFF

"↕": turns ON or OFF according to the conditions

Program example:
Compares two BCD data in DT0 and DT1.

①...When DT0 < DT1, internal relay R0 turns ON
②...When DT0 = DT1, internal relay R1 turns ON
③...When DT0 > DT1, internal relay R2 turns ON



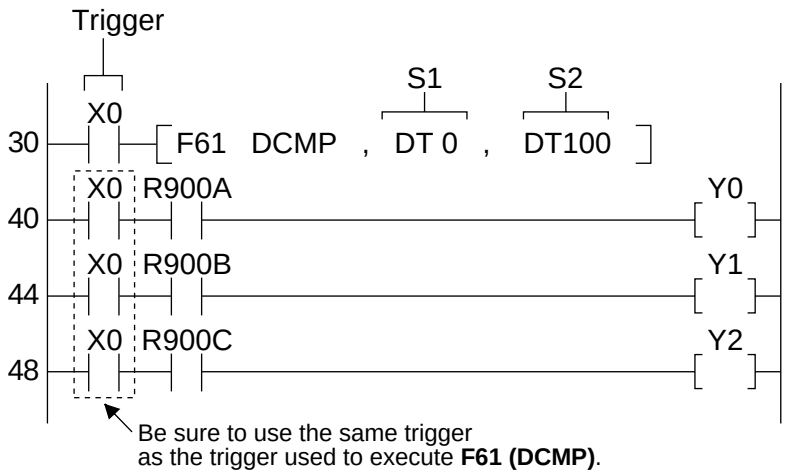
F61 (DCMP) 32-bit data compare

Step	Availability
9	All series

Outline Compares one 32-bit data with another.

Program example

Ladder Diagram



Boolean Non-ladder

Address	Instruction
30	ST X 0
31	F 61 (DCMP)
	DT 0
	DT 100
40	ST X 0
41	AN R 900A
43	OT Y 0
44	ST X 0
45	AN R 900B
47	OT Y 1
48	ST X 0
49	AN R 900C
51	OT Y 2

S1	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared
S2	32-bit equivalent constant or lower 16-bit area of 32-bit data to be compared

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S1	A	A	A	A	A	A	A	N/A	A	A	A
S2	A	A	A	A	A	A	A	N/A	A	A	A

A: Available
N/A: Not Available

■ Explanation of example

• Compares the content of data registers DT101 and DT100 with the content of data registers DT1 and DT0 when trigger X0 turns ON.
The compared result is stored in special internal relays R900A, R900B, and R900C.
When (DT1 and DT0) > (DT101 and DT100), R900A turns ON and external output relay Y0 turns ON.
When (DT1 and DT0) = (DT101 and DT100), R900B turns ON and external output relay Y1 turns ON.
When (DT1 and DT0) < (DT101 and DT100), R900C turns ON and external output relay Y2 turns ON.
In this program example, the comparison will be performed only when X0 turns ON.

Note:

• When processing 32-bit data, the higher 16-bit areas (S1+1, S2+1) are automatically decided if the lower 16-bit areas (S1, S2) are specified.
e.g., S1+1 (higher) = DT1, S1 (lower) = DT0
S2+1 (higher) = DT101, S2 (lower) = DT100

Description

• Compares the 32-bit data or 32-bit equivalent constant specified by S1 with one specified by S2 when the trigger turns ON. The compared result is stored in special internal relays R9009, and R900A to R900C.

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9017 and held. (See note below.)

• Error flag (R9008): Turns ON for an instant when the area specified using the index modifier exceeds the limit. The error address is transferred to DT9018. (See note below.)

• The following table lists the conditions of carry flag (R9009), > flag (R900A), = flag (R900B), and < flag (R900C), depending on the relative sizes of (S1+1, S1) and (S2+1, S2).

Comparison between (S1+1, S1) and (S2+1, S2)	Flag			
	R900A (> flag)	R900B (= flag)	R900C (< flag)	R9009 (carry flag)
(S1+1, S1) < (S2+1, S2)	OFF	OFF	ON	↕
(S1+1, S1) = (S2+1, S2)	OFF	ON	OFF	OFF
(S1+1, S1) > (S2+1, S2)	ON	OFF	OFF	↕

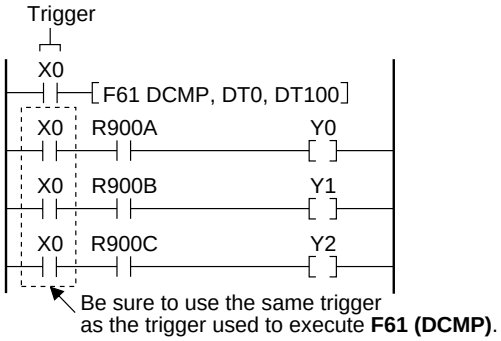
" ↕ ": turns ON or OFF according to the conditions

Notes:

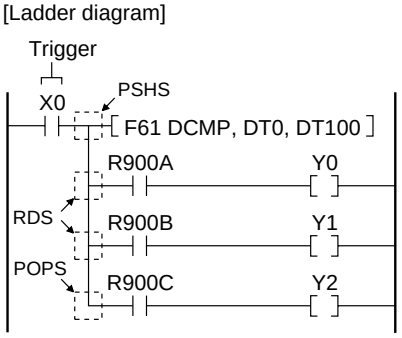
- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix "B" on the part number have this function.)
- When using special internal relays R9008, R9009, R900A, R900B, and R900C as the flags for this instruction, be sure to program the flags at the address immediately after the instruction.
- Refer to page 223, "8-3. Table of Special Internal Relays", for details about error flags.

Notes:

• Do not forget to program the same trigger as the instruction to get the accurate comparison result. Even if special relays are also programmed in other parts of the program, the trigger prevents the result of the other instruction from affecting them.



• You can also program the above using the **PSHS**, **RDS**, and **POPS** instructions.

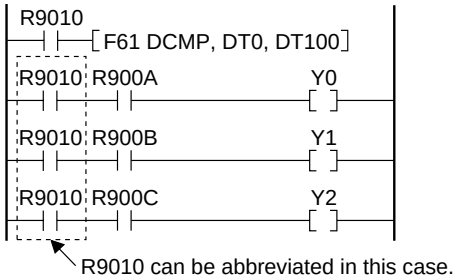



```
[Boolean Non-ladder]
ST    X      0
PSHS
F61   DCMP
      DT     0
      DT     100
RDS
AN    R      900A
OT    Y      0
RDS
AN    R      900B
OT    Y      1
POPS
AN    R      900C
OT    Y      2
```

Continued

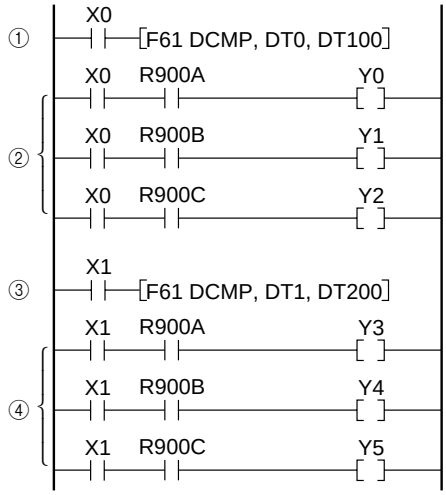
Notes:

- If you program the **F61 (DCMP)** instruction using special internal relay R9010 (ON all the time), the same trigger as the instruction need not be programmed.



- The comparison instruction flags R900A to R900C are updated with each execution of the comparison instruction. If you use two or more comparison instructions in your program, be sure to use the flags immediately after each comparison instruction using the output relays or the internal relays.
  The compared result of ① is stored in the output relays (Y0, Y1, and Y2) of program ②.
  The compared result of ③ is stored in the output relays (Y3, Y4, and Y5) of program ④.

Program example:
Compares DT0 with DT100 when X0 turns ON, and DT1 with DT200 when X1 turns ON



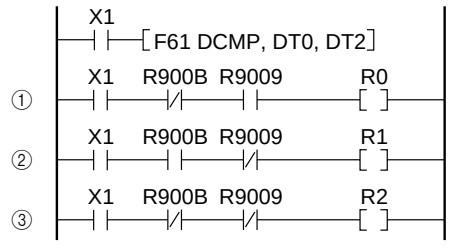
- When comparing special data, such as BCD or binary without signs, flags R9009, R900A, R900B, and R900C move as shown in the table below. In this case, construct your program as shown in the program example below, using special internal relays R900B and R9009.

Comparison between (S1+1, S1) and (S2+1, S2)	Flag			
	R900A (> flag)	R900B (= flag)	R900C (< flag)	R9009 (carry flag)
(S1+1, S1) < (S2+1, S2)	↕	OFF	↕	ON
(S1+1, S1) = (S2+1, S2)	OFF	ON	OFF	OFF
(S1+1, S1) > (S2+1, S2)	↕	OFF	↕	OFF

" ↕ ": turns ON or OFF according to the conditions

Program example:
Compares two BCD data in (DT1, DT0) and (DT3, DT2).

① ...When (DT1, DT0) < (DT3, DT2), internal relay R0 turns ON
② ...When (DT1, DT0) = (DT3, DT2), internal relay R1 turns ON.
③ ...When (DT1, DT0) > (DT3, DT2), internal relay R2 turns ON



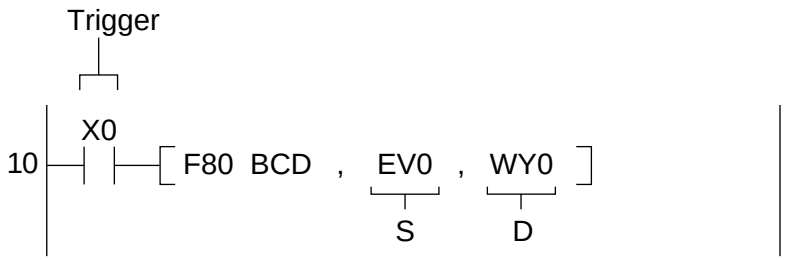
F80 (BCD) 16-bit data → 4-digit BCD data

Step	Availability
5	All series

Outline Converts 16-bit binary data to BCD code that expresses 4-digit decimals.

Program example

Ladder Diagram



Boolean Non-ladder	
Address	Instruction
10	ST X 0
11	F 80 (BCD)
	EV 0
	WY 0

S	16-bit equivalent constant or 16-bit area for storing binary data (source) Available range: K0 to K9999
D	16-bit area for 4-digit BCD code (destination)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S	A	A	A	A	A	A	A	A	A	A	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

■ Explanation of example

• Converts the contents of timer/counter elapsed value area EV0 to BCD code that expresses 4-digit decimals when trigger X0 turns ON. The converted data is stored in word external output relay WY0.

Source [S]: K16

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
EV0	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 0
Decimal	K16			

X0: ON

Destination [D]: H16 (BCD)

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WY0	0 0 0 0	0 0 0 0	0 0 0 1	0 1 1 0
BCD H code	0	0	1	6

Description

- Converts the 16-bit binary data specified by S to the BCD code that expresses 4-digit decimal when the trigger turns ON.
  The converted data is stored in D.
- The binary data that can be converted to BCD code are in the range of K0 (H0) to K9,999 (H270F).

■ Flag condition

- Error flag (R9007): Turns ON and keeps the ON state,
  - when the area specified using the index modifier exceeds the limit.
  - when the 16-bit binary data outside the range of K0 (H0) to K9,999 (H270F) is converted.

  The error address is transferred to DT9017 and held. (See notes below.)
- Error flag (R9008): Turns ON for an instant,
  - when the area specified using the index modifier exceeds the limit.
  - when the 16-bit binary data outside the range of K0 (H0) to K9,999 (H270F) is converted.

  The error address is transferred to DT9018. (See notes below.)

Notes:

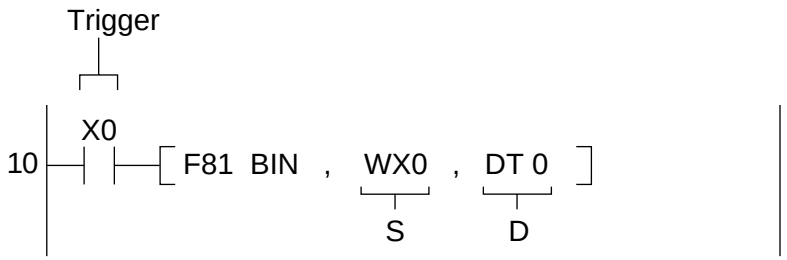
- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
- When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
- Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

F81 (BIN) 4-digit BCD data → 16-bit data

Step	Availability
5	All series

Outline Converts BCD code that expresses 4-digit decimals to 16-bit binary data.

Program example

Ladder Diagram	Boolean Non-ladder	
	Address	Instruction
	10	ST X 0
	11	F 81 (BIN)
		WX 0
		DT 0

S	4-digit BCD equivalent constant or 16-bit area for 4-digit BCD data (source)
D	16-bit area for storing 16-bit binary data (destination)

■ Operands

Operand	Relay			Timer/Counter		Register	Index register		Constant		Index modifier
	WX	WY	WR	SV	EV	DT	IX	IY	K	H	
S	A	A	A	A	A	A	A	A	A*	A**	A
D	N/A	A	A	A	A	A	A	A	N/A	N/A	A

A: Available
N/A: Not Available

* The K constant available here is in the range of K0 to K9999.
** The H data specified here should be in the form of BCD code that express 4-digit decimal ranging from H0 (BCD) to H9999 (BCD).

■ Explanation of example

• Converts word external input relay WX0 to 16-bit binary data when trigger X0 turns ON.
The converted data is stored in data register DT0.

Source [S]: H15 (BCD)

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
WX0	0 0 0 0	0 0 0 0	0 0 0 1	0 1 0 1
BCD H code	0	0	1	5

X0: ON

Destination [D]: K15

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
DT0	0 0 0 0	0 0 0 0	0 0 0 0	1 1 1 1
Decimal	K15			

Description

• Converts the BCD code that expresses 4-digit decimals specified by S to 16-bit binary data when the trigger turns ON. The converted data is stored in D.

■ Flag condition

• Error flag (R9007): Turns ON and keeps the ON state,
- when the area specified using the index modifier exceeds the limit.
- when the data specified by S is not BCD data.
The error address is transferred to DT9017 and held. (See notes below.)

• Error flag (R9008): Turns ON for an instant,
- when the area specified using the index modifier exceeds the limit.
- when the data specified by S is not BCD data.
The error address is transferred to DT9018. (See notes below.)

Notes:

• Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)
• When using special internal relay R9008 as the flag for this instruction, be sure to program the flag at the address immediately after the instruction.
• Refer to page 223, “8-3. Table of Special Internal Relays”, for details about error flags.

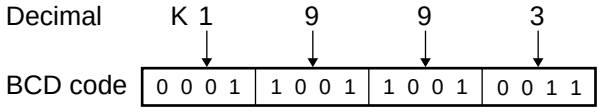
6-4. Hints for Programming High-level Instructions

1. How to Use BCD Data

1) BCD Data

BCD stands for Binary Coded Decimal and is one of the codes represented in binary. It was introduced as convenient way to handle numbers which had to be input to digital machines, and to interpret numbers output from the machine. BCD converts decimal values, which are readily handled by man to binary values, which are readily handled by the equipment. The BCD representation of a decimal number is obtained by simply converting each decimal digit to four binary digits (bits). BCD data are often used when data are input from digital switches or when data are output to 7-segment indicators.

Example: When K1993 (decimal) is expressed in BCD.



Notes:

- In decimal, we have the numbers 0 through 9, whereas in BCD, each of these numbers is represented by a 4-bit binary number and cannot have numbers over 1001 [K9 (decimal)].
- Compared to standard binary, BCD data expresses a smaller range of numbers when the same number of bits are used, as shown in the example.

Example:

	Standard binary data	BCD data
Single word	K-32,768 to K32,767	K0 to K9,999
Double word	K-2,147,483,648 to K2,147,483,647	K0 to K99,999,999

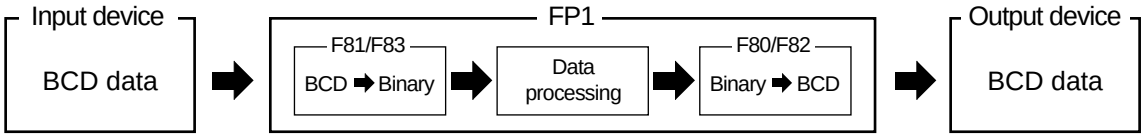
Table of Decimal and BCD

Decimal	BCD (Binary Coded Decimal)
0	0000 0000 0000 0000
1	0000 0000 0000 0001
2	0000 0000 0000 0010
3	0000 0000 0000 0011
4	0000 0000 0000 0100
5	0000 0000 0000 0101
6	0000 0000 0000 0110
7	0000 0000 0000 0111
•	•
•	•
•	•
99	0000 0000 1001 1001
•	•
•	•
•	•
9999	1001 1001 1001 1001

2) Processing BCD Data in the Programmable Controllers

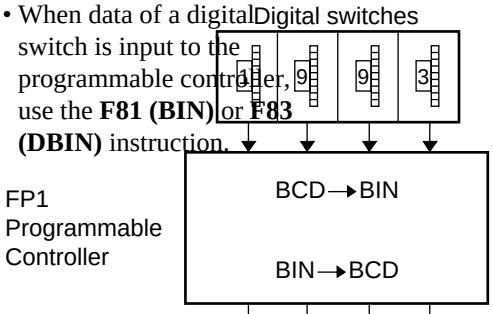
• Since the data in the programmable controllers are basically processed in standard binary, it is recommended that data in the programmable controllers be proceeded by the binary form using the **F80 (BCD)**, **F81 (BIN)**, **F82 (DBCD)**, and **F83 (DBIN)** instructions.

[BCD data flow]

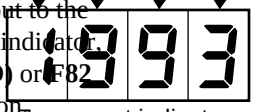


■ Application Example:

• When data of a digital switch is input to the programmable controller, use the **F81 (BIN)** or **F83 (DBIN)** instruction.



• When data is output to the 7-segment digital indicator, use the **F80 (BCD)** or **F82 (DBCD)** instruction.



Decimal	1	9	9	3
BCD data	0 0 0 1	1 0 0 1	1 0 0 1	0 0 1 1

High-level instruction
F81 (4-digit BCD data
→ 16-bit data)

Bit position	15 • • 12	11 • • 8	7 • • 4	3 • • 0
Binary data	0 0 0 0	0 1 1 1	1 1 0 0	1 0 0 1

High-level instruction
F80 (16-bit data
→ 4-digit BCD data)

Decimal	1	9	9	3
BCD data	0 0 0 1	1 0 0 1	1 0 0 1	0 0 1 1

2. How to Use Index Registers (IX, IY)

1) Index Registers (IX, IY)

- Each FP1 has two index registers available (IX and IY).
- The functions of index registers are classified into two types as follows:
  - modifier of other operands
  - memory area

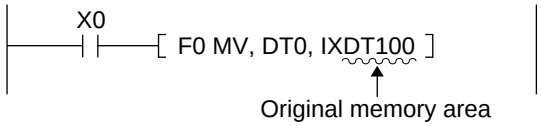
■ When used as modifier of other operands

The index register can be used as a modifier for other operands (WX, WY, WR, SV, EV, DT, and constants K and H) in the high-level and some basic instructions.
With this ability, a single instruction can control as if many instructions were programmed.

- **Address modifier function (for WX, WY, WR, SV, EV, and DT)**
  When the index register is programmed together with another operand (WX, WY, WR, SV, EV, or DT), the address of the original memory area is shifted as many times as the value in the index register (IX or IY).
  When the index register is used as an address modifier, IX and IY work independently.

Example: When the data in the DT0 is transferred to a data register (DT) specified by the DT100 and the IX.

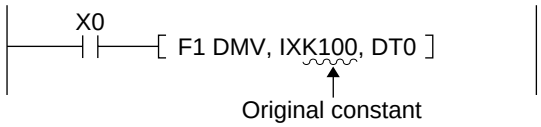
When IX = K10,
the data in DT0 is transferred to DT110.
When IX = K20,
the data in DT0 is transferred to DT120.



- **Constant modifier function (for K and H)**
  When the index register is programmed together with a constant (K or H), the value in the index register is added to the original constant value (K or H).
  When the index register is used as a constant modifier, pay attention to the following:
  - in the 16-bit instruction...IX and IY can be used independently.
  - in the 32-bit instruction...IX is regarded as lower 16-bit and IY as higher 16-bit (only IX can be specified).

