Panasonic

PANEL MOUNTED CONTROLLER

FP-e

User's Manual

ARCT1F369E-8

2013.7 | panasonic.net/id/pidsx/global

Safety Precautions

Observe the following notices to ensure personal safety or to prevent accidents.
To ensure that you use this product correctly, read this User's Manual thoroughly before use.
Make sure that you fully understand the product and information on safety.
This manual uses two safety flags to indicate different levels of danger.

WARNING

If critical situations that could lead to user's death or serious injury is assumed by mishandling of the product.

-Always take precautions to ensure the overall safety of your system, so that the whole system remains safe in the event of failure of this product or other external factor.
-Do not use this product in areas with inflammable gas. It could lead to an explosion.
-Exposing this product to excessive heat or open flames could cause damage to the lithium battery or other electronic parts.
-Battery may explode if mistreated. Do not recharge, disassemble or dispose of fire.

CAUTION

If critical situations that could lead to user's injury or only property damage is assumed by mishandling of the product.

-To prevent excessive exothermic heat or smoke generation, use this product at the values less than the maximum of the characteristics and performance that are assured in these specifications.
-Do not dismantle or remodel the product. It could cause excessive exothermic heat or smoke generation.
-Do not touch the terminal while turning on electricity. It could lead to an electric shock.
-Use the external devices to function the emergency stop and interlock circuit.
-Connect the wires or connectors securely.
The loose connection could cause excessive exothermic heat or smoke generation.
-Do not allow foreign matters such as liquid, flammable materials, metals to go into the inside of the product. It could cause excessive exothermic heat or smoke generation.
-Do not undertake construction (such as connection and disconnection) while the power supply is on. It could lead to an electric shock.

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Before You Start

Operating environment (Use the unit within the range of the general specifications when installing)
*Ambient temperatures:0 ~ +55℃
*Ambient humidity: 30% to 85% RH (at 25°C, non-condensing)
*For use in pollution Degree 2 environment.
*Do not use it in the following environments.
-Direct sunlight
-Sudden temperature changes causing condensation.
-Inflammable or corrosive gas.
-E-xcessive airborne dust, metal particles or saline matter.
-Benzine, paint thinner, alcohol or other organic solvents or strong alkaline solutions such as ammonia or caustic soda.
-Direct vibration, shock or direct drop of water.
- Influence from power transmission lines, high voltage equipment, power cables, power equipment, radio transmitters, or any other equipment that would generate high switching surges. (Min.100mm or less)

Static electricity
-Before touching the unit, always touch a grounded piece of metal in order to discharge static electricity.
-In dry locations, excessive static electricity can cause problems.

Wiring the Power Supply to the Control Unit
-Use a power supply wire that is thicker than 2 mm2 (AWG14), and twist it.
-The unit has sufficient noise immunity against the noise generated on the power line. However, it is recommended to take measures for reducing noise such as using a isolating transformer before supplying the power.
-Allocate an independent wiring for each power supplying line, input/output device and operating device.
-If using a power supply without a protective circuit, power should be supplied through a protective element such as a fuse.
-Be sure to supply power to a control and an expansion units from a single power supply. Turning on/off of the power of all the units must be conducted simultaneously.

Power supply sequence
In order to protect the power supply sequence, make sure to turn off the control unit before the input/output power supply. If the input/output power supply is turned off before the control unit, or if the control unit is not shut off momentarily, the controller detects change of input level, and might conduct an unexpected operation.

Before turning on the power
When turning on the power for the first time, be sure to take the precautions given below.
- When performing installation, check to make sure that there are no scraps of wiring, particularly conductive fragments, adhering to the unit.
- Verify that the power supply wiring, I/O wiring, and power supply voltage are all correct.
- Sufficiently tighten the installation screws and terminal screws.
- Set the mode selector to PROG. Mode.

Before entering a program
Be sure to perform a program clear operation before entering a program.

Operation procedure when using FPWIN GR Ver.2
Select “Online Edit Mode” on the FPWIN GR “On line” menu.
Select “Clear Program” on the “Edit” menu.
When the confirmation dialog box is displayed, click on “Yes” to clear the program.

Request concerning program storage
To prevent the accidental loss of programs, the user should consider the following measures.

- Drafting of documents
  To avoid accidentally losing programs, destroying files, or overwriting the contents of a file, documents should be printed out and then saved.
- Specifying the password carefully
  The password setting is designed to avoid programs being accidentally overwritten. If the password is forgotten, however, it will be impossible to overwrite the program even if you want to. Also, if a possword is forcibly bypassed, the program is deleted. When specifying the password, note it in the specifications manual or in another safe location in case it is forgotten at some point.
- Upload protection
  When the upload protection setting is