Example: The added result of K100 and the data in IY and IX is written to DT0.

When IY, IX = K10,
K110 is written to DT1 and DT0.
When IY, IX = K1,000,000,
K1,000,100 is written to DT1 and DT0.



Notes:

- The index register cannot be modified with an index register.
- When the index register is used as an address modifier, be sure to check that the shifted address does not exceed its last address. If the shifted address is beyond its last address, an operation error occurs and the ERR. LED turns ON. For details about operation errors, refer to page 196, “3. Operation Errors”.
- When the index register is used as a constant modifier, the modified data may overflow or underflow.

■ When used as memory area

- When the index registers are used as a 16-bit memory area, IX and IY work independently.
- When the index registers are used as a 32-bit memory area, IX is regarded as lower 16-bit and IY as higher 16-bit. When programming it as a 32-bit operand, if you specify IX, IY is automatically specified as higher 16-bit.

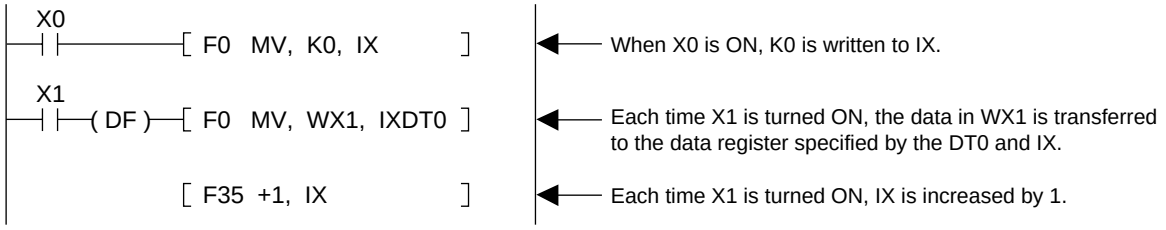
Higher 16-bit	Lower 16-bit
IY	IX

2) Application Examples of Index Registers (IX, IY)

■ Saving/Outputting data in the same order that it is received/stored

Example 1: When saving the data in the same order in which it is received

• The data input from WX1 is transferred to the data registers starting from DT0 in the same order in which it is received.

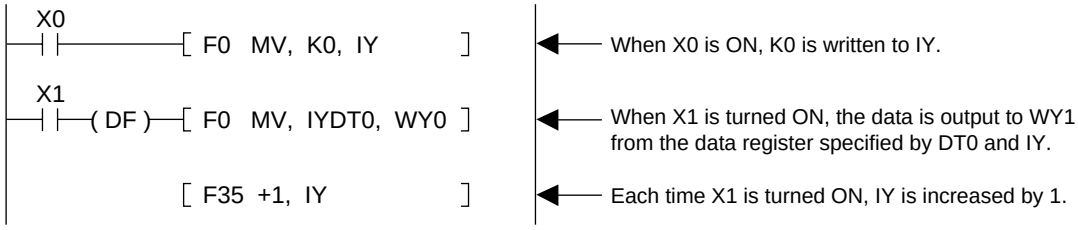


The contents of IX and the destination register address are changed as shown in the following table.

Input times of X1	Contents of IX	Destination data register
1st	0 → 1	DT0
2nd	1 → 2	DT1
3rd	2 → 3	DT2
⋮	⋮	⋮

Example 2: When outputting the data in the same order in which it is stored.

• The data is output to WY0 starting from DT0 in the same order in which it is stored.



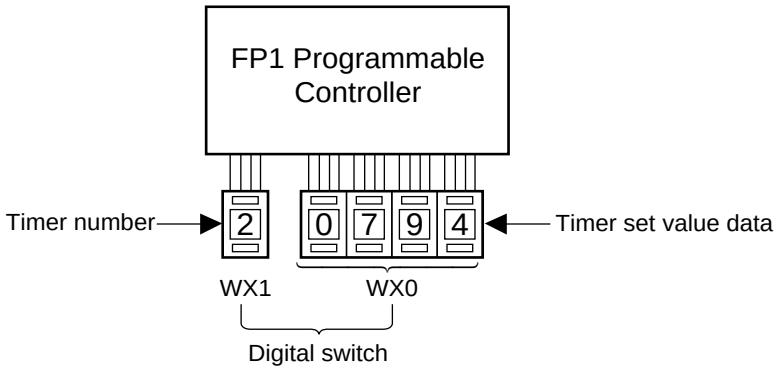
The contents of IY and the source data register address are changed as shown in the following table.

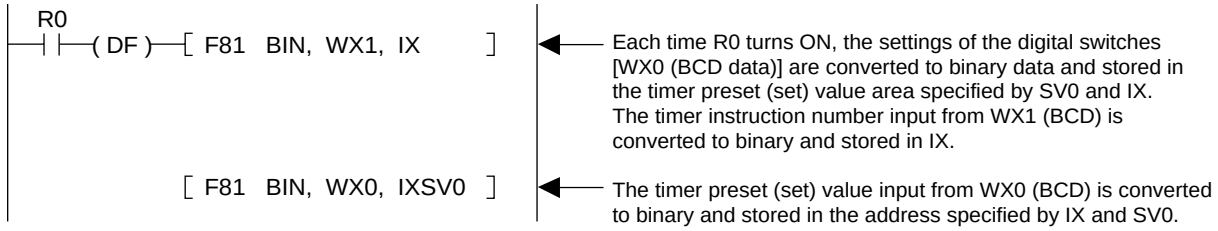
Input times of X1	Contents of IY	Source data register address
1st	0 → 1	DT0
2nd	1 → 2	DT1
3rd	2 → 3	DT2
⋮	⋮	⋮

■ Setting/Displaying data according to digital switch input

Example 1: When setting the timer set (preset) values input from the digital switch

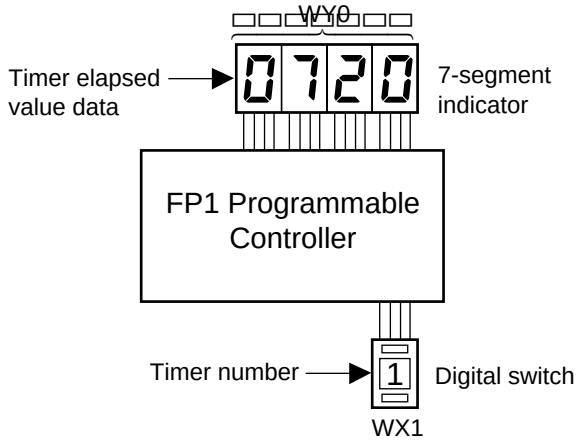
- The selection of the timer instruction number is performed using the input from the digital switches (WX1). The timer preset (set) value can be input from the digit switches (WX0).

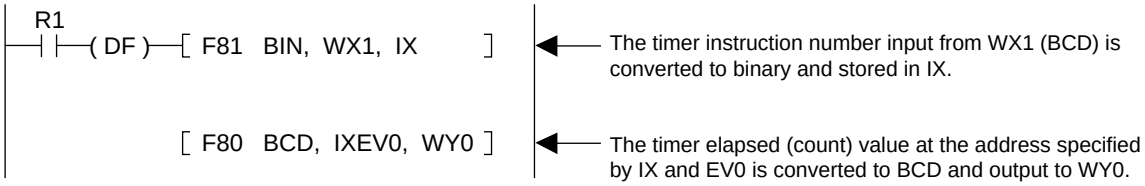




Example 2: When displaying the data in the programmable controller

- The elapsed value of the timer instruction is displayed on the 7-segment digital indicators (WY0). The timer instruction number is selected by the input from the digital switch (WX1).





3. Operation Errors

1) Operation Errors

- An operation error is one of the errors in the programmable controllers. These errors occur when an instcruction [one of high-level/some basic (e.g., **ST =**) instructions] is executed abnormally.
- When an operation error occurs, operation of the programmable controller stops. At the same time, operation error flags R9007 and R9008 turn ON, the error address is stored in DT9017 and DT9018, the error code [K45 (H2D)] is set at DT9000, and the ERR. LED lights.

Note:

- FP1s with the error address storage function (the DT9017 and the DT9018 are available) have CPU version 2.7 or later (all FP1s with the suffix “B” on the part number have this function).

2) Types of Operation Error

Item	Description
Address error	This error occurs when the address modified by the index register exceeds its last address in the instruction.
BCD data error	This error occurs when the data not represented in BCD is handled as BCD in the instruction.
Parameter error	This error occurs when the control data is wrongly specified in the instruciton.
Over area error	This error occurs when a block of registers specified as a source exceeds the last address of the operands specified as a destination in the high-level instructions.

3) Status of Programmable Controller When an Operation Error Occurs

- The operation of the programmable controller stops when an operation error occurs. However, when you set system register 26 to “1” (start), the programmable controller operates even if an operation error occurs.
- Refer to page 230, “8-5. System Registers”, for details about how to change the system register number.

4) Steps to Take When an Operation Error Occurs

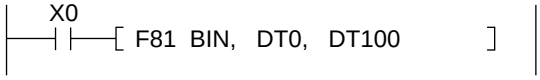
■ Searching the errors

- First, confirm that K45 (H2D) is stored in the special data register DT9000 by using the NPST-GR Software or FP Programmer Ⅱ. This means that an operation error occurred.
- Then check the content of special data register DT9017 to search for the address where the operation error occurred.
- Finally, check the instruction at the address that you got from the step above referring to following examples:

Example 1: Check if an extraordinarily large value or negative value was stored in the index register (IX) used as an address modifier.

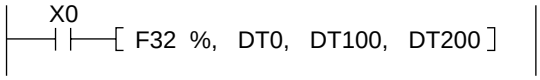
In this case, index register IX modifies the address of data register DT0. If data in the IX is larger than the last address of the data register, an operation error will occur.
If the programmable controller you are using is of the FP1 C14 series, the last address of the data register is DT255. If the data in IX exceeds the range of K0 to K255, an operation error will occur.

Example 2: Check if data not in BCD is stored in the data area when executing the BCD instruction.



In this case, if each 4-bit of the DT0 exceeds the range of K0 to K9, an operation error will occur.

Example 3: Check if the data stored in the divisor is not K0.



In this case, if the content of DT100 is K0, an operation error will occur.

Notes:

- FP1s with the error address storage function (the DT9017 and the DT9018 are available) have CPU version 2.7 or later (all FP1s with the suffix “B” on the part number have this function). If your FP1’s CPU version is eariler than 2.7, use the following procedure.
  - First, confirm that K45 (H2D) is stored in special data register DT9000 by using the NPST-GR Software or FP Programmer Ⅱ. This means that an operation error occurred.
  - Then, check the instructions, instruction by instruction, referring to the examples above. If it is not easy to find the error, reexamine the program dividing it with **ED** instructions.

■ How to escape from error status

- After correcting the program, you can cancel the error status in the following ways:
  - turn the power OFF and then ON.
  - cancel the error status using the NPST-GR Ver 3.1 or the FP Programmer Ⅱ (see notes below).

Notes:

- The error cancellation function is available only for FP1s with CPU Ver. 2.7 or later. (All FP1s with the suffix “B” on the part number have this function.)
- To perform this function, use **OP 112** of the FP Programmer Ⅱ or **STATUS DISPLAY** of the NPST-GR Ver. 3.1 Software. **(This function is not available with a conventional FP Programmer or with NPST-GR Ver. 3.0 or earlier.)**

4. Overflow and Underflow

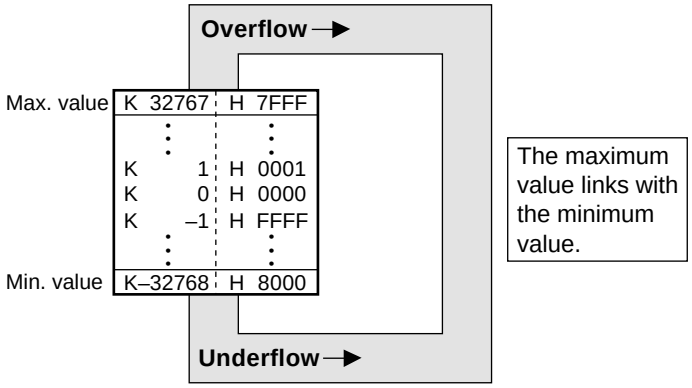
1) Overflow and Underflow

- When performing some instructions, the operation result may exceed the maximum overflow or go below the minimum underflow in the range of 16-bit or 32-bit data.
  When an overflow or underflow occurs, the carry flag (R9009) turns ON.

2) Overflow and Underflow in Binary Operations (16-bit or 32-bit)

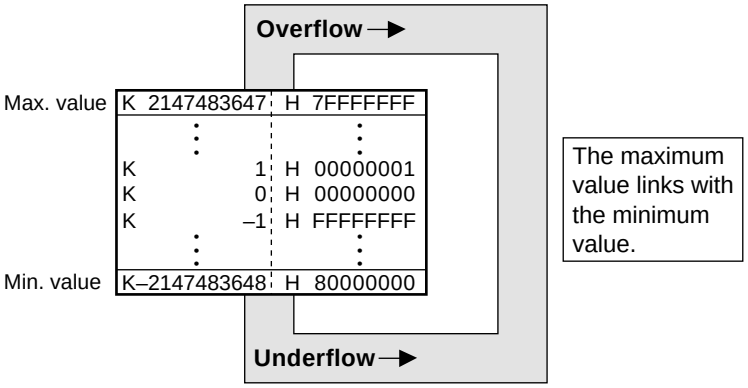
■ 16-bit Binary Operation

- Overflow:
  The result becomes a negative minimum value (K-32768/H8000) if K1 is added to the positive maximum value (K32767/H7FFF).
- Underflow:
  The result becomes a positive maximum value (K32767/H7FFF) if K1 is subtracted from the negative minimum value (K-32768/H8000).

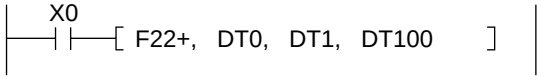


■ 32-bit Binary Operation

- Overflow:
  The result becomes a negative minimum value (K-2147483648/H80000000) if K1 is added to the positive maximum value (K2147483647/H7FFFFFFF).
- Underflow:
  The result becomes a positive maximum value (K2147483647/H7FFFFFFF) if K1 is subtracted from the negative minimum value (K-2147483648/H80000000).



Example:



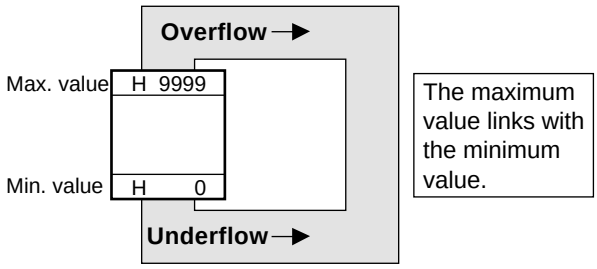
- Overflow
  When DT0 = K32767 and DT1 = K1,
  K-32768 is stored in DT100 and R9009 turns ON.
- Underflow
  When DT0 = K-32768 and DT1 = K-1,
  K32767 is stored in DT100 and R9009 turns ON.

3) Overflow and Underflow in BCD Operations (4-digit or 8-digit)

In BCD data, only positive numbers can be handled in the FP1.

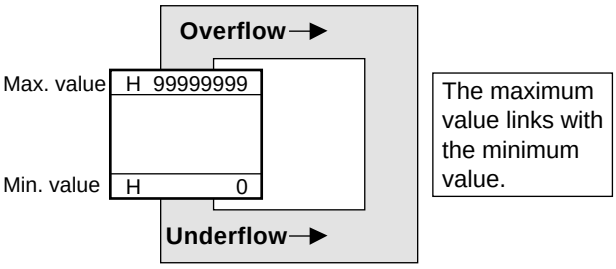
■ 4-digit BCD Operation

- Overflow:
  The result becomes a minimum value (H0000) if K1 is added to the maximum value (H9999).
- Underflow:
  The result becomes a maximum value (H9999) if K1 is subtracted from the minimum value (H0000).

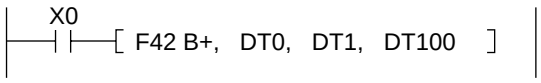


■ 8-digit BCD Operation

- Overflow:
  The result becomes a minimum value (H00000000) if K1 is added to the maximum value (H99999999).
- Underflow:
  The result becomes a maximum value (H99999999) if K1 is subtracted from the minimum value (H00000000).



Example:



- Overflow
  When DT0 = H9999 and DT1 = H1 (BCD),
  H0 (BCD) is stored in DT100 and R9009 turns ON.
- Underflow
  When DT0 = H0 and DT1 = H-1,
  H9999 is stored in DT100 and R9009 turns ON.

CHAPTER 7

TROUBLESHOOTING

7-1. Self-diagnostic Function

FP1 programmable controllers use the self-diagnostic function when something goes wrong with the FP1. The abnormalities detected by the self-diagnostic function are divided into three categories:

• Self-diagnostic error

This type of error is detected when the following occurs:
- Hardware problem in CPU or ROM, and backup battery problem. (ROM, system, interrupt, or battery abnormality)
- An instruction is incorrectly executed in RUN mode (operation error).

• Total-check error

This type of error is detected by a total-check operation when the following occurs. The total-check operation is performed when the mode selector is changed from PROG. to RUN.
- Program abnormalities such as syntax errors, duplicated use of output, and instruction combination errors. (syntax error, duplicated output error, not paired error, mismatch error, program area error, operand error)

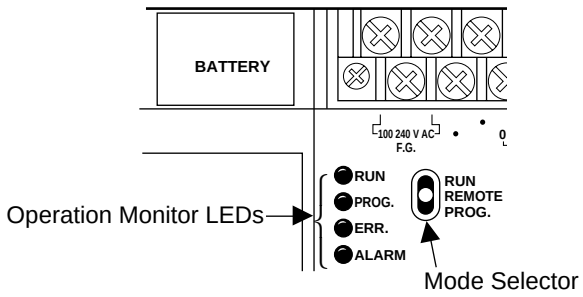
The total-check operation can also be performed by using the FP Programmer Ⅱ (OP9 function) or the NPST-GR Software [“1.TOTALLY CHECK A PROGRAM” (menu 1) or “V.TOTALLY CHECK” (menu 2)].

• System watchdog timer error

This type of error is detected when the following occurs:
- program scan time is extraordinarily long
- hardware abnormality is detected

1. Operation Monitor LEDs When an Error Occurs

The status of the Operation Monitor LEDs on the Control Unit vary, as shown in the table below.



Content	Position of the Mode Selector	LED status			
		RUN	PROG.	ERR.	ALARM
Normal operation	RUN	ON	OFF	OFF	OFF
	PROG.	OFF	ON	OFF	OFF
Forcing ON/OFF	RUN	Flash	OFF	Varies	OFF
	PROG.	OFF	ON	Varies	OFF
When a self-diagnostic error occurred	RUN	Varies	Varies	ON	OFF
	PROG.	OFF	ON	ON	OFF
When a total-check error occurred	RUN	OFF	ON	ON	OFF
	PROG.	OFF	ON	OFF	OFF
When a system watchdog timer error occurred	RUN	Varies	Varies	Varies	ON
	PROG.	Varies	Varies	Varies	ON

2. Operation Status When an Error Occurs

When an error occurs, the FP1 usually stops operating. However, regarding duplicated output errors, a backup battery abnormality, and operation errors, you can continue operation by changing the system register settings.

1) Duplicated Output Error (Total-check Error)

• If the duplicated use of output is detected, the FP1 stops operating and the ERR. LED turns ON.
When you change system register 20 settings using the FP Programmer Ⅱ or NPST-GR Software, duplicated output is not regarded as an error and the FP1 continues to operate. In this case, the ERR. LED does not turn ON.

Duplicated output error: system register 20 (K1 or ENAB)
[FP Programmer Ⅱ: K0 (stops operation), K1 (continues operation)]
[NPST-GR Ver.3.1: DISA (stops operation), ENAB (continues operation)]

2) Battery Error (Self-diagnostic Error)

• If the voltage of the backup battery lowers or if the backup battery disconnects, the ERR. LED turns ON.

Battery error: system register 4 (K1 or NO)
[FP Programmer Ⅱ: K0 (stops operation), K1 (continues operation)]
[NPST-GR Ver. 3.1: YES (stops operation), NO (continues operation)]

Notes:

- C14 and C16 series FP1s do not have a backup battery. Battery errors occur only for C24, C40, C52, and C72 series FP1s.
- FP1s with the battery error disregarding function have CPU version 2.7 or later (all FP1s with a suffix “B” on the part number have this function).

3) Operation Error (Self-diagnostic Error)

• When an instruction [high-level and some basic (e.g., **ST=**) instructions] executes abnormally, an operation error occurs. When an operation error occurs, operation of the programmable controller stops and the ERR. LED turns ON.
However, when you change system register 26 settings using the FP Programmer Ⅱ or NPST-GR Software (Ver.3.1 or later), the FP1 continues to operate. In this case, even if the FP1 continues to operate, this is regarded as an error and the ERR. LED stays ON.

Operation error: system register 26
[FP Programmer Ⅱ: K0 (stops operation), K1 (continues operation)]
[NPST-GR Ver.3.1: STOP (stops operation), STRT (continues operation)]

7-2. Troubleshooting

1. Points to be Checked When an Error Occurs

When an abnormality is detected, check the following points.

- If the ERR. LED is turned ON,
  refer to page 205, ■ **When an ERR. LED is ON.**
- If the ALARM LED is turned ON,
  refer to page 209, ■ **When an ALARM LED is ON.**
- If the all LEDs are turned OFF,
  refer to page 210, ■ **When all LEDs are OFF.**
- If the output do not work,
  refer to page 211, ■ **Diagnosing output malfunction.**
- If the communication error is detected by the NPST-GR Software,
  refer to page 214, ■ **When “PLC = COMM. ERR” is displayed on the NPST-GR screen.**
- If the protect error is detected by the programming tool,
  refer to page 215, ■ **When “PROTECT ERROR” is displayed.**

Note:

- Check the entire system including peripheral devices, referring the following:
  - Observe what is happening.
  - Check for error repetition.
  - Check the status of indicators.
  - Check that power is properly supplied to the programmable controller.
  - Check whether the trouble detected is in the programmable controller or in other devices.
  - Check whether the trouble detected is in the I/O section or other parts.
  - Check whether there is problem with the program or not.

■ When an ERR. LED is ON

<Condition: an error is detected by the self-diagnostic function>

Set the mode selector of the programmable controller from RUN to PROG.

Is ERR. LED on the programmable controller turned OFF?

NO (ERR. LED ON) **Go to page 207.**

YES (ERR. LED OFF)

Probably a total-check error.
Check the program using the programming tool.

• Using NPST-GR Software Ver. 3.1

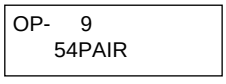
<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, and then select "CHECK A PROGRAM" to skip to the [CHECK A PROGRAM] subwindow. In the [CHECK A PROGRAM] subwindow, select "1. TOTALLY CHECK A PROGRAM".

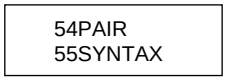
<If you are using MENU 2 screen type>
Open [ONLINE MONITOR FUNCTION MENU] by pressing **Esc**, and then select "V. TOTALLY CHECK".

In the [TOTALLY CHK] window, press **F1** to execute the program check.
You can get the address and program where a total-check error occurs. The type of errors can also be displayed.

• Using FP Programmer II

Press the keys on the FP Programmer II as shown on the right.
When a total-check error occurs, the screen shown on the right is displayed.
You can find the address and program where a total-check error occurs by pressing the READ ▼ key.





(Next page)

Correct the program according to the following table.

Total-check error code

Error code	Name of error	Description	Steps to take
E1	Syntax error (SYNTAX)	Instruction is incorrectly programmed.	Input the instruction correctly, referring to the description for that instruction.
E2	Duplicated output error (DUP USE)	Two or more **OT** instructions are programmed using same relay.	Correct the program so that one relay is not used for two or more **OT** instructions.
E3	Not paired error (PAIR)	One of the instructions, which must be paired, is missing (e.g., **JP** and **LBL**). The paired instruction sets may have been programmed in the incorrect order (e.g., **MC** and **MCE**).	Program the missing instruction. Program the instruction sets in the proper order, referring to the description of the instruction.
E4	System register parameter error (MISMATCH)	The operand for the instruction is out of the range set in the system register.	Check the system register parameter using a FP Programmer II (OP50) or NPST-GR Software (1. SYSTEM REGISTER in the PLC CONFIGURATION).
E5	Program area error (PRG AREA)	The instruction has been programmed in the incorrect position (e.g., **INT** and **IRET** instructions are programmed at the address before the **ED** instruction).	Program the instruction in the proper position, referring to the description of the instruction.
E8	Operand error (OPR COMBI)	Incorrect operand has been entered for the instruction.	Program the instruction using the correct operand, referring to the description of the instruction.

Set the mode selector of the programmable controller from PROG. to RUN.

From page 205

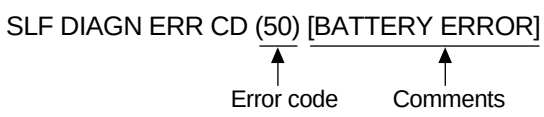
Probably a self-diagnostic error.
Check the program using the programming tool.

• Using NPST-GR Software Ver. 3.1

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, and then select "MONITOR" to skip to the [MONITOR] subwindow. In the [MONITOR] subwindow, select "7. STATUS DISPLAY".

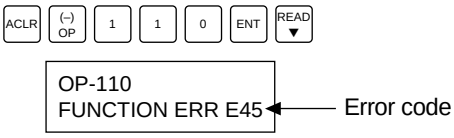
<If you are using MENU 2 screen type>
Open [ONLINE MONITOR FUNCTION MENU] by pressing **Ctrl** + **F10** together, and then select "P. STATUS DISPLAY".

At the bottom of the [STATUS DISPLAY] window, you can find the error code in "( )", represented in decimal, and comments in "[ ]", as shown on the right.



• Using FP Programmer II

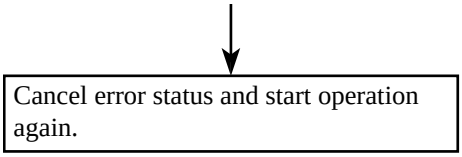
Press the keys on the FP Programmer II as shown on the right.
When self-diagnostic error occurs, the screen shown on the right is displayed.



Self-diagnostic error code

Error code	Name of error	Description	Steps to take
E26	ROM error	C14 and C16 series: Probably an abnormality in the internal EEPROM.	Please contact us.
		C24, C40, C56, and C72 series: Probably an abnormality in the Memory Unit or Master Memory Unit.	Program the Memory or Master Memory Unit again and try to operate. If the same error is detected, try to operate with another Memory or Master Memory Unit.
E28	System register error	Probably an abnormality in the system register.	Initialize the system register and set it again.
E31	Interrupt error	Probably a hardware abnormality or an abnormality caused by noise.	Check the surrounding noise level.
E32			
E45	Operation error	Probably an abnormality was detected when an instruction (a high-level or basic instruction) was executed.	Check the program, referring to page 196.
E50	Battery error	The voltage of the backup battery lowers or the connector of the backup battery is disconnected.	Replace the backup battery, referring to the page 216.

(Next page)



• You can cancel the error status in the following ways:
- Turn the power OFF and then ON.
- Cancel the error status using the NPST-GR Software Ver. 3.1 or the FP Programmer Ⅱ (See notes).

Notes:

- The error cancellation function of the programming tool is available for FP1s with CPU Ver. 2.7 or later. (All FP1s with the suffix “B” on the part number have this function.)
- To perform this function, use “OP 112” of the FP Programmer Ⅱ or [STATUS DISPLAY] of NPST-GR Software Ver. 3.1. (This function is not available with a conventional FP Programmer or with NPST-GR Software Ver. 3.0 or earlier.)

■ When an ALARM LED is ON

<Condition: a system watchdog timer error occurs>

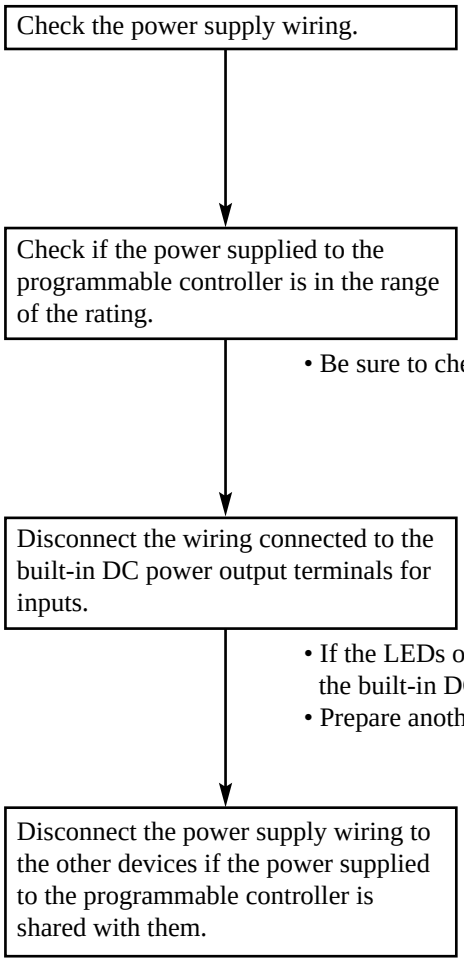
Set the mode selector of the programmable controller from RUN to PROG. and turn the power OFF and then ON.

- If the ALARM LED is turned ON again, there is probably an abnormality in the FP1. Please contact your dealer.
- If the ERR. LED is turned ON, go to page 205, ■ When an ERR. LED is ON.

Set the mode selector of the programmable controller from PROG. to RUN.

- If the ALARM LED is turned ON, the program execution time is too long. Check the program, referring the following:
  - Check if instructions such as **JP** or **LOOP** are programmed in such a way that a scan can never finish.
  - Check that interrupt instructions are executed in succession.

■ When all LEDs are OFF



- Be sure to check the fluctuation in the power supply.

- If the LEDs on the programmable controller turn ON at this moment, the capacity of the built-in DC power supply is not enough to control the load.
- Prepare another power supply to control the input devices.

- If the LEDs on the programmable controller turn ON at this moment, the capacity of the power supply is not enough to control other devices as well.
- Prepare another power supply for other devices or increase the capacity of the power supply.

■ Diagnosing output malfunction

<First check the output condition and then the input condition>

① Output condition: the output indicators are ON

Check the wiring of the output devices.

↓

Check if the power is properly supplied to the output devices.

- If the power is properly supplied to the load, there is probably an abnormality in the load. Check the load again.
- If the power is not supplied to the load, there is probably an abnormality in the FP1's output.
  Please contact your dealer.

② Output condition: the output indicators are OFF

Monitor the output condition using a programming tool.

How to monitor the outputs:

• Using the NPST-GR Software Ver. 3.1

<If you are using MENU 1 screen type>

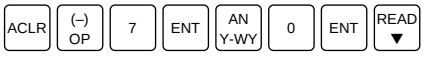
Open [NPST MENU] by pressing **Esc**, then select "MONITOR" to skip to the [MONITOR] subwindow.
In the [MONITOR] subwindow, select "3. MONITOR LISTED RELAYS".

<If you are using MENU 2 screen type>

Open [ONLINE MONITOR FUNCTION MENU] by pressing **Ctrl** and **F10** together, then select "I. LISTED RELAYS".

• Using the FP Programmer II

Press the keys on the FP Programmer II as shown on the right.



If the output monitored is turned ON, there is probably a duplicated output error.
Refer to page 141, for details about the duplicated output error.

↓

(Next page)

Forcing ON the output using a programming tool.

• Using NPST-GR Software Ver. 3.1

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, then select "RELAYS/REGISTERS" to skip to the [RELAYS/REGISTERS] subwindow.
In the [RELAYS/REGISTERS] subwindow, select "1. FORCE I/O".

<If you are using MENU 2 screen type>
Open [ONLINE MONITOR FUNCTION MENU] by pressing **Ctrl** and **F10** together, then select "D. FORCE I/O".

• Using FP Programmer II

Press the keys on the FP Programmer II as shown on the right.

Check if the output indicator is ON.

- If the output indicator is turned ON, go to input condition check.
- If the output indicator remains OFF, there is probably an abnormality in the FP1's output circuit.
  Please contact your dealer.

③ Input condition: the input indicators are ON

Monitor the input condition using a programming tool.

How to monitor the inputs:

• Using NPST-GR Software Ver. 3.1

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, then select "MONITOR" to skip to the [MONITOR] subwindow.
In the [MONITOR] subwindow, select "3. MONITOR LISTED RELAYS".

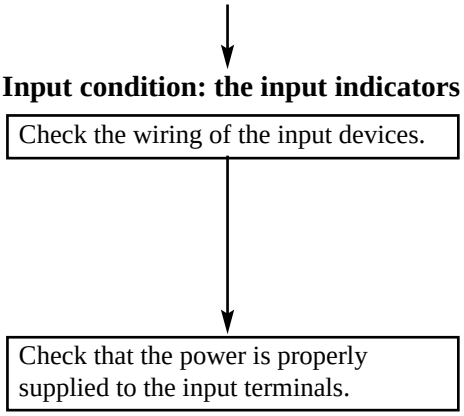
<If you are using MENU 2 screen type>
Open the [ONLINE MONITOR FUNCTION MENU] by pressing **Ctrl** and **F10** together, then select "I.LISTED RELAYS".

• Using the FP Programmer II

Press the keys on the FP Programmer II as shown on the right.

If the input monitored is OFF, there is probably an abnormality with the FP1's input.
Please contact your dealer.
If the input monitored is ON, check the program again.
Also, check for the duplicated use of output or the program flow when a control instruction such as **MC** or **JP** is used.
Refer to page 141, for details about the duplicated output error.

(Next page)



- If the power is properly supplied to the input terminal, there is probably an abnormality in the FP1's internal circuit.
  Please contact your dealer.
- If the power is not properly supplied to the input terminal, there is probably an abnormality in the input device or input power supply.
  Check the wiring again.

■ When "PLC = COMM. ERR" is displayed on the NPST-GR screen

Check if the baud rate settings of the FP1 and NPST-GR are the same.

• NPST-GR baud rate setting

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing the **Esc** key, then select "NPST CONFIGURATION" to skip to the [NPST CONFIGURATION] subwindow. In the [NPST CONFIGURATION] subwindow, select "1. NPST CONFIGURATION".

<If you are using MENU 2 screen type>
Open [NPST FUNCTION MENU] by pressing the **Esc** key, then select "Z. NPST CONFIGURATION".

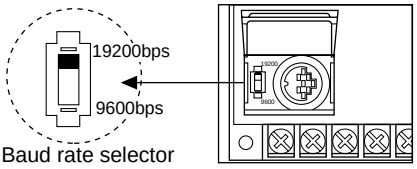
In this window, you can find the baud rate as shown below:

TRNS RATE (bps) [19200 / 9600 / 4800 / 2400 / 1200 / 600 / 300]

Select a baud rate (19200 or 9600), press the **F1** key and select "SAVE DISK ? YES" to register this change onto the disk.

• FP1 baud rate setting

Set the baud rate using the baud rate selector inside the FP1 Control Unit.



Note:

- Even when both the NPST-GR and FP1 are set to 19200 bps, sometimes a computer cannot communicate with the FP1 properly at 19200 bps. If this happens, change both of their settings to 9,600 bps and try again.

Check the cable and the RS422/232C adapter.

- Confirm the cable specifications, referring to the following examples:

RS422/232C Adapter & IBM PC-AT (9 pins)

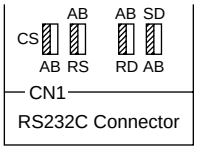
Connected to RS422/232C Adapter (25 pins male)		Connected to IBM PC-AT (9 pins female)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	CD (DCD)
2	SD (TXD)	2	RD (RXD)
3	RD (RXD)	3	SD (TXD)
4	RS (RTS)	4	ER (DTR)
5	CS (CTS)	5	SG
6	DR (DSR)	6	DR (DSR)
7	SG	7	RS (RTS)
8	CD (DCD)	8	CS (CTS)
20	ER (DTR)	9	RI (CI)

RS422/232C Adapter & Personal Computer (25 pins)

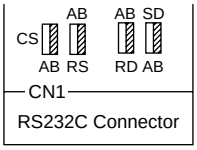
Connected to RS422/232C Adapter (25 pins male)		Connected to Personal Computer (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)

- Confirm the RS422/232C adapter pin setting, referring to the following:

① When the cables described above are used



② When a cable with reverse wiring specifications is used



▨: Denotes the pin position.

When shipped from the factory, the pins are set as shown in ①.

Confirm the setting of the personal computer referring to the manual for your computer.

■ When "PROTECT ERROR" is displayed

① When memory unit (EPROM) or master memory unit (EEPROM) is installed in the programmable controller

If memory unit (EPROM) or master memory unit (EEPROM) is installed on the programmable controller, the program cannot be modified.
Proceed with program modification as follows:

First, turn OFF the power of the programmable controller.
Then, remove the memory unit (EPROM) or the master memory unit (EEPROM) from the programmable controller.

↓

Modify the program using a programming tool.

↓

Save the modified program to the memory unit (EPROM) or master memory unit (EEPROM) and start operation again.
(Refer to page 86, "4-5. Memory Unit Creation and ROM Operation", for details about ROM operation.)

② When a password is set for the programmable controller

Change the setting of the password using a programming tool.

• Using NPST-GR Software Ver. 3.1

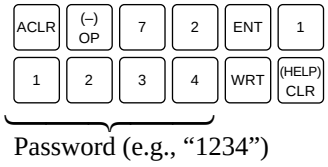
<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing the **Esc** key, and then select "PLC CONFIGURATION" to skip to the [PLC CONFIGURATION] subwindow.
In the [PLC CONFIGURATION] subwindow, select "5. SET PLC PASSWORD".

<If you are using MENU 2 screen type>
Open [NPST FUNCTION MENU] by pressing the **Esc** key in the ONLINE mode, and then select "SET PLC PASSWORD".

In the [SET PLC PASSWORD] window, select ENAB and press the **Enter** key to set the mode of the password setting to enable saving and loading of the program.

• Using FP Programmer II

Press the keys on the FP Programmer II as shown on the right.



7-3. Maintenance

Although programmable controllers have been designed in such a way to minimize maintenance and offer trouble-free operation, several maintenance aspects should be taken into consideration. If preventive maintenance is performed periodically, you will minimize the possibility of system malfunctions.

1. Preventive Maintenance

Item	Check point	Criteria for judgement
Power supply voltage	• Check the power supply condition by measuring it at the power supply terminals of the programmable controller.	AC type: 85 V AC to 264 V AC DC type: 20.4 V DC to 26.4 V DC
Environment	• Ambient temperature (e.g., temperature in the control box) • Ambient humidity (e.g., humidity in the control box) • Is dirt and dust present?	Ambient temperature: 0˚C to 55˚C/32˚F to 131˚F Ambient humidity: 30 % to 85 % RH (no condensation)
I/O power supply voltage	• Measure the operating voltage at the input/output terminals.	Refer to page 43.
Mounting condition	• Are all of the units firmly fixed in place? • Are all the terminal screws securely tightened? • Are wiring and terminals being properly kept?	———
Backup battery	• Is the backup battery being periodically replaced?	Refer to the following. (Part number: AFP1801)

2. Replacement of Backup Battery

1) Battery Life

Control Units	Battery life (at 25˚C/77˚F ambient temperature)
C24, C40, C56, and C72 standard types	Approx. 53,000 hours (approx. 6 years)
C24C, C40C, C56C, and C72C types	Approx. 27,000 hours (approx. 3 years)

• When the voltage of the backup battery lowers, special internal relays R9005 and R9006 turn ON and the ERR. LED turns ON. Replace the backup battery within a month after this battery error is detected.

Caution:

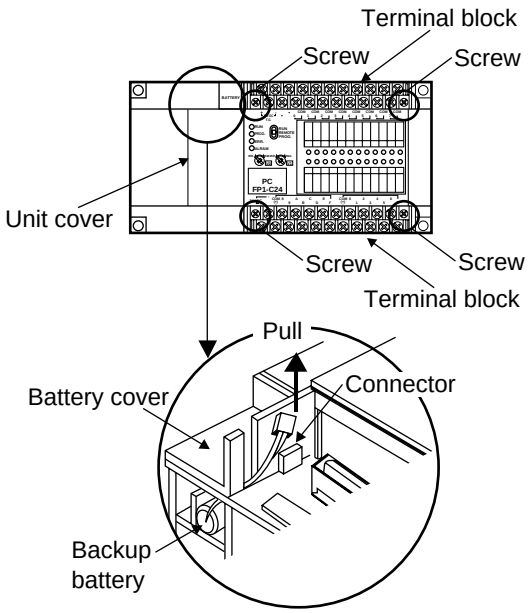
• Never throw batteries into a fire. Do not dispose of them in trash that will be incinerated.

2) How to Replace Backup Battery

• Replace the battery within three minutes, after applying the power to the programmable controller more than one minute.

Procedure

① Turn OFF the power of the programmable controller.
② Remove the memory unit cover.
③ Disconnect the connector of the backup battery and pull it up so that the battery cover is removed, as shown in the figure on the right.
④ Take out the battery by pulling up the lead wire.
⑤ Install a new battery and connect it to the connector on the programmable controller.
⑥ Replace the battery cover and the memory unit cover.
⑦ Turn ON the power of the programmable controller.



3. Removable Terminal

• Removable terminal construction is used for C24, C40, C56, and C72 series Control Units. This makes wiring of the I/O terminal easier.
If the Control Units are replaced for some reason, there will be no need to disconnect and re-connect all the cables to the terminals again by changing the terminal blocks.

CHAPTER 8

APPENDIX

8-1. FP1 I/O Allocation Table

The I/O addresses for the FP1 Control Unit, primary and secondary Expansion Units, and Intelligent Units (FP1 I/O Link Unit, FP1 A/D Converter Unit, and FP1 D/A Converter Unit) are assigned as follows.

Unit type			Input allocation	Output allocation
Control Unit	C14 series		X0 to X7	Y0 to Y4, Y7
	C16 series		X0 to X7	Y0 to Y7
	C24 series		X0 to XF	Y0 to Y7
	C40 series		X0 to XF X10 to X17	Y0 to YF
	C56 series		X0 to XF X10 to X1F	Y0 to YF Y10 to Y17
	C72 series		X0 to XF X10 to X1F X20 to X27	Y0 to YF Y10 to Y1F
Primary Expansion Unit	E8 series	Input type	X30 to X37	———
		I/O type	X30 to X33	Y30 to Y33
		Output type	———	Y30 to Y37
	E16 series	Input type	X30 to X3F	———
		I/O type	X30 to X37	Y30 to Y37
		Output type	———	Y30 to Y3F
	E24 series	I/O type	X30 to X3F	Y30 to Y37
	E40 series	I/O type	X30 to X3F X40 to X47	Y30 to Y3F
Secondary Expansion Unit	E8 series	Input type	X50 to X57	———
		I/O type	X50 to X53	Y50 to Y53
		Output type	———	Y50 to Y57
	E16 series	Input type	X50 to X5F	———
		I/O type	X50 to X57	Y50 to Y57
		Output type	———	Y50 to Y5F
	E24 series	I/O type	X50 to X5F	Y50 to Y57
	E40 series	I/O type	X50 to X5F X60 to X67	Y50 to Y5F
Transmitter Master Unit	SW5: ON SW6: ON (When used as two expansion units)		X30 to X47 X50 to X67	Y30 to Y3F Y50 to Y5F
	SW5: OFF SW6: ON (When used as an expansion unit)		X30 to X47 X50 to X67 (See notes below.)	Y30 to Y3F Y50 to Y5F (See notes below.)
	SW5: varies SW6: OFF (When used as an I/O Link unit)		X70 to X8F	Y70 to Y8F
I/O Link Unit			X70 to X7F (WX7) X80 to X8F (WX8)	Y70 to Y7F (WY7) Y80 to Y8F (WY8)
FP1 A/D Converter Unit		Channel 0	X90 to X9F (WX9)	———
		Channel 1	X100 to X10F (WX10)	———
		Channel 2	X110 to X11F (WX11)	———
		Channel 3	X120 to X12F (WX12)	———
FP1 D/A Converter Unit	Unit number 0	Channel 0	———	Y90 to Y9F (WY9)
		Channel 1	———	Y100 to Y10F (WY10)
	Unit number 1	Channel 0	———	Y110 to Y11F (WY11)
		Channel 1	———	Y120 to Y12F (WY12)

Notes:

- X50 to X67 and Y50 to Y5F are allocated for the FP1 Transmitter Master Unit when it is used instead of an expansion unit for FP1 C24, C40, C52 and C72 series, which have expansion units.
- The maximum number of expansion units that can be connected to the control unit is as follows:
  - FP1 C14 and C16 series: 1 expansion unit (including FP1 Transmitter Master Unit)
  - FP1 C24, C40, C56 and C72 series: 2 expansion units (including FP1 Transmitter Master Unit)
- Number of expandable units together:
  - FP1 Transmitter Master Unit/FP1 I/O link unit: Max. 1 unit

8-2. Table of Memory Areas

Item	Name and Function	Symbol	Numbering		
			C14/C16	C24/C40	C56/C72
External I/O relays	**External input relay** This relay feeds signals to the programmable controller from an external device such as a limit switch or photoelectric sensor.	X (bit)	208 points (X0 to X12F)		
		WX (word)	13 words (WX0 to WX12)		
	External output relay This relay outputs the program execution result of the programmable controller and activates an external device such as a solenoid or motor.	Y (bit)	208 points (Y0 to Y12F)		
		WY (word)	13 words (WY0 to WY12)		
Internal relays	**Internal relay** This relay does not provide an external output and can be used only within the programmable controller.	R (bit)	256 points (R0 to R15F)	1,008 points (R0 to R62F)	
		WR (word)	16 words (WR0 to WR15)	63 words (WR0 to WR62)	
	Special internal relay This relay is a special internal relay which has specific applications. This relay cannot be used for output. Use it only as a contact. Refer to page 223, “8-3. Table of Special Internal Relays”.	R (bit)	64 points (R9000 to R903F)		
		WR (word)	4 words (WR900 to WR903)		
Timer/ Counter	**Timer contact** This contact is the output of a **TM** (Timer) instruction. If a **TM** instruction has timed out, the contact with the same number turns ON.	T (bit)	100 points (T0 to T99)		
	Counter contact This contact is the output of a **CT** (Counter) instruction. If a **CT** instruction has counted up, the contact with the same number turns ON.	C (bit)	28 points (C100 to C127)	44 points (C100 to C143)	
	Timer/Counter set value The timer/counter set value area is a memory area where the set value of the **TM/CT** (Timer/Counter) instructions is stored. Each timer/counter set value area consists of 1 word (1 word = 16 bits). The address of this memory area corresponds to the **TM/CT** instruction number.	SV (word)	128 words (SV0 to SV127)	144 words (SV0 to SV143)	
	Timer/Counter elapsed value The timer/counter elapsed value area is a memory area where the elapsed value of the **TM/CT** (Timer/Counter) instruction is stored. Each timer/counter elapsed value area consists of 1 word (1 word = 16 bits). The address of this memory area corresponds to the **TM/CT** instruction number.	EV (word)	128 words (EV0 to EV127)	144 words (EV0 to EV143)	

Notes:

- Timer/Counter contacts are represented in decimal.
- Word addresses are represented in decimal.
- The addresses for relay bits (X, Y, and R) are represented by a combination of word addresses (decimal) and hexadecimals. The least significant digit is hexadecimal and the rest of the digits are decimal.

Item	Name and Function	Symbol	Numbering		
			C14/C16	C24/C40	C56/C72
Data area	**Data register** The data register is a memory area for data processed within the programmable controllers and each data register consists of 1 word (1 word = 16 bits).	DT (word)	256 words (DT0 to DT255)	1,660 words (DT0 to DT1659)	6,144 words (DT0 to DT6143)
	Special data register The special data register is a memory area that has special applications. Refer to page 226, “8-4. Table of Special Data Registers” for details about the special data register.	DT (word)	70 words (DT9000 to DT9069)		
Index modifier	**Index register** The index register can be used as an address and constants modifier. Refer to page 193, “2. How to Use Index Registers (IX, IY)”.	IX (word) IY (word)	One word each (No numbering system)		
Constant	**Decimal constants**	K	16-bit constant (word): K-32,768 to K32,767		
			32-bit constant (double word): K-2,147,483,648 to K2,147,483,647		
	Hexadecimal constants	H	16-bit constant (word): H0 to HFFFF		
			32-bit constant (double word): H0 to HFFFFFFFF		

8-3. Table of Special Internal Relays

The special internal relays are used for special purposes in the FP1 Programmable Controller.
These special internal relays cannot output. Use special internal relays only as contacts.

Address	Name	Description	Availability		
			C14/C16	C24/C40	C56/C72
R9000	Self-diagnostic error flag	Turns ON when a self-diagnostic error occurs. The self-diagnostic error code is stored in DT9000.	A		
R9005	Battery error flag (Non-hold)	Turns ON for an instant when a battery error occurs.	N/A	A	
R9006	Battery error flag (Hold)	Turns ON and keeps the ON state when a battery error occurs.			
R9007	Operation error flag (Hold)	Turns ON and keeps the ON state when an operation error occurs. The error address is set in DT9017. (See note.)	A		
R9008	Operation error flag (Non-hold)	Turns ON for an instant when an operation error occurs. The error address is set in DT9018. (See note.)			
R9009	Carry flag	Turns ON for an instant, - when an overflow or an underflow occurs. - when “1” is set by one of the shift instructions. This is also used as flag for the **F60 (CMP)/F61 (DCMP)** instructions.			
R900A	> flag	Turns ON for an instant when the compared results are larger.			
R900B	= flag	Turns ON for an instant, - when the calculated results become 0 in the high-level instructions. - when the compared results are equal in the high-level instructions.			
R900C	< flag	Turns ON for an instant when the compared results are smaller.			
R900D	Auxiliary timer instruction (F137)	Turns ON when the set value is decreased and reaches 0. (See note.)	N/A		A
R900E	RS422 error flag	Turns ON when an RS422 error occurs.	A		
R900F	Constant scan error flag	Turns ON when a constant scan error occurs.			
R9010	Always ON relay	Always ON.			
R9011	Always OFF relay	Always OFF.			

A: Available, N/A: Not available

Notes:

- Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B”on the part number have this function.)
- The **F137 (STMR)** is available for FP1 C56 and C72 series with CPU version 2.7 or later. (All FP1 C56 and C72 series with a suffix “B” on the part number have this function.)

Address	Name	Description	Availability		
			C14/C16	C24/C40	C56/C72
R9012	Scan pulse relay	Turns ON and OFF alternately at each scan.	A		
R9013	Initial ON relay	Turns ON only at the first scan in the operation. Turns OFF from the second scan and maintains the OFF state.			
R9014	Initial OFF relay	Turns OFF only at the first scan in the operation. Turns ON from the second scan and maintains the ON state.			
R9015	Step ladder initial ON relay	Turns ON for an instant only in the first scan of the process the moment step ladder process is opened.			
R9018	0.01 s clock pulse relay	Repeats ON/OFF operations in 0.01 s cycles. (ON : OFF = 0.005 s : 0.005 s)			
R9019	0.02 s clock pulse relay	Repeats ON/OFF operations in 0.02 s cycles. (ON : OFF = 0.01 s : 0.01 s)			
R901A	0.1 s clock pulse relay	Repeats ON/OFF operations in 0.1 s cycles. (ON : OFF = 0.05 s : 0.05 s)			
R901B	0.2 s clock pulse relay	Repeats ON/OFF operations in 0.2 s. cycles (ON : OFF = 0.1 s : 0.1 s)			
R901C	1 s clock pulse relay	Repeats ON/OFF operations in 1 s cycles. (ON : OFF = 0.5 s : 0.5 s)			
R901D	2 s clock pulse relay	Repeats ON/OFF operations in 2 s cycles. (ON : OFF = 1 s : 1 s)			
R901E	1 min clock pulse relay	Repeats ON/OFF operations in 1 min cycles. (ON : OFF = 30 s : 30 s)			
R9020	RUN mode flag	ON while mode of the programmable controller is set to RUN.			
R9026	Message flag	ON while the **F149 (MSG)** instruction is executed.	N/A	A	
R9027	Remote mode flag	ON while mode selector switch is set to REMOTE.	A		
R9029	Forced flag	ON during forced ON/OFF operation.			
R902A	Interrupt flag	ON while external interrupts are enabled. Refer to description of **ICTL** instructions.	N/A	A	
R902B	Interrupt error flag	Turns ON when an interrupt error occurs.			
R9032	RS232C port selection flag	ON while the RS232C port is set to GENERAL (K2) in the system register 412.		A (See note.)	

A: Available, N/A: Not available

Note:

• C24C, C40C, C56C, and C72C types only.

Address	Name	Description	Availability		
			C14/C16	C24/C40	C56/C72
R9033	Print-out flag	ON while a **F147 (PR)** instruction is executed. Refer to the description for the **F147 (PR)** instruction.	N/A	A	
R9036	I/O Link error flag	Turns ON when an I/O Link error occurs.	A		
R9037	RS232C error flag	Turns ON when an RS232C error occurs.	N/A	A (See note.)	
R9038	RS232C receive flag (F144)	Turns ON when a terminator is received by the programmable controller using the **F144 (TRNS)** instruction. Refer to the description for the **F144 (TRNS)** instruction.			
R9039	RS232C send flag (F144)	ON while data is not been sent by the **F144 (TRNS)** instruction. OFF while data is being sent by the **F144 (TRNS)** instruction. Refer to the description for the **F144 (TRNS)** instruction.			
R903A	High-speed counter control flag	ON while a high-speed counter is controlled using the **F162 (HC0S)**, **F163 (HC0R)**, **F164(SPD0)**, and **F165 (CAM0)** instructions. Refer to the description for the **F162 (HC0S)**, **F163 (HC0R)**, **F164 (SPD0)**, and **F165 (CAM0)** instructions.	A		
R903B	Cam control flag	ON while a **F165 (CAM0)** instruction is executed. Refer to the description for the **F165 (CAM0)** instruction.			

A: Available, N/A: Not available

Note:

• C24C, C40C, C56C, and C72C types only.

8-4. Table of Special Data Registers

Each special data register is prepared for the specific application.

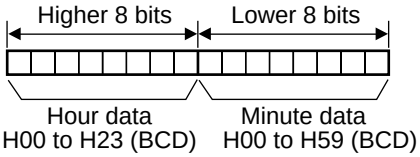
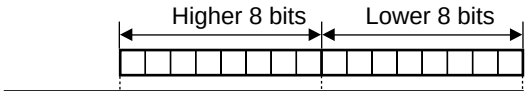
	Address	Name	Description	Availability		
				C14/C16	C24/C40	C56/C72
	DT9000	Self-diagnostic error code register	• The self-diagnostic error code is stored in DT9000 when a self-diagnostic error occurs.	A		
	DT9014	Auxiliary register (for F105 and F106 instructions)	• One shift-out hexadecimal digit is stored in hexadecimal digit position 0 (bit positions 0 to 3) when an **F105 (BSR)** or **F106 (BSL)** instruction is executed. • Refer to the description for the **F105 (BSR)** and **F106 (BSL)** instructions.			
	DT9015	Auxiliary register (for F32, F33, F52, and F53 instructions)	• Divided remainder is stored in DT9015 when an **F32 (%)** or **F52 (B%)** instruction is executed. • Lower 16-bit of divided remainder is stored in DT9015 when an **F33 (D%)** or **F53 (DB%)** instruction is executed. • Refer to the description for the **F32 (%)**, **F52 (B%)**, **F33 (D%)**, and **F53 (DB%)** instructions.			
	DT9016	Auxiliary register (for F33 and F53 instructions)	• Higher 16-bit of divided remainder is stored in DT9016 when an **F33 (D%)** or **F53 (DB%)** instruction is executed. • Refer to the description for the **F33 (D%)** and **F53 (DB%)** instructions.			
*	DT9017	Operation error address register (hold)	• An operation error address is stored in DT9017 and held when an operation error is detected.			
*	DT9018	Operation error address register (non-hold)	• The address of the latest operation error is stored in DT9018 when an operation error is detected.			
	DT9019	2.5 ms ring counter register	• The data in DT9019 is increased by one every 2.5 ms. This can be used to determine the elapsed time of some procedures by calculating the time differences.			
	DT9022	Scan time register (current value)	• Current scan time is stored in DT9022. Scan time is calculated using the formula: Scan time (ms) = data × 0.1 (ms)			
	DT9023	Scan time register (minimum value)	• Minimum scan time is stored in DT9023. Scan time is calculated using the formula: Scan time (ms) = data × 0.1 (ms)			
	DT9024	Scan time register (maximum value)	• Maximum scan time is stored in DT9024. Scan time is calculated using the formula: Scan time (ms) = data × 0.1 (ms)			

Note:

• * Special data registers DT9017 and DT9018 are available only for FP1s with CPU version 2.7 or later. (All FP1s with a suffix “B” on the part number have this function.)

<table>
<tr><th rowspan="2">Address</th><th rowspan="2">Name</th><th rowspan="2">Description</th><th colspan="3">Availability</th></tr>
<tr><th>C14/ C16</th><th>C24/ C40</th><th>C56/ C72</th></tr>
<tr><td>DT9025</td><td>Interrupt enabled status register</td><td>• The mask conditions of interrupts are stored in DT9025. This register is available for monitoring the interrupt condition.
• The mask conditions are judged by the status of each bit:
Interrupt disabled: 0 Interrupt enabled: 1
Each bit position of DT9025 (bit positions 0 to 7) falls on an interrupt instruction number.
• Refer to the description for the ICTL instruction.</td><td rowspan="8">N/A</td><td colspan="2" rowspan="8">A</td></tr>
<tr><td>DT9027</td><td>Time interrupt interval register</td><td>• The time interrupt interval is stored in DT9027. This register is available for monitoring the time interrupt interval.
The interval is calculated using the formula:
Interval (ms) = data × 10 (ms)
• Refer to the description for the ICTL instruction.</td></tr>
<tr><td>DT9030</td><td>Message 0 register</td><td rowspan="6">• The contents of the specified message are stored in DT9030, DT9031, DT9032, DT9033, DT9034, and DT9035 when an F149 (MSG) instruction is executed.
• Refer to the description for the F149 (MSG) instruction.</td></tr>
<tr><td>DT9031</td><td>Message 1 register</td></tr>
<tr><td>DT9032</td><td>Message 2 register</td></tr>
<tr><td>DT9033</td><td>Message 3 register</td></tr>
<tr><td>DT9034</td><td>Message 4 register</td></tr>
<tr><td>DT9035</td><td>Message 5 register</td></tr>
<tr><td>DT9037</td><td>Work register 1 (for F96 instruction)</td><td>• The number of found data is stored in DT9037 when an F96 (SRC) instruction is executed.
• Refer to the description for the F96 (SRC) instruction.</td><td colspan="3" rowspan="2">A</td></tr>
<tr><td>DT9038</td><td>Work register 2 (for F96 instruction)</td><td>The position the data found in the first place counting from the first 16-bit area is stored in DT9038 when an F96 (SRC) instruction is executed.
The address stored is counted from the starting address of the register specified by S2.
• Refer to the description for the F96 (SRC) instruction.</td></tr>
<tr><td>DT9040</td><td>Manual dial-set register (V0)</td><td rowspan="4">Values of the potentiometers (V0, V1, V2, and V3) are stored as:
- FP1 C14 and C16 series: V0 → DT9040
- FP1 C24 series and FP-M: V0 → DT9040
V1 → DT9041
- FP1 C40, C56, and C72 series: V0 → DT9040
V1 → DT9041
V2 → DT9042
V3 → DT9043</td><td colspan="3">A</td></tr>
<tr><td>DT9041</td><td>Manual dial-set register (V1)</td><td>N/A</td><td colspan="2">A</td></tr>
<tr><td>DT9042</td><td>Manual dial-set register (V2)</td><td rowspan="2">N/A</td><td rowspan="2">A (C40 series only)</td><td rowspan="2">A</td></tr>
<tr><td>DT9043</td><td>Manual dial-set register (V3)</td></tr>
</table>

A: Available, N/A: Not available

<table>
<tr><th rowspan="2">Address</th><th rowspan="2">Name</th><th rowspan="2">Description</th><th colspan="3">Availability</th></tr>
<tr><th>C14/ C16</th><th>C24/ C40</th><th>C56/ C72</th></tr>
<tr><td>DT9044</td><td>High-speed counter elapsed value area (lower 16-bit)</td><td>• Lower 16-bit of high-speed counter elapsed value is stored in DT9044.</td><td colspan="3" rowspan="5">A</td></tr>
<tr><td>DT9045</td><td>High-speed counter elapsed value area (higher 16-bit)</td><td>• Higher 16-bit of high-speed counter elapsed value is stored in DT9045.</td></tr>
<tr><td>DT9046</td><td>High-speed counter set value area (lower 16-bit)</td><td>• Lower 16-bit of high-speed counter set value is stored in DT9046.</td></tr>
<tr><td>DT9047</td><td>High-speed counter set value area (higher 16-bit)</td><td>• Higher 16-bit of high-speed counter set value is stored in DT9047.</td></tr>
<tr><td>DT9052</td><td>High-speed counter control register</td><td>• A register dedicated to control high-speed counter operation.
• Refer to the description for the F0 (MV) (high-speed counter control) instruction.</td></tr>
<tr><td>DT9053</td><td>Clock/calendar monitor register</td><td>• Hour and minute data of the clock/calendar are stored in DT9053.
This register is available only for monitoring the data.
• The hour and minute data is stored in BCD as:
 
</td><td rowspan="5">N/A</td><td rowspan="5">A
(See note.)</td></tr>
<tr><td>DT9054</td><td>Clock/calendar monitor & setting register (minute/second)</td><td rowspan="4">• Data of the clock/calendar are stored in DT9054, DT9055, DT9056, and DT9057.
These registers are available both for settings and for monitoring the clock/calendar.
• When setting the clock/calendar by using F0 (MV) instructions, the revised setting becomes effective from the time when the most significant bit of DT9058 becomes “1”.
• The data is stored in BCD as:
 

<table>
<tr><td>DT9054</td><td>Minute
H00 to H59 (BCD)</td><td>Second
H00 to H59 (BCD)</td></tr>
<tr><td>DT9055</td><td>Day
H01 to H31 (BCD)</td><td>Hour
H00 to H23 (BCD)</td></tr>
<tr><td>DT9056</td><td>Year
H00 to H99 (BCD)</td><td>Month
H01 to H12 (BCD)</td></tr>
<tr><td>DT9057</td><td>——</td><td>Day of week
H00 to H06 (BCD)</td></tr>
</table></td></tr>
<tr><td>DT9055</td><td>Clock/calendar monitor & setting register (day/hour)</td></tr>
<tr><td>DT9056</td><td>Clock/calendar monitor & setting register (year/month)</td></tr>
<tr><td>DT9057</td><td>Clock/calendar monitor & setting register (day of week)</td></tr>
</table>

A: Available, N/A: Not available

Note:

• C24C, C40C, C56C, and C72C types only.

<table>
<tr><th rowspan="2">Address</th><th rowspan="2" colspan="2">Name</th><th rowspan="2">Description</th><th colspan="3">Availability</th></tr>
<tr><th>C14/ C16</th><th>C24/ C40</th><th>C56/ C72</th></tr>
<tr><td>DT9058</td><td colspan="2">Clock/calendar adjustment register</td><td>• The clock/calendar is adjusted as follows when the least significant bit of DT9058 is set to “1”.
- When second data is H00 to H29 (BCD), the second data is cut off to H00 (BCD).
- When second data is H30 to H59 (BCD), the second data is cut off to H00 (BCD) and one is added to the minute data.
• The revised clock/calendar settings, which are performed using F0 (MV) instructions, become effective when the most significant bit of DT9058 is set to “1”.</td><td rowspan="2">N/A</td><td colspan="2" rowspan="2">A
(See note.)</td></tr>
<tr><td>DT9059</td><td colspan="2">Communication error code register</td><td>• An RS232C port communication error code is stored in the higher 8-bit area of DT9059.
• A programming tools port communication error code is stored in the lower 8-bit area of DT9059.</td></tr>
<tr><td>DT9060</td><td rowspan="8">Step ladder process monitor registers</td><td>Process number: 0 to 15</td><td rowspan="8">• These registers monitor the condition of step ladder programs.
Execution of the step ladder program is monitored as follows:
- Executing: 1
- Not executing: 0

<EXAMPLE>
Each bit in the registers corresponds to a step ladder process as shown in the following example: When bit position 0 of DT9061 is “1”, step ladder process 16 is executing.
<table><tr><td>Bit position</td><td colspan="4">15 • • 12</td><td colspan="4">11 • • 8</td><td colspan="4">7 • • 4</td><td colspan="4">3 • • 0</td></tr><tr><td>Process number</td><td colspan="4">31 • • 28</td><td colspan="4">27 • • 24</td><td colspan="4">23 • • 20</td><td colspan="4">19 • • 16</td></tr><tr><td>DT9061</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr></table></td><td colspan="3" rowspan="8">A</td></tr>
<tr><td>DT9061</td><td>Process number: 16 to 31</td></tr>
<tr><td>DT9062</td><td>Process number: 32 to 47</td></tr>
<tr><td>DT9063</td><td>Process number: 48 to 63</td></tr>
<tr><td>DT9064</td><td>Process number: 64 to 79</td></tr>
<tr><td>DT9065</td><td>Process number: 80 to 95</td></tr>
<tr><td>DT9066</td><td>Process number: 96 to 111</td></tr>
<tr><td>DT9067</td><td>Process number: 112 to 127</td></tr>
</table>

A: Available, N/A: Not available

Note:

• C24C, C40C, C56C, and C72C types only.

8-5. System Registers

1. What are System Registers

- The FP series programmable controller is configured by setting certain parameters. The parameters, which configure the system and special functions, are called system registers.
- Like other registers in the FP1, each system register consists of 16 bits. System register addresses are also assigned to each of the system registers.

■ Summarizing the Functions of System Registers

By function, system registers of the FP1 are classified into 8 types, as follows:

① **System register 0:** Size prepared for program capacity (fixed).
The value in this system register cannot be changed when you use an FP1.
You can use it only for monitoring the program capacity of the FP1.

② **System registers 5, 6, 7, 8, and 14:** Characteristics settings of operands.
Performs assignments for numbers of timers/counters and the hold/non-hold area.

③ **System registers 4, 20, and 26:** Operation settings when abnormality is detected.
Sets whether the duplicated use of output and battery errors are to be regarded as errors, or whether the programmable controller should execute a program when an operation error occurs.

④ **System registers 31 and 34:** Processing time settings.
Sets the scan time of the programmable controller and the waiting time of computer link communication.

⑤ **System registers 400, 402, and 403:** Input mode settings.
Performs settings of the inputs, such as high-speed counter input, pulse catch inputs, and interrupt inputs.

⑥ **System registers 404 through 407:** Input time filtering settings.
Sets the input time constants in 8-input units.

⑦ **System registers 410 and 411:** Communication settings of port for programming tools (RS422).
Sets the station number, the character length, and the modem compatibility for the programming port.

⑧ **System registers 412 through 418:** Communication settings of RS232C serial port.
Sets the communication specifications of the RS232C serial port, such as communication mode, data format, and modem compatibility.

■ How to set system registers

The system registers can be set by a programming tool.

• Using NPST-GR Software Ver. 3.1

① Set the mode of the programmable controller to PROG.

② Open the [SYSTEM REGISTER] window using the following procedure:

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc** , and then select "PLC CONFIGURATION" to skip to the [PLC CONFIGURATION] subwindow.
Select "1. SYSTEM REGISTER" in the [PLC CONFIGURATION] subwindow.

<If you are using MENU 2 screen type>
Open [NPST FUNCTION MENU] by pressing **Esc** , and then select "R. SYSTEM REGISTER".

Set the mode of the NPST-GR Software to ONLINE by pressing **Ctrl** + **Esc** together.
Open the window you want to set by pressing one of **F6** through **F10** or **Shift** + **F6** through **F10** , and change the value in the system register.

③ After setting, press **F1** and type " **Y** " to save the revised settings to the programmable controller.

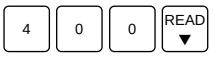
• Using FP Programmer Ⅱ

① Set the mode of the programmable controller to PROG.

② Press the keys on the FP Programmer Ⅱ, as shown on the right.

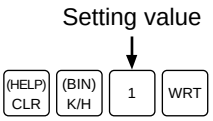
③ Input the system register address referring to the example and read the current settings.

EXAMPLE:
When reading system register 400, press the keys as shown on the right.



④ Input new settings referring to the example.

EXAMPLE:
To input K1, press the keys as shown on the right.



You can also input new settings in hexadecimals by pressing (BIN) K/H before inputting the setting value.

Note:

• The revised settings of the system register become effective when the mode of the programmable controller is set from PROG. to RUN or when the power is turned from OFF to ON.

2. Table of System Registers

Address	Name of system register	Default value	Description
0	Program capacity	K1, K3, or K5	The program capacity is automatically specified according to the type of the programmable controller C14/C16 series (900 steps): K1 C24/C40 series (2,720 steps): K3 C56/C72 series (5,000 steps): K5 The value in this system register is fixed.
4	Operation without backup battery*	K0	This register specifies the ERR. LED status of the FP1 when the voltage of the backup battery lowers or when the backup battery disconnects. K0: the conditions above are regarded as errors K1: the conditions above are not regarded as errors
5	Counter instruction starting address	K100	Starting number for counter instructions is specified. • Setting range C14/C16 series: K0 to K128 C24/C40/C56/C72 series: K0 to K144 • Setting the same value as system register 6 is recommended. • If the maximum value of the setting range is input, all of the areas are used as timers. EXAMPLE: If the system register 5 of C16 series is set to K110: - Timers: T0 to T109 (110 timers) - Counters: C110 to C127 (18 counters)
6	Hold area starting address settings for timer/counter area	K100	Hold area starting address for timer/counter is specified. • Setting range C14/C16 series: K0 to K128 C24/C40/C56/C72 series: K0 to K144 • Setting the same value as system register 5 is recommended. • If the maximum value of the setting range is input, all of the areas are used as non-hold areas. EXAMPLE: If system register 6 of C16 series is set to K110: - Non-hold area: 0 to 109 - Hold area: 110 to 127

Note:

• * This function is available for C24, C40, C56, and C72 series with CPU version 2.7 or later. (All C24, C40, C56, and C72 series with a suffix “B” on the part number have this function.)

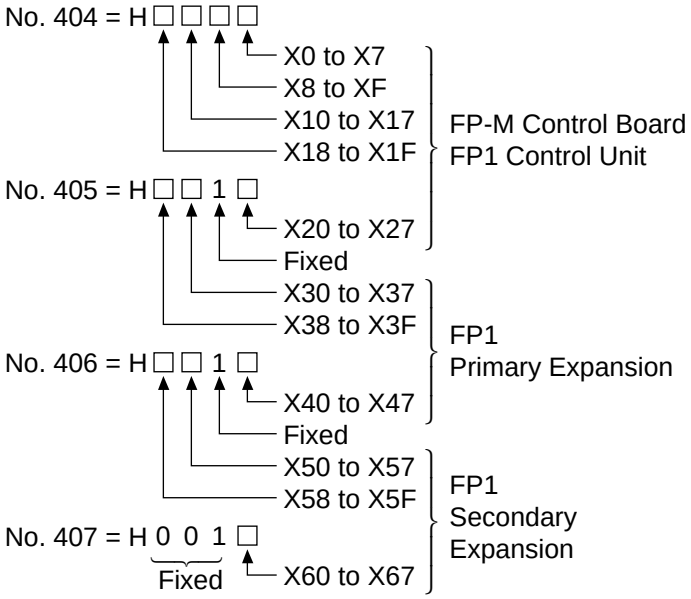
Address	Name of system register	Default value	Description
7	Hold area starting address settings for internal relays	K10	Hold area starting address for internal relays is specified in word-units. • Setting range C14/C16 series: K0 to K16 C24/C40/C56/C72 series: K0 to K63 • If the maximum value of the setting range is input, all of the areas are used as non-hold areas. EXAMPLE: If system register 7 of C14 series is set to K5: - Non-hold area: R0 to R4F - Hold area: R50 to R15F
8	Hold area starting address settings for data registers	K0	Hold area starting address for data registers is specified. • Setting range C14/C16 series: K0 to K256 C24/C40 series: K0 to K1660 C56/C72 series: K0 to K6144 • If the maximum value of the setting range is input, all of the areas are used as non-hold areas. EXAMPLE: If the system register 8 of C14 series is set to K10: - Non-hold area: DT0 to DT9 - Hold area: DT10 to DT255
14	Hold/non-hold setting for step ladder	K1	Hold/non-hold setting for step ladder operation is specified. K0: Hold K1: Non-hold
20	Operation settings for duplicated use of output	K0	This register specifies the operation of the FP1 when a duplicated use of output is programmed. K0: a duplicated use of output is regarded as a total-check error. K1: a duplicated use of output is not regarded as an error.
26	Operation settings when an operation error occurs	K0	This register specifies the operation of the FP1 when an operation error is detected. K0: FP1 stops operation if an operation error occurs. K1: FP1 continues operation even if an operation error occurs.
31	Waiting time settings for multi-frame communication	K2600 (6500 ms)	This register specifies the maximum waiting time between delimiters when multi-frame communication is performed with the computer link. • Setting range K4 to K32760: 10 ms to 81.9 s • The formula to calculate the waiting time is: set value × 2.5 ms Note: - When you set this register using NPST-GR Software, set a time that can be divided by 2.5.

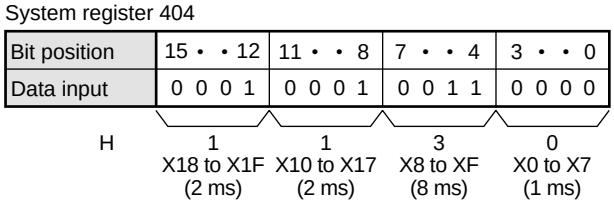
<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>34</td><td>Constant value settings for scan time</td><td>K0</td><td>This register specifies the constant scan time.
• Setting range
K0: the constant scan function is not used
K1 to K64: 2.5 ms to 160 ms
• The formula to calculate the constant scan time is:
set value × 2.5 ms
Note:
- When you set this register using NPST-GR Software, set a time that can be divided by 2.5.</td></tr>
<tr><td>400*</td><td>High-speed counter mode settings</td><td>H0</td><td>H0 □ 0 □
Setting
<table>
<tr><th rowspan="2">Set value</th><th colspan="3">Input contact of FP1s</th></tr>
<tr><th>X0</th><th>X1</th><th>X2</th></tr>
<tr><td>H0</td><td colspan="3">High-speed counter function not used.</td></tr>
<tr><td>H1</td><td colspan="2">2-phase input</td><td>————</td></tr>
<tr><td>H2</td><td colspan="2">2-phase input</td><td>Reset input</td></tr>
<tr><td>H3</td><td>Up input</td><td colspan="2">————</td></tr>
<tr><td>H4</td><td>Up input</td><td>————</td><td>Reset input</td></tr>
<tr><td>H5</td><td>————</td><td>Down input</td><td>————</td></tr>
<tr><td>H6</td><td>————</td><td>Down input</td><td>Reset input</td></tr>
<tr><td>H7</td><td colspan="2">Up/Down input
(X0: Up input, X1: Down input)</td><td>————</td></tr>
<tr><td>H8</td><td colspan="2">Up/Down input
(X0: Up input, X1: Down input)</td><td>Reset input</td></tr>
</table>
Setting
H0: Internally not connected
H1: Internally connected
• Output pulse internal connection setting:
Available for transistor output type C56 and C72 series.
• If you are using is the transistor output type C56 or C72 series, the pulses from Y6 and Y7 can be directly input to X0 and X1 without external wiring.
However, if X0 and X1 are used as inputs for pulses from Y6 and Y7, they cannot be used as other input terminals.
<table>
<tr><th>Set value</th><th>Operation mode</th></tr>
<tr><td>H107</td><td>Pulse output Y7 → Up input X0
Pulse output Y6 → Down input X1
X2 is not used for high-speed counter</td></tr>
<tr><td>H108</td><td>Pulse output Y7 → Up input X0
Pulse output Y6 → Down input X1
X2 is used as reset input</td></tr>
</table>
</td></tr>
</table>

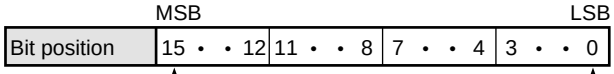
Note:

• * When system registers 400, 402, 403, and 404 are set at the same time, their priorities are:
-1st 400 (high-speed counter mode settings)
-2nd 402 (pulse catch input function settings)
-3rd 403 (interrupt trigger settings)
-last 404 (input time filtering settings)

<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>402</td><td>Pulse catch input function settings
⟨Pulse of 500 µs or more duration⟩</td><td>H0</td><td>This register specifies the pulse catch inputting function availabilities for X0 to X7.
• Settings
0: standard input mode
1: pulse catch input mode
Input the specific value in an order so that the bit corresponding to each input becomes “1” when you use the pulse catch function.
System register 402
<table>
<tr><td>Bit position</td><td>15 • • 12</td><td>11 • • 8</td><td>7 • • 4</td><td>3 • • 0</td></tr>
<tr><td>Corresponding input</td><td>———</td><td>———</td><td>X7 X6 X5 X4</td><td>X3 X2 X1 X0</td></tr>
</table>
• Setting range
C14/C16 series (4 inputs X0 to X3): H0 to HF
C24/C40/C56/C72 series (8 inputs X0 to X7): H0 to HFF
EXAMPLE:
If the pulse catch function is used for inputs X3, X4, and X5 of the C24 series, input H38 as follows:
System register 402
<table>
<tr><td>Bit position</td><td>15 • • 12</td><td>11 • • 8</td><td>7 • • 4</td><td>3 • • 0</td></tr>
<tr><td>Corresponding input</td><td>———</td><td>———</td><td>X7 X6 X5 X4</td><td>X3 X2 X1 X0</td></tr>
<tr><td>Data input</td><td>0 0 0 0</td><td>0 0 0 0</td><td>0 0 1 1</td><td>1 0 0 0</td></tr>
<tr><td></td><td></td><td></td><td>H 3</td><td>8</td></tr>
</table></td></tr>
<tr><td>403</td><td>Interrupt trigger settings</td><td>H0</td><td>This register specifies inputs of the FP1 as interrupt triggers.
• Settings
0: standard input mode
1: interrupt input mode
Input the specific value in an order so that the bit corresponding to each input becomes “1” when you use interrupt programs.
System register 403
<table>
<tr><td>Bit position</td><td>15 • • 12</td><td>11 • • 8</td><td>7 • • 4</td><td>3 • • 0</td></tr>
<tr><td>Corresponding input</td><td>———</td><td>———</td><td>X7 X6 X5 X4</td><td>X3 X2 X1 X0</td></tr>
</table>
• Setting range
C14/C16 series: Not available
C24/C40/C56/C72 series
(8 inputs X0 to X7): H0 to HFF
EXAMPLE:
If the interrupt input function is used for inputs X1 and X2 of the C24 series, input H6 as follows:
System register 403
<table>
<tr><td>Bit position</td><td>15 • • 12</td><td>11 • • 8</td><td>7 • • 4</td><td>3 • • 0</td></tr>
<tr><td>Corresponding input</td><td>———</td><td>———</td><td>X7 X6 X5 X4</td><td>X3 X2 X1 X0</td></tr>
<tr><td>Data input</td><td>0 0 0 0</td><td>0 0 0 0</td><td>0 0 0 0</td><td>0 1 1 0</td></tr>
<tr><td></td><td></td><td></td><td></td><td>H 6</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>404</td><td>Input time filtering setting (X0 to X1F)</td><td>H1111 (all 2 ms)</td><td rowspan="4">Sets the input filtering time in 8-input units.
• Settings
<table><tr><th>Set value</th><th>Input filtering time</th></tr><tr><td>H0</td><td>1 ms</td></tr><tr><td>H1</td><td>2 ms</td></tr><tr><td>H2</td><td>4 ms</td></tr><tr><td>H3</td><td>8 ms</td></tr><tr><td>H4</td><td>16 ms</td></tr><tr><td>H5</td><td>32 ms</td></tr><tr><td>H6</td><td>64 ms</td></tr><tr><td>H7</td><td>128 ms</td></tr></table>• Set system registers 404, 405, 406, and 407, referring to the following:
 

EXAMPLE:
If you specify the input filtering time for X0 to X7 as 1 ms, for X8 to XF as 8 ms, for X10 to X17 as 2 ms, and for X18 to X1F as 2 ms, input H1130 to system register 404.
 
</td></tr>
<tr><td>405</td><td>Input time filtering setting (X20 to X3F)</td><td>H1111 (all 2 ms)</td></tr>
<tr><td>406</td><td>Input time filtering setting (X40 to X5F)</td><td>H1111 (all 2 ms)</td></tr>
<tr><td>407</td><td>Input time filtering setting (X60 to X6F)</td><td>H0011 (all 2 ms)</td></tr>
</table>

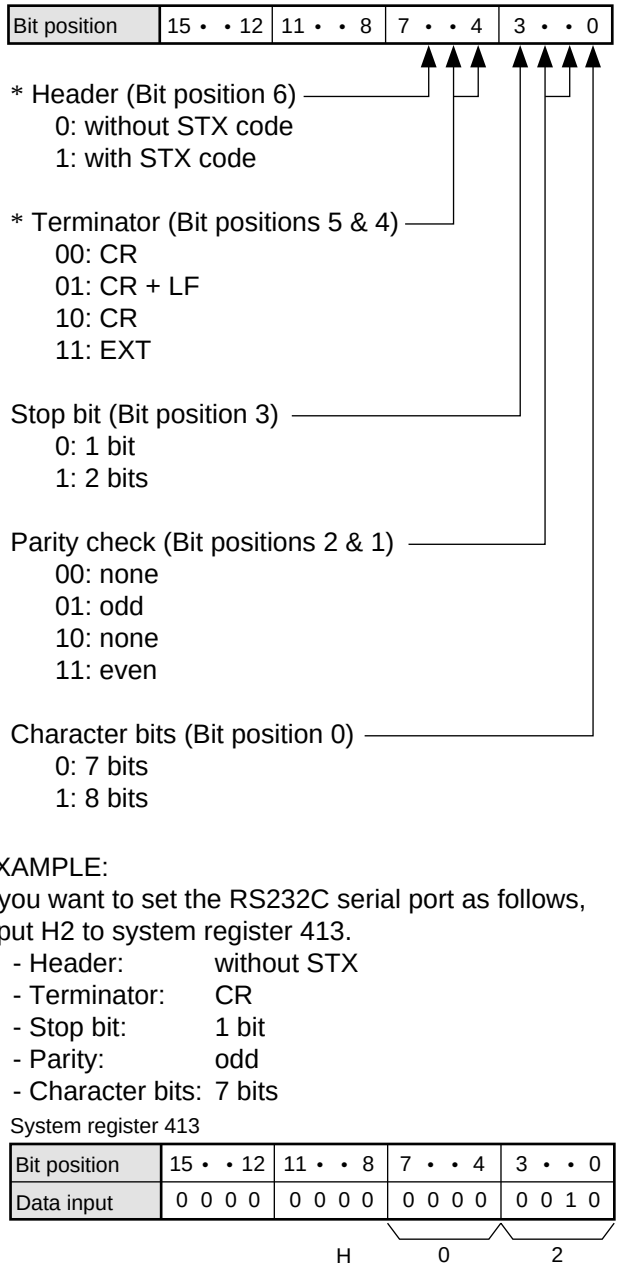
<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>410</td><td>Station number setting for programming tool port (RS422 port)</td><td>K1</td><td>This register specifies the station number when the computer link communication is performed through the programming tool port (RS422 port).
• Setting range
K1 to K32</td></tr>
<tr><td>411</td><td>Communication format & modem* setting for programming tool port (RS422 port)</td><td>H0</td><td>Communication format settings and the settings for modem communication compatibility are performed when the programming tool port (RS422 port) is used.
• Setting
 

Modem communication
0: Disabled
1: Enabled

Communication format (character bits)
0: 8 bits
1: 7 bits
<table>
<tr><th rowspan="2">Set value</th><th colspan="2">Settings</th></tr>
<tr><th>Modem</th><th>Character bits</th></tr>
<tr><td>H0</td><td rowspan="2">Disabled</td><td>8 bits</td></tr>
<tr><td>H1</td><td>7 bits</td></tr>
<tr><td>H8000</td><td rowspan="2">Enabled</td><td>8 bits</td></tr>
<tr><td>H8001</td><td>7 bits</td></tr>
</table></td></tr>
<tr><td>412</td><td>Communication mode settings for RS232C serial port</td><td>K0</td><td>Selects the functions for the RS232C serial port.
• Settings
K0: when the RS232C serial port is not used.
K1: when the RS232C serial port is used for computer link communication.
K2: when the RS232C serial port is used for general purpose communication.</td></tr>
</table>

Note:

• * The modem communication settings (system register 411 MSB) are available only for C24, C40, C56, and C72 series FP1s with CPU Ver. 2.7 or later. (All C24, C40, C56, and C72 series FP1s with a suffix “B” on the part number have this function.)

<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>413</td><td>Communication format setting for RS232C serial port</td><td>H3</td><td>This register specifies the communication settings for the RS232C serial port.
• Settings
 

EXAMPLE:
If you want to set the RS232C serial port as follows, input H2 to system register 413.
- Header: without STX
- Terminator: CR
- Stop bit: 1 bit
- Parity: odd
- Character bits: 7 bits
System register 413
</td></tr>
</table>

Note:

• * The settings for the header and the terminator in system register 413 become effective when system register 412 is set to K2 (GENERAL). If you select K1 (COMPTR LNK) or K0 (UNUSED), the settings are discarded.

<table>
<tr><th>Address</th><th>Name of system register</th><th>Default value</th><th>Description</th></tr>
<tr><td>414</td><td>Baud rate settings for RS232C serial port</td><td>K1</td><td>This register specifies the baud rate of the RS232C serial port.
• Settings
<table>
<tr><th>Set value</th><th>Baud rate</th></tr>
<tr><td>K0</td><td>19,200 bps</td></tr>
<tr><td>K1</td><td>9,600 bps</td></tr>
<tr><td>K2</td><td>4,800 bps</td></tr>
<tr><td>K3</td><td>2,400 bps</td></tr>
<tr><td>K4</td><td>1,200 bps</td></tr>
<tr><td>K5</td><td>600 bps</td></tr>
<tr><td>K6</td><td>300 bps</td></tr>
</table></td></tr>
<tr><td>415</td><td>Station number settings for RS232C serial port</td><td>K1</td><td>This register specifies the station number when the RS232C serial port is used for computer link communication.
(Refer to system registers 412 and 413 on pages 237 and 238 for details about the computer link communication settings.)
• Setting range
K1 to K32</td></tr>
<tr><td>416</td><td>Modem communication settings for RS232C serial port*</td><td>H0</td><td>The setting for modem communication compatibility is performed when the RS232C serial port is used.
• Settings
H0: modem communication disabled
H8000: modem communication enabled
When modem communication is enabled, set system registers 412, 413, 415. Refer to page 246, “8-8. FP1 Modem Communication”.</td></tr>
<tr><td>417</td><td>Starting address setting for data received from RS232C serial port</td><td>K0</td><td>This register specifies the starting address of data registers used as the buffer for data received from the RS232C serial port when general-purpose communication is performed.
(Refer to system registers 412 and 413 on pages 237 and 238 for details about general-purpose communication settings.)
• Setting range
C24C/C40C types: K0 to K1660
C56C/C72C types: K0 to K6144
EXAMPLE:
If K0 is input to system register 417, the number of bytes received from the RS232C serial port is stored in DT0 and the data received are stored starting from DT1.</td></tr>
</table>

Note:

• * The system register 416 setting is available only for C24C, C40C, C56C, and C72C type FP1s with CPU Ver. 2.7 or later. (All C24C, C40C, C56C, and C72C type FP1s with a suffix “B” on the part number have this function.) To specify system register 416, NPST-GR Software version 3.1 or later is required.

Address	Name of system register	Default value	Description
418	Buffer capacity setting for data received from RS232C serial port	K1660	This register specifies the number of words to be used as a buffer. (Refer to system register 417 on page 239 for details about the starting address settings.) • Setting range C24C/C40C types: K0 to K1660 C56C/C72C types: K0 to K6144 EXAMPLE: If K0 is input to system register 417 and K100 to system register 418, the number of data received is stored to DT0 and the data received are stored starting from DT1 to DT99.

8-6. Versions of Programming Tools

1. Differences Between NPST-GR Ver. 2.4 and 3.1

NPST-GR Software Ver. 3.1 is designed to support all the functions of the FP1 programmable controllers described in this manual. However, compared with previous NPST-GR Software, version 3.1 requires an additional system. For this reason, NPST-GR Ver. 2.4 has been introduced for computers without the system required for Ver. 3.1.
The differences in functions and requirements between NPST-GR Ver. 2.4 and 3.1 are explained in the table below.

■ System Requirements

Item	NPST-GR Ver. 2.4 (AFP266528)	NPST-GR Ver. 3.1 (AFP266538)
Type of computer	IBM-PC AT or 100% compatible	
CPU	i80286, i80386, or i80486	i80386 or i80486 recommended
Hard Disk Space	2 MB or more if installed in your hard disk drive. [If your computer has two floppy disk drives (including RAM drive), no hard disk drive is required.]	Approx. 2 MB or more
Floppy Disk Drive	One disk drive for 3.5-inch 2HD floppies formatted at 1.44 MB or one for 5.25-inch 2HD floppies formatted at 1.2 MB.	
Main Memory	500 KB or more free	
EMS	Not required	800 KB or more free
Video Mode	EGA or VGA (CGA type can also be used if the time chart monitoring function is not used.)	
RS232C port	COM 1 or COM 2	
Operating System	PC-DOS or MS-DOS version 3.3 or later ANSI. SYS required	PC-DOS or MS-DOS version 5.0 or later ANSI. SYS required for installation EMS driver based on LIM V4.0

■ Functions

Item		NPST-GR Ver. 2.4 (AFP266528)	NPST-GR Ver. 3.1 (AFP266538)
Programmable controllers supported		FP1: 0.9 k FP1/FP-M: 2.7 k FP1/FP-M: 5 k FP3: 10 k FP3/FP-C: 16 k FP5: 16 k	FP1: 0.9 k FP1/FP-M: 2.7 k FP1/FP-M: 5 k FP3: 10 k FP3/FP-C: 16 k FP5: 16 k FP10/FP10S: 30 k FP10: 60 k
Instructions*	36 comparison instructions**	36 comparison instructions (**ST=**, **AN <**, etc.) not available	All the instructions of an FP1 with CPU version 2.7 can be programmed.
Modem communication settings**		Not available. Modem communication parameters cannot be set. (System register 416 for the RS232C port and 411 for the RS422 port cannot be set using NPST-GR Ver. 2.4.)	Available. Modem communication parameters can be set. (System register 416 for the RS232C port and 411 for the RS422 port)
Error clear function**		Not available.	Available.
Battery error disregarding function**		Operation without backup battery cannot be selected. (System register 4 cannot be set using NPST-GR Ver. 2.4.)	Operation without backup battery can be selected. (System register 4 can be modified.)

Notes:

- * Since NPST-GR Ver. 2.4 does not support FP10 or FP10S, some instructions, that are supported only by FP10 or FP10S, are not included in the table.
- ** The availability of the functions depends on the type of programmable controller and the CPU version. For details about functions available for the FP1 CPU version 2.7, refer to page 245, “8-7. FP1 CPU Version 2.7”.

2. Differences Between the FP Programmer and FP Programmer Ⅱ

The FP Programmer Ⅱ is designed to support all the functions of the FP1 programmable controllers described in this manual. Differences in functions between the FP Programmer and the FP Programmer Ⅱ are explained in the table.

■ FP Programmer (AFP1112 and AFP1112A) and FP Programmer Ⅱ (AFP1114)

Item	FP Programmer (AFP1112)	FP Programmer (AFP1112A)	FP Programmer Ⅱ (AFP1114)
Programmable controllers supported	FP1, FP3, FP5	FP1, FP3, FP5	FP-M, FP-C, FP1, FP3, FP5, FP10S, FP10
Communication parameters	Fixed as: Baud rate: 19,200 bps Character bits: 8 bits Parity: ODD Stop bit: 1 bit	The parameters are automatically adjusted when connected to the programmable controller. Baud rate: 19,200 bps or 9,600 bps Character bits: 8 bits or 7 bits Parity: ODD Stop bit: 1 bit	The parameters are automatically adjusted when connected to the programmable controller. Baud rate: 19,200 bps or 9,600 bps Character bits: 8 bits or 7 bits Parity: ODD Stop bit: 1 bit
36 comparison instructions (**ST =** etc.)*	Not available	Not available	Available
NSTL instruction*	Not available	Available	Available
F12 (ICRD)/P12 (PICRD), **F13 (ICWT)/P13 (PICWT)**, **F14 (PGRD)/P14 (PPGRD)** instructions*	Not available	Not available	Available
F64 (BCMP)/P64 (PBCMP), F98 (CMPR)/ P98 (PCMPR), F99 (CMPW)/P99 (PCMPW), F157 (CADD)/P157 (PCADD), F158 (CSUB)/ P158 (PCSUB) instructions*	Not available. These instructions cannot be programmed . However, you can monitor the instructions with it.	Available	Available

Note:

- * The availability of instructions and functions depends on the type of the programmable controller and the CPU version. For details about functions available for FP1 CPU version 2.7, refer to page 245, “8-7. FP1 CPU Version 2.7”.

Item	FP Programmer (AFP1112)	FP Programmer (AFP1112A)	FP Programmer II (AFP1114)
OP 21 (route number settings)**	Available. Only routes 1 to 3 can be selected.	Available Routes 1 to 6 can be selected.	Available Routes 1 to 6 can be selected.
OP 72 (password enabled/disabled settings)	Not available	Available	Available
OP 73 (password registration function)	Not available	Not available	Available
OP 74 (password forcing clear function)***	Not available	Not available	Available
OP 91 (program/system register read/write function)	Not available	Not available	Available
OP 92 (system register read/write function)	Not available	Not available	Available
OP 99 (EEPROM write function)*	Available. However, "BCC ERR" is displayed on the LCD if a program with more than 11 k steps is written to EEPROM.	Available	Available
OP 112 (Error cancellation function)*	Not available	Not available	Available

Notes:

- * The availability of instructions and functions depends on the type of the programmable controller and the CPU version. For details about functions available for FP1 CPU version 2.7, refer to page 245, “8-7. FP1 CPU Version 2.7”.
- ** The OP 21 function is not used by the FP1.
- *** If the OP 74 function is executed, the program stored in the programmable controller will be deleted.

8-7. FP1 CPU Version 2.7

We pursue a policy of continuing improvement in the design and performance of our products. Therefore, some aspects of FP1 design and performance may change from time to time. Such changes and improvements are identifiable by the CPU version.
In this chapter, differences between CPU version 2.7 and earlier version are clarified.

Note:

- The CPU version is printed on the identification label of each FP1. The identification label is located on the back of the Control Unit.

FP1 CPU Ver. 2.7 Additional Functions

Function	C14/C16 series	C24/C40 series	C56/C72 series
Timer/Counter instruction SV setting*	2.7 or later	2.7 or later	2.7 or later
Pulse output frequency range selection	2.7 or later	2.7 or later	2.7 or later
Error address recognition function (DT9017 and DT9018)	2.7 or later	2.7 or later	2.7 or later
Error clearance from the programming tool*	2.7 or later	2.7 or later	2.7 or later
Error clearance by the **F148** instruction	Not available	2.7 or later	2.7 or later
36 comparison instructions (**ST =**, **AN <**, etc.)*		2.7 or later	2.7 or later
Modem control function (system registers 411 and 416)*		2.7 or later	2.7 or later
Operation without backup battery enabled**		2.7 or later	2.7 or later

Notes:

- * An FP Programmer Ⅱ or NPST-GR Software version 3.1 or later is required to perform these functions.
- ** NPST-GR Software Ver. 3.0 or earlier cannot perform this function.

8-8. FP1 Modem Communication

C24, C40, C56, and C72 series FP1 programmable controllers have modem communication functions. This allows data transfer and long-distance communication between a personal computer and an FP1. This function is available not only for the computer link function but also when NPST-GR Software is used.

1. Using the Programming Tool Port (RS422)

When modem communication is performed using the RS422 port of an FP1, not only computer link but also programming with NPST-GR Software can be performed.

To perform modem communication using the RS422 port, set system registers 410 and 411 as follows:

- System register 410.....K1 though K32 (See notes below.)
- System register 411.....H8001

H8001 means
Character bit: 7 bits
Parity check: Odd
Stop bit: 1 bit

Notes:

- The modem communication function is available for C24, C40, C56, and C72 series with CPU Ver. 2.7 or later. (All C24, C40, C56, and C72 series FP1s with a suffix “B” on the part number have this function.)
- With NPST-GR Software version 3.0 or higher, you cannot set system register 411 to the modem enable mode.
- The baud rate is fixed at 2,400 bps and the setting in system register 414 is ignored.
- The same station number (UNIT NO.) cannot be assigned to FP1s in the same network.
- Since initialization of the modem is performed only by an FP1 whose UNIT NO. (system register 410) is set to K1, pay attention to the following when station numbers (UNIT NO.s) are assigned to FP1s:
  - when one computer communicates with one FP1, system register 410 should be set to K1.
  - when one computer communicates with two or more FP1s, no two FP1s can have the same station number (UNIT NO.) and one of the FP1s in the network must be assigned as station number 1 (UNIT NO. 1).
- Modem initialization is performed only when the mode of the programmable controller is set from PROG. to RUN or when the power turns ON in the RUN mode by an FP1 whose UNIT NO. (system register 410) is set to K1. Therefore, be sure to apply power to the modem, before the FP1 is turned ON.
- Once the modem is initialized successfully, it will not re-initialize if the mode of the programmable controller is set to RUN from PROG. again.
- When one computer communicates with two or more programmable controllers, set the modem to the mode without character echo.
- Be sure to set the computer and C-NET Adapters to the same communication format.

■ How to Set System Registers 410 and 411

- Using NPST-GR Software version 3.1

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, and then select “PLC CONFIGURATION” to skip to the [PLC CONFIGURATION] subwindow.
In the [PLC CONFIGURATION] subwindow, select “1. SYSTEM REGISTER”.

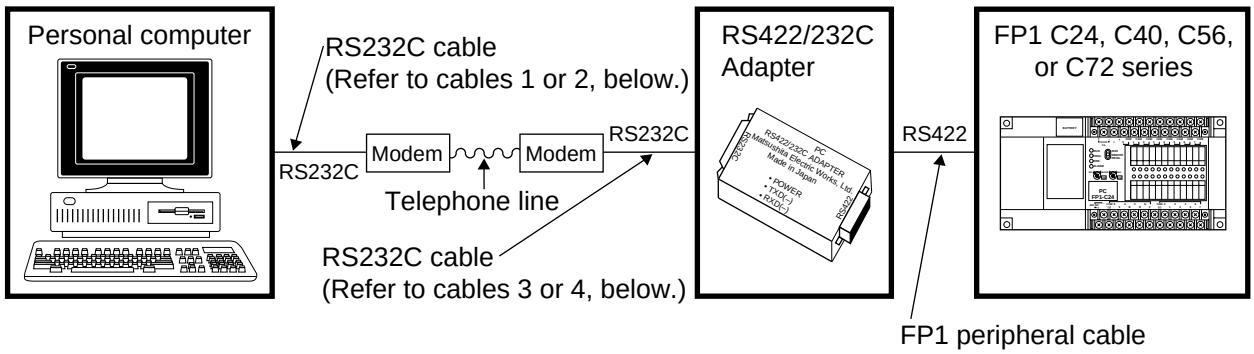
<If you are using MENU 2 screen type>
Open [NPST FUNCTION MENU] by pressing **Esc**, and then select “R. SYSTEM REGISTER”.

Open the [SYSTEM REGISTER]-[SET RS422 PORT] window by pressing **Shift** + **F9** together.
The following is displayed:

410	UNIT NO.	[1] (1- 32).....Set K1.
411	RS422 FORMAT DATA LENGTH	[8BIT/ 7BIT].....Select 8-bit or 7-bit.
	RS422 MODEM CONNECTION	[ENAB / DISA].....Select ENAB.

After setting, save the status of system registers by pressing **F1**.

• System configuration: one computer, one programmable controller



Cable 1: RS232C cable between a personal computer (IBM PC-AT) and a modem

Connected to IBM PC-AT (9 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	CD (DCD)	1	FG
2	RD (RXD)	2	SD (TXD)
3	SD (TXD)	3	RD (RXD)
4	ER (DTR)	4	RS (RTS)
5	SG	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	RS (RTS)	7	SG
8	CS (CTS)	8	CD (DCD)
9	RI (CI)	20	ER (DTR)
		22	RI (CI)

Cable 2: RS232C cable between a personal computer and a modem

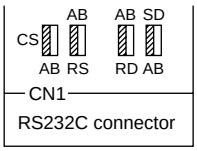
Connected to personal computer (25 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)
		22	RI (CI)

Cable 3: RS232C cable between a modem and RS422/232C adapter

Connected to modem (25 pins male)		Connected to RS422/232C adapter (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)
22	RI (CI)		

• Confirm the RS422/232C adapter pin settings, referring to the following:

When the cable described above is used



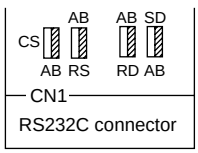
▨: Denotes the pin position.

Cable 4: RS232C cable between a modem and RS422/232C adapter

Connected to modem (25 pins male)		Connected to RS422/232C adapter (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)
22	RI (CI)		

• Confirm the RS422/232C adapter pin settings, referring to the following:

When the cable described above is used



▨: Denotes the pin position.

When shipped from the factory, the RS422/232C Adapter pins are set as shown in Cable 3.

2. Using the RS232C Port

When modem communication is performed using an FP1 RS232C port, the computer link function can be performed. To perform modem communication using the RS232C port, set system registers 412, 413, 415, and 416 as follows:

- System register 412.....K1 (select computer link)
- System register 413.....Data format
  - Start bit: 1 (fixed, no need to set this)
  - Character bits: 7 bits or 8 bits
  - Parity bit: None or 1 bit (ODD or EVEN)
  - Stop bit: 1 bit or 2 bits
  - Set the character bits, parity bit, and stop bit so that the total number of bits used to send a character adds up to 10 bits.
  - Control code
    - Header: NO STX or STX
    - Terminator: CR, CR + LF, or ETX
    - These settings are ignored when the computer link is selected.
- System register 415.....K1 though K32 (See notes below.)
- System register 416.....H8000 (RS232C MODEM CONNECTION ENABLED)

Notes:

- The modem communication function is available for C24C, C40C, C56C, and C72C types with CPU Ver. 2.7 or later. (All C24C, C40C, C56C, and C72C type FP1s with a suffix “B” on the part number have this function.)
- With NPST-GR Software version 3.0 or earlier, you cannot set system register 416 to the modem enable mode.
- The baud rate is fixed at 2,400 bps and the setting of system register 414 is ignored.
- The same station number (UNIT NO.) cannot be assigned to FP1s in the same network.
- Since initialization of the modem is performed only by an FP1 whose UNIT NO. (system register 415) is set to K1, pay attention to the following when station numbers (UNIT NOs.) are assigned to FP1s:
  - when one computer communicates with one FP1, system register 415 should be set to K1.
  - when one computer communicates with two or more FP1s, no two FP1s can have same station number (UNIT NO.) and one of the FP1s in the network must be assigned as station number 1 (UNIT NO. 1).
- Modem initialization is performed only when the mode of the programmable controller set to RUN from PROG., or when the power is turned ON in the RUN mode by an FP1 whose UNIT NO. (system register 415) is set to K1. Therefore, be sure to apply power to the modem, before the FP1 is turned ON.
- Once the modem is initialized successfully, it will not re-initialize if the mode of the programmable controller is set to RUN from PROG. again.
- When one computer communicates with two or more programmable controllers, set the modem to the mode without character echo.
- Be sure to set the computer and C-NET Adapters to the same communication format.

■ How to Set System Registers 412, 413, 416, and 415

• Using NPST-GR Software version 3.1

<If you are using MENU 1 screen type>
Open [NPST MENU] by pressing **Esc**, and then select "PLC CONFIGURATION" to skip to the [PLC CONFIGURATION] subwindow.
In the [PLC CONFIGURATION] subwindow, select "1. SYSTEM REGISTER".

<If you are using MENU 2 screen type>
Open [NPST FUNCTION MENU] by pressing **Esc**, and then select "R. SYSTEM REGISTER".

Open the [SYSTEM REGISTER]-[SET RS232C] window by pressing **Shift** + **F8** together.
The following is displayed:

412	RS232C PORT SELECTION		[UNUSED / COMPTR LNK / GENERAL]
			.....Select COMPTR LNK.
413	RS232C SEND FORM		
		DATA LENG*	[7BIT / 8BIT].....Select 7-bit or 8-bit.
		PARITY CHK	[NONE / WITH] ....Select with or without parity check
			[ODD / EVEN] .....Select ODD or EVEN when the parity, above, is selected.
		STOP BIT	[1BIT / 2BIT].....Select 1-bit or 2-bit.
		TERMINATOR	[CR / CR+LF / CR / ETX]
		HEADER	[NO STX / STX]
			Terminator and header settings are ignored in the computer link mode.
414	RS232C BAUDRATE		[1].....This setting is ignored when the modem connection is selected.
416	RS232C MODEM CONNECTION		[ENAB / DISA].....Select "ENAB".

Open the [SYSTEM REGISTER]-[COMPUTER LIN] window by pressing **Shift** + **F7** together and the following is displayed:

415	UNIT NO.	[1].....Select K1 though K32.

After setting, save the status of the system registers by pressing **F1**.

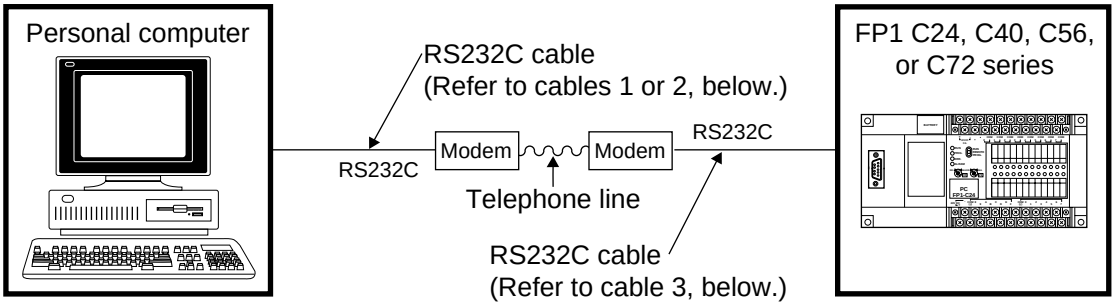
Note:

• * Set the character length, parity check, and stop bit so that the total number of bits used to send a character add up to 10 bits.

EXAMPLES

Start bit		Character bits		Parity bit		Stop bits		Total
1	+	7	+	1	+	1	=	10 bits
1	+	7	+	0	+	2	=	10 bits
1	+	8	+	0	+	1	=	10 bits

• System configuration: one computer, one programmable controller



Cable 1: RS232C cable between a personal computer (IBM PC-AT) and a modem

Connected to IBM PC-AT (9 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	CD (DCD)	1	FG
2	RD (RXD)	2	SD (TXD)
3	SD (TXD)	3	RD (RXD)
4	ER (DTR)	4	RS (RTS)
5	SG	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	RS (RTS)	7	SG
8	CS (CTS)	8	CD (DCD)
9	RI (CI)	20	ER (DTR)
		22	RI (CI)

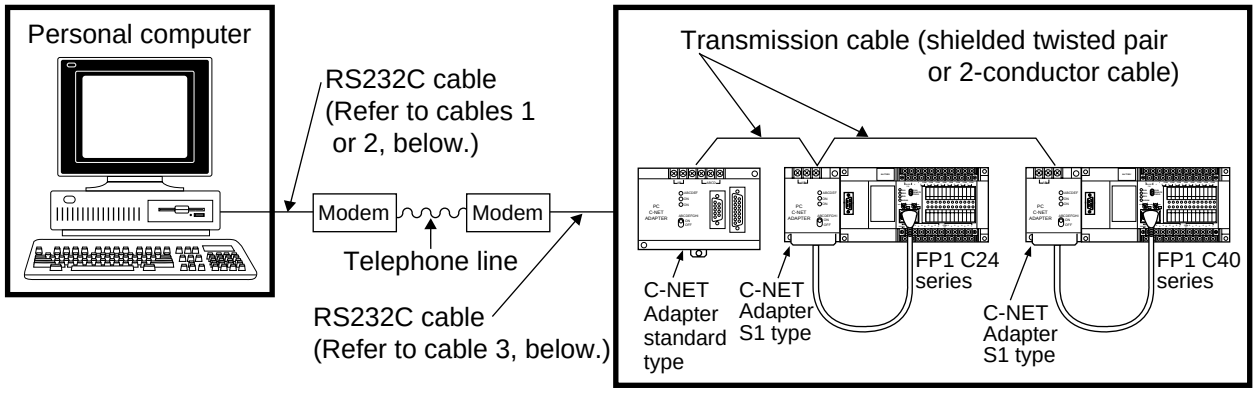
Cable 2: RS232C cable between a personal computer and a modem

Connected to personal computer (25 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)
		22	RI (CI)

Cable 3: RS232C cable between a modem and FP1

Connected to modem (25 pins male)		Connected to FP1 RS232C port (9 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	———
7	SG	7	SG
8	CD (DCD)	8	———
20	ER (DTR)	9	RI (CI)
22	RI (CI)		

3. System Configuration: One Computer and Two or More Programmable Controllers



Cable 1: RS232C cable between a personal computer (IBM PC-AT) and a modem

Connected to IBM PC-AT (9 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	CD (DCD)	1	FG
2	RD (RXD)	2	SD (TXD)
3	SD (TXD)	3	RD (RXD)
4	ER (DTR)	4	RS (RTS)
5	SG	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	RS (RTS)	7	SG
8	CS (CTS)	8	CD (DCD)
9	RI (CI)	20	ER (DTR)
		22	RI (CI)

Cable 2: RS232C cable between a personal computer and a modem

Connected to personal computer (25 pins female)		Connected to modem (25 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)
		22	RI (CI)

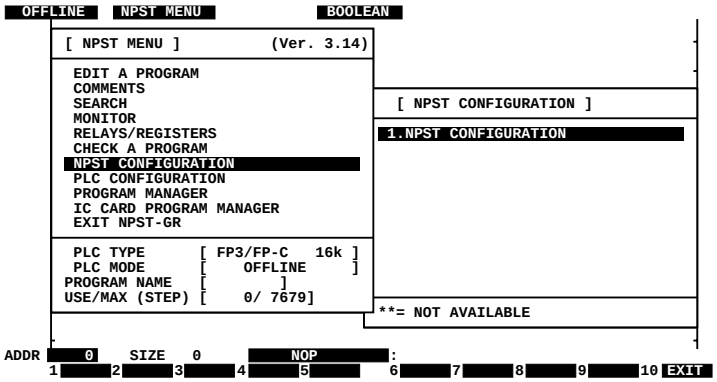
Cable 3: RS232C cable between a modem and standard type C-NET Adapter

Connected to modem (25 pins male)		Connected to C-NET Adapter standard type RS232C port (9 pins male)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	———
7	SG	7	SG
8	CD (DCD)	8	———
20	ER (DTR)	9	RI (CI)
22	RI (CI)		

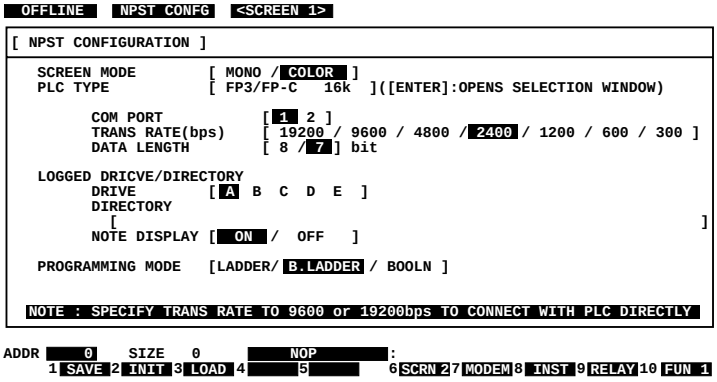
4. NPST-GR Settings

When modem communication is performed between an FP1 and a personal computer installed with NPST-GR Software, you need to set the NPST-GR Software as follows.

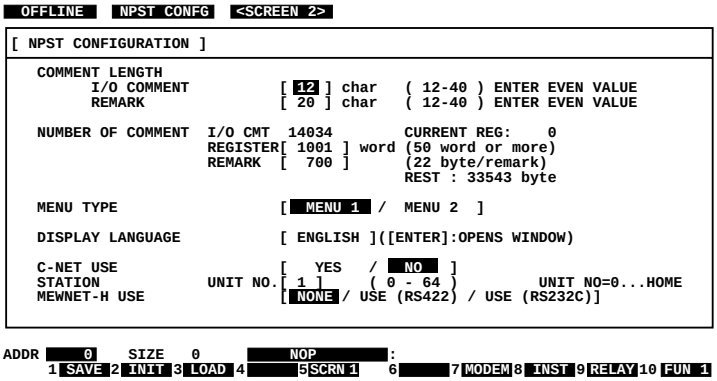
① Select “NPST CONFIGURATION” from the “NPST MENU” and then select “1. NPST CONFIGURATION” to open the <SCREEN 1> window in the OFFLINE mode.



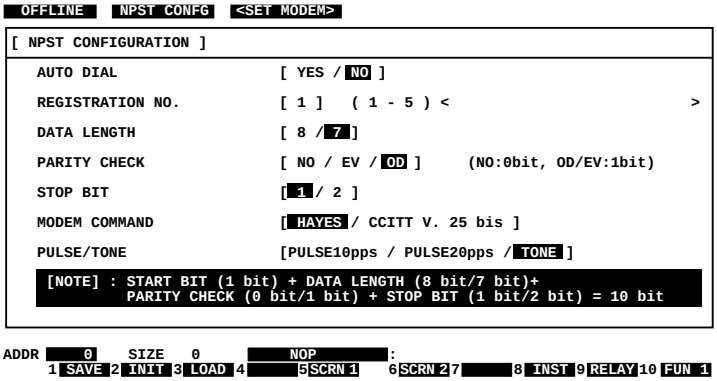
② Set the parameters in the <SCREEN 1> window as follows:
PLC TYPE .....select the one you want to communicate with.
COM PORT .....select 1 or 2 of your personal computer
TRANS RATE (bps).....set to 2400 bps
DATE LENGTH..... select 8 or 7 bits according to that which you specified for the PLC.



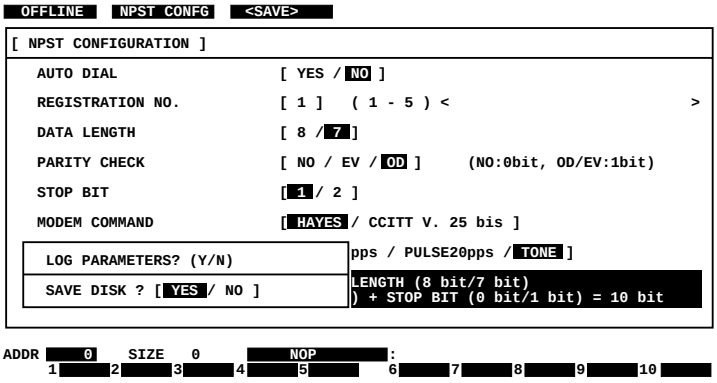
③ Set the parameters in the <SCREEN 2> window as follows:
By pressing the F6 key, you can open the <SCREEN 2> window.
C-NET USE .....select YES or NO
STATION UNIT NO. .....set the station number (UNIT NO.) of the target programmable controller.



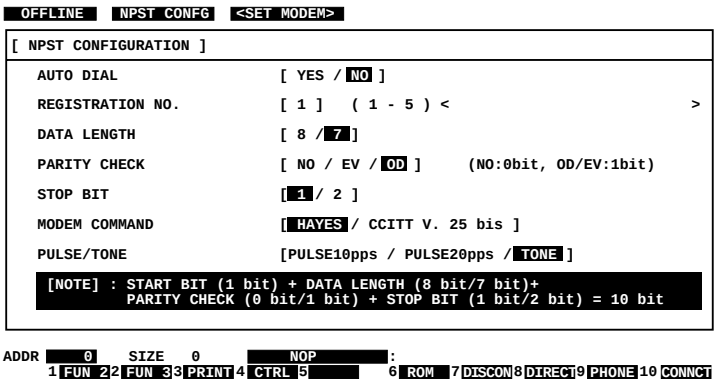
④ Set the parameters in the <MODEM> window as follows:
By pressing the F7 key, you can open the <MODEM> window.
AUTO DIAL .....select YES or NO
REGISTRATION NO.....if you select “YES” for AUTO DIAL, set the registered phone number in the <PHONE> window.
DATA LENGTH .....select 8 or 7 bits according to that which you specified for the programmable controller.
PARITY CHECK.....select “NO”, “EV” or “OD” according to that which you specified for the programmable controller.
STOP BIT .....select 1 or 2 bits according to that which you specified for the programmable controller.
MODEM COMMAND.....select “HAYES” or “CCITT V. 25bis”.
PULSE/TONE.....select “PULSE10pps”,“PULSE20pps” or “TONE” in accordance with the line specifications.



⑤ Log all the parameters in ②, ③ and ④, by pressing the F1 (SAVE) key. If you want to save the settings as NPST-GR start-up conditions, select YES for the save disk ? option.



⑥ Open the line between your computer and modem by pressing the F8 key or F10 key while holding down the shift key. After the modem has successfully connected, change the NPST-GR Software mode to ONLINE by pressing the Esc key while holding down the Ctrl key.



8-9. Terminology

address: An alphanumeric value that identifies where data is stored.

ambient temperature: The temperature of the air surrounding a system.

American Wire Gauge (AWG): A standard system used for designating the size of electrical conductors. Larger gauge numbers have smaller diameter.

AND: A Boolean operation that produces a logic "1" output if all inputs are "1", and a logic "0" if any input is "0".

ASCII: American Standard Code for Information Interchange. ASCII is normally used when alphanumeric (letters and decimal numbers) and control codes are sent as information to printers, etc. ASCII can be represented using 7 or 8 bits and is often expressed in a 2-digit hexadecimal form converted from specific binary expressions. ASCII expressed in 2-digit hexadecimals is called "ASCII HEX code". For details about actual ASCII codes, refer to the table for ASCII.
[EXAMPLE] When a letter "M" is expressed in ASCII code:
7-bit ASCII : 1001101 (binary)
ASCII HEX code: 4D (hexadecimal)

asynchronous: Not synchronous. Repeated operations that take place in patterns unrelated over time.

AWG: See American Wire Gauge (AWG).

backplane: A printed circuit board located in the back of a chassis, that contains a data bus, power bus, and mating connectors for units. For FP3, FP5, FP10S and FP10 programmable controllers, two types of backplanes are available:
Master Backplane
Expansion Backplane

backup: A device that is kept available to replace something that may fail during operation.

battery backup: A battery or set of batteries that will provide power to the processor memory only when system power is lost. C24, C40, C56, and C72 series FP1 programmable controllers have a battery backup system.

battery low: A condition that exists when the backup battery voltage drops low enough to require battery replacement. For FP1 C24, C40, C56, and C72 series, the ERR. LED turns ON.

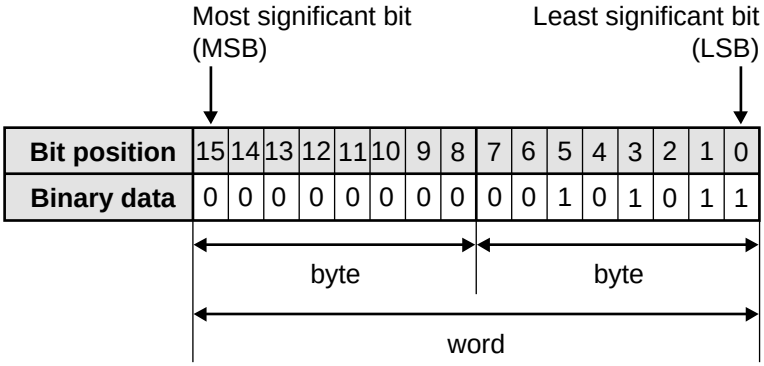
baud: Formally defined as the shortest pulse width in data communication. However, usually used to refer to the number of binary bits transmitted per second (bps) during serial data communication.

BCC: See Block Check Code

BCD: See Binary Coded Decimal

binary:

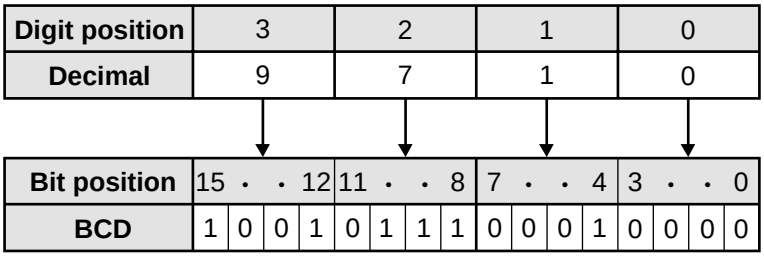
In general, programmable controllers work with binary numbers in one form or another to represent various codes or quantities. The binary number system uses the number 2 as the base and the only allowable symbols are “0” and “1”. There are no 2s, 3s, etc. Each digit of a binary code is called as “bit”. “Bit” means “binary digit”. A group of 8 bits is called a “byte” and a group of 16 bits (two bytes) is called a “word”.



The binary number “0000000000101011” is expressed in decimal as follows:
$1 \times 2^0 + 1 \times 2^1 + 0 \times 2^2 + 1 \times 2^3 + 0 \times 2^4 + 1 \times 2^5 + \cdots\cdots + 0 \times 2^{15}$
$= 1 + 2 + 0 + 8 + 0 + 32 + \cdots\cdots + 0$
$= 43$

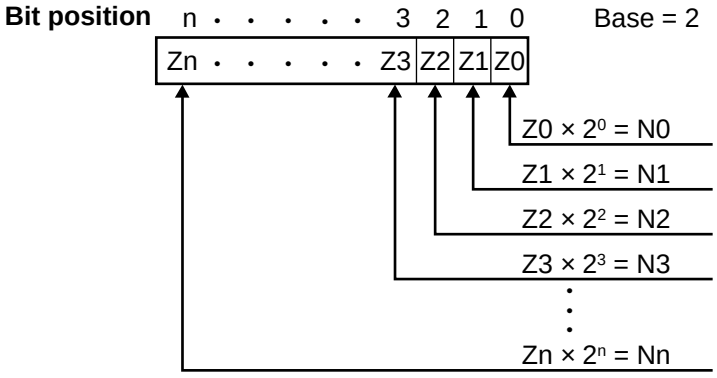
Binary Coded Decimal (BCD):

One of the codes expressed in binary. BCD is a binary code in which each decimal digit from 0 to 9 is represented by four binary digits (bits). The four positions have a weighted value of 1, 2, 4, and 8, respectively, starting with the least significant bit. A thumbwheel switch is specified as a BCD device, and when connected to a programmable controller, each decimal digit requires four inputs.
[EXAMPLE]



binary number system:

A number system that uses two symbols, “0” and “1”. Each digit position has a weighted value of 1, 2, 4, 8, 16, 32, 64, and so on begining with the least significant (right-most) digit.



The sum of N0 through Nn is the decimal equivalent of the number in base “2”.

Block Check Code (BCC): This code is used to detect errors in message transmissions. It is created by Exclusive ORing all of the codes from the header though the last text character, then translating the result (8-bit) data into two ASCII characters.

buffer: A group of registers used for temporary data storage. This is used for data transmission and works effectively when there are transmission rate differences between sending and receiving devices.

bug: Software errors which will cause unexpected actions.

bus: Power distribution conductors.

Central Processing Unit: The Central Processing Unit is usually referred to as the CPU. The CPU controls system activities of the programmable controller.

character: A symbol such as a letter of the alphabet or decimal number. An ASCII character is most commonly used to express characters using binary.

complement: A logical operation that inverts a signal or bit. The complement of “1” is “0”, and the complement of “0” is “1”.

computer link: One of the communication methods between a computer and programmable controllers. In a computer link, the computer is the host, and it can control programmable controllers using a protocol. For FP series programmable controllers, communication between a computer and programmable controllers is performed using MEWTOCOL-COM, a half-duplex communication protocol. From the computer, you can read, write, or monitor data stored in the memory of a programmable controller.

CPU: See Central Processing Unit.

CRT: Abbreviation for cathode-ray tube.

debug: Removing errors from a program.

decimal number system: The decimal number system uses the number 10 as the base and the allowable symbols are “0”, “1”, “2”, “3”, “4”, “5”, “6”, “7”, “8”, and “9”. Each digit position has a weighted value of 1, 10, 100, 1000, and so on, begining with the least significant (right-most) digit.

duplex: See full-duplex.

EEPROM: Electrically Erasable Programmable Read Only Memory. EEPROM can be programmed and erased by electrical pulses.

EPROM: Erasable Programmable Read Only Memory. EPROM can be reprogrammed after being entirely erased with the use of an ultra-violet light source.

FIFO: See First-In-First-Out.

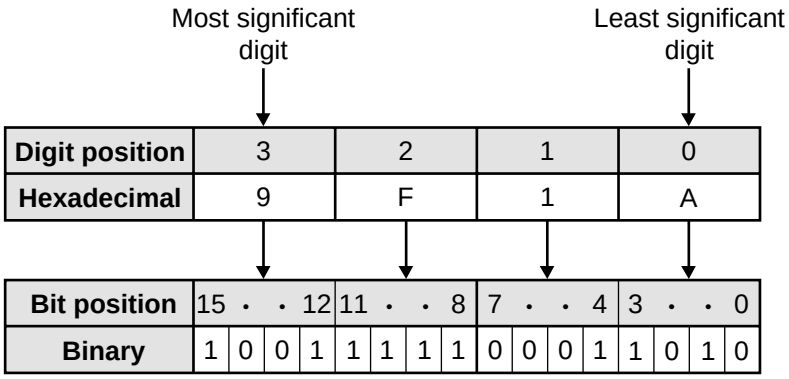
First-In-First-Out: The order that data is written in, and read from registers.

flag: A relay used to detect and remember certain events in the programmable controller. In FP series programmable controllers, some of the special internal relays are used as flags.

full-duplex: A communication link in which data can be transmitted and received at the same time.

half-duplex: A communication link in which transmission is limited to one direction at a time.

hexadecimal: The hexadecimal number system uses 16 as the base. The allowable symbols are numbers 0 through 9 and letters A through F. The letters are substituted for numbers 10 to 15, respectively, to represent all 16 numbers in one digit. The binary number system can easily be represented in hexadecimal with 4 bit groups. In this manner, a very large binary number can be represented by a hexadecimal number with significantly fewer digits.



hold: The memory area whose contents will not be lost or modified if operating power is lost or if the mode of the programmable controller is changed from RUN to PROG.

interrupt: The act of performing a more urgent task by putting off the presently executing task. FP series programmable controllers have three types of interrupts, as follows:
- input initiated interrupt
- high-speed counter initiated interrupt
- time initiated interrupt

I/O: Abbreviation of Input/Output.

I/O update: Taking the input data at the input interface into the memory for program execution and outputting the result of program execution to the output interface.

ladder diagram: A standard for representing relay-logic systems.

LCD: Abbreviation for Liquid Crystal Display.

leading edge differential: A programming technique to operate a bit only for one scan at the moment its input condition turns ON from the OFF state.

Least Significant Bit (LSB): The bit which represents the smallest value in a byte, word, or double-word.

Least Significant Digit (LSD): The digit which represents the smallest value in a number.

LED: Abbreviation for Light-Emitting Diode.

malfunction: Incorrect function.

Master Control Relay: A relay which controls any series of programs with its operation. If the master control relay is de-energized, all of the contacts and devices controlled by the master control relay are de-energized.

MEWTOCOL-COM: A half-duplex communication protocol for FP series programmable controllers that performs communication between a computer and programmable controllers.

modem: Abbreviation for MOdulator/DEModulator. The modem modulates digital signals and transmits them through a telephone line.

Most Significant Bit (MSB): The bit which represents the greatest value in a byte, word, or double-word.

Most Significant Digit (MSD): The digit which represents the greatest value in a number.

multidrop link: A communication link in which one host can communicate with two or more stations.

noise: Random, unexpected electrical signals, that are caused by radio waves or by electrical or magnetic fields.

non-hold: The memory area whose contents will be lost or modified if operating power is lost or if the mode of the programmable controller is changed from RUN to PROG.

normally-closed contact: A contact which is closed when the coil of the relay is not activated.

normally-open contact: A contact which is open when the coil of the relay is not activated.

offline: Not being in continuous communication with another processor.

online: Being in continuous communication with another processor.

overflow: The act of exceeding the maximum limit in a registers capacity.

parity check: A check method for the number of 1s in a character when data communication is performed. The parity check is performed by calculating the number of ones in a character.

peripheral device: Devices that are connected to the programmable controller.

PLC: Abbreviation for Programmable Logic Controller. See programmable controller.

potentiometer: A simple transducer which works based on resistance change. The FP1 manual-set registers work according to the potentiometers named “V0”, “V1”, “V2”, or “V3”.

programmable controller: A control device which can be programmed to control process or machine operations. A programmable controller is often referred to as a PLC when abbreviated.

RAM: Random Access Memory. RAM provides an excellent means for easily creating and altering a program. Many of the FP series programmable controllers use RAM with battery backup for the application memory.

register: A unit of memory for various types of data. A register is usually 16 bits wide.

ROM: Read Only Memory. See EEPROM and EPROM.

RS232C: An EIA communication standard for data transmission media that is less than 15 m. Most common serial communication standard.

RS422: An EIA communication standard for data transmission media.

rung: Term for a ladder program. A rung refers to the programmed instructions that drive one output.

scan: Time required to read all inputs, execute the program, and update local and remote information.

self-diagnostic function: A function within the programmable controller which monitors operation and indicates any fault that is detected.

serial communication: A communication style in which data is transmitted bit by bit serially.

stop bit: The last bit when a character is transmitted.

system errors: Errors resulting from the device or the environment.

system register: The registers used only for system settings of the programmable controller.

trailing edge differential: A programming technique to operate a bit only for one scan at the moment its input condition turns OFF from the ON state.

two's complement: A number system used to express positive and negative numbers in binary. In this system, the number becomes negative if the most significant bit of the data is “1”. In FP series programmable controllers, numbers are expressed using the two’s complement.

underflow: The act of going below the minimum limit in a register’s capacity.

watchdog timer: A timer that monitors processing time of the programmable controller. If the program does not time out, the processor is assumed to be faulty.

word: A unit of bits which is usually executed at the same time. A word is composed of 16 bits.

8-10. Product Types

1. Control Units

Series		Built-in memory	I/O point	Operating voltage	Input type	Output type	Part number
C14	Standard types	EEPROM	14 Input: 8 Output: 6	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12313B AFP12343B AFP12353B
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12317B AFP12347B AFP12357B
C16	Standard types	EEPROM	16 Input: 8 Output: 8	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12113B AFP12143B AFP12153B
					Source	Relay Transistor (NPN open collector)	AFP12112B AFP12142B
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12117B AFP12147B AFP12157B
					Source	Relay Transistor (NPN open collector)	AFP12116B AFP12146B
C24	Standard types	RAM	24 Input: 16 Output: 8	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12213B AFP12243B AFP12253B
					Source	Relay Transistor (NPN open collector)	AFP12212B AFP12242B
				100 V to 240 V AC	Sink/ Source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12217B AFP12247B AFP12257B
					Source	Relay Transistor (NPN open collector)	AFP12216B AFP12246B
	C24C types (with RS232C port and Clock/ Calender function)	RAM	24 Input: 16 Output: 8	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12213CB AFP12243CB AFP12253CB
					Source	Relay Transistor (NPN open collector)	AFP12212CB AFP12242CB
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12217CB AFP12247CB AFP12257CB
					Source	Relay Transistor (NPN open collector)	AFP12216CB AFP12246CB

Series		Built-in memory	I/O point	Operating voltage	Input type	Output type	Part number
C40	Standard types	RAM	40 Input: 24 Output: 16	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12413B AFP12443B AFP12453B
					Source	Relay Transistor (NPN open collector)	AFP12412B AFP12442B
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12417B AFP12447B AFP12457B
					Source	Relay Transistor (NPN open collector)	AFP12416B AFP12446B
	C40C types (with RS232C port and Clock/ Calender function)	RAM	40 Input: 24 Output: 16	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12413CB AFP12443CB AFP12453CB
					Source	Relay Transistor (NPN open collector)	AFP12412CB AFP12442CB
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12417CB AFP12447CB AFP12457CB
					Source	Relay Transistor (NPN open collector)	AFP12416CB AFP12446CB
C56	Standard types	RAM	56 Input: 32 Output: 24	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12513B AFP12543B AFP12553B
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12517B AFP12547B AFP12557B
	C56C types (with RS232C port and Clock/ Calender function)	RAM	56 Input: 32 Output: 24	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12513CB AFP12543CB AFP12553CB
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12517CB AFP12547CB AFP12557CB
C72	Standard types	RAM	72 Input: 40 Output: 32	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12713B AFP12743B AFP12753B
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12717B AFP12747B AFP12757B
	C72C types (with RS232C port and Clock/ Calender function)	RAM	72 Input: 40 Output: 32	24 V DC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12713CB AFP12743CB AFP12753CB
				100 V to 240 V AC	Sink/ source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP12717CB AFP12747CB AFP12757CB

2. Expansion Units

Series	I/O point	Operating voltage	Input type	Output type	Part number
E8	8 Input: 8	——	Source	——	AFP13802
			Sink/source	——	AFP13803
	8 Input: 4 Output: 4	——	Source	Relay Transistor (NPN open collector)	AFP13812 AFP13842
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13813 AFP13843 AFP13853
	8 Output: 8	——	——	Relay Transistor (NPN open collector) Transistor (PNP open collector) Triac	AFP13810 AFP13840 AFP13850 AFP13870
E16	16 Input: 16	——	Sink/source	——	AFP13103
	16 Input: 8 Output: 8	——	Source	Relay Transistor (NPN open collector)	AFP13112 AFP13142
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13113 AFP13143 AFP13153
	16 Output: 16	——	——	Relay Transistor (NPN open collector)	AFP13110 AFP13140
E24	24 Input: 16 Output: 8	24 V DC	Source	Relay Transistor (NPN open collector)	AFP13212 AFP13242
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13213 AFP13243 AFP13253
		100 V to 240 V AC	Source	Relay Transistor (NPN open collector)	AFP13216 AFP13246
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13217 AFP13247 AFP13257
E40	40 Input: 24 Output: 16	24 V DC	Source	Relay Transistor (NPN open collector)	AFP13412 AFP13442
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13413 AFP13443 AFP13453
		100 V to 240 V AC	Source	Relay Transistor (NPN open collector)	AFP13416 AFP13446
			Sink/source	Relay Transistor (NPN open collector) Transistor (PNP open collector)	AFP13417 AFP13447 AFP13457

3. Intelligent Units

Type	Specification	Operating voltage	Part number
FP1 A/D Converter Unit	• Analog input points: 4 channels/unit • Analog input range: 0 to 5 V, 0 to 10 V, 0 to 20 mA • Digital output range: K0 to K1000	24 V DC	AFP1402
		100 V to 240 V AC	AFP1406
FP1 D/A Converter Unit	• Analog input points: 2 channels/unit • Analog input range: 0 to 5 V, 0 to 10 V, 0 to 20 mA • Digital output range: K0 to K1000	24 V DC	AFP1412
		100 V to 240 V AC	AFP1416

4. Link Units

Type	Specification	Operating voltage	Part number
FP1 Transmitter Master Unit	FP1 Transmitter Master Unit enables the FP1 to exchange I/O information with slave stations at a remote site using a twisted pair cable. By connecting with another FP1 Transmitter Master Unit or with an FP3 Transmitter Master Unit, you can exchange I/O information with another FP1. Communication medium (RS485 port): Twisted pair cable up to 32 inputs and 32 outputs can be controlled per unit.	24 V DC	AFP1752
		100 V to 240 V AC	AFP1756
FP1 I/O Link Unit	The FP1 I/O Link Unit is the interface unit for exchanging I/O information between an FP3/FP5 and an FP1. When the FP1 is connected to the FP3/FP5 Remote I/O System via the FP1 I/O Link Unit, you can exchange I/O information, using a 2-conductor cable.	24 V DC	AFP1732
		100 V to 240 V AC	AFP1736
C-NET Adapter	RS485 ↔ RS422/RS232C signal converter. Used for communication between the programmable controller and your computer. Communication medium (RS485 port): 2-conductor cable or twisted pair cable	24 V DC	AFP8532
		100 V to 240 V AC	AFP8536
C-NET Adapter S1 type (for FP1 Control Unit only)	RS485 ↔ RS422 signal converter for FP1 Control Unit. Used for communication between the C-NET Adapter and FP1 Control Unit.	———	AFP15401

5. Programming Tools

FP Programmer Ⅱ

Type		Part number	Description
FP Programmer Ⅱ		AFP1114	Handheld programming device for FP Series programmable controllers
FP1 Peripheral Cable	0.5 m/1.640 ft.	AFP15205	Cable needed for connection between the Control Unit's RS422 port and the FP Programmer Ⅱ's communication port.
	3 m/9.843 ft.	AFP1523	

NPST-GR Programming Support Tool

Type		Part number	Description
NPST-GR Software Ver.3		AFP266538	Program editing software for use with commercially available computers. (System required: IBM PC-AT or 100% compatible with 4MB or more EMS, 2MB or more hard disk space, MS-DOS Ver. 5.0 or later, and EGA or VGA display mode)
NPST-GR Software Ver.2		AFP266528	Program editing software used with commercially available computer. (System required: IBM PC-AT or 100% compatible) Some instructions (compare instructions such as "**ST =**") cannot be programmed with NPST-GR Ver. 2.
FP1 Peripheral Cable	0.5 m/1.640 ft.	AFP15205	Cable needed for connection between the Control Unit's RS422 port and the RS422/232C Adapter's RS422 port.
	3 m/9.843 ft.	AFP1523	
RS422/RS232C Adapter		AFP8550	RS422 ↔ RS232C signal converter. Used for connection between the computer's RS232C port and the FP1 Control Unit's RS422 port when programming with NPST-GR.
RS232C Cable		Needs to be made to match your computer	Cable needed for connection between the RS422/232C Adapter's RS232C port and your computer. Refer to the wiring example below.

RS232C Cable Example:

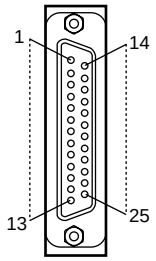
① RS422/232C Adapter & IBM PC-AT (9 pin)

Connected to RS422/232C Adapter (25-pin male type)		Connected to IBM PC-AT side (9-pin female type)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	CD (DCD)
2	SD (TXD)	2	RD (RXD)
3	RD (RXD)	3	SD (TXD)
4	RS (RTS)	4	ER (DTR)
5	CS (CTS)	5	SG
6	DR (DSR)	6	DR (DSR)
7	SG	7	RS (RTS)
8	CD (DCD)	8	CS (CTS)
20	ER (DTR)	9	RI (CI)

② RS422/232C Adapter & personal computer (25 pin)

Connected to RS422/232C Adapter (25-pin male type)		Connected to personal computer side (25-pin male type)	
Pin No.	Abbreviation	Pin No.	Abbreviation
1	FG	1	FG
2	SD (TXD)	2	SD (TXD)
3	RD (RXD)	3	RD (RXD)
4	RS (RTS)	4	RS (RTS)
5	CS (CTS)	5	CS (CTS)
6	DR (DSR)	6	DR (DSR)
7	SG	7	SG
8	CD (DCD)	8	CD (DCD)
20	ER (DTR)	20	ER (DTR)

*RS232C interface connector pins of RS422/232C Adapter (25-pin female type)



Memory (for C24, C40, C56, and C72 series)

Type		Part number	Description
FP1 Memory Unit		AFP1201	EPROM built-in
FP1 Master Memory	for C24/C40 series	AFP1202	EEPROM built-in
	for C56/C72 series	AFP1203	EEPROM built-in

FP ROM Writer

Type		Part number	Description
FP ROM Writer		AFP5651	ROM programmer for FP series Programmable Controllers [EEPROM (28C256 or equivalent) cannot be programmed].
FP1 Peripheral Cable	0.5 m/1.640 ft.	AFP15205	Cable needed for connection between the Control Unit's RS422 port and the RS422/232C Adapter's RS422 port.
	3 m/9.843 ft.	AFP1523	
FP1 ROM Writer Socket Adapter		AFP1810	Adapter needed to program the FP1 Memory Unit (AFP1201) and Master Memory Units using the FP ROM Writer or commercially available ROM writer (recommended ROM writer: Aval Data Corporation's PECKER11).

6. Maintenance Parts

Type		Part number	Description
Lithium Battery		AFP1801	For FP1 Control Unit (C24, C40, C56, and C72 series)
FP1 Short-Circuit Bar		AFP1803	Used to short the COM terminals when loads of the same voltage are connected to the FP1's outputs.
FP1 Expansion Cable	7 cm/0.230 ft.	AFP15101	Cable needed for connection between the Control Unit and Expansion Unit.
	30 cm/0.984 ft.	AFP15103	
	50 cm/1.640 ft.	AFP15105	

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RECORD OF CHANGES

ACG No.	Date	Description of Changes
ACG-M0051-1 ACG-M0051-2	DEC.1993 FEB. 1995	First edition 2nd edition The descriptions of MEWNET-TR are added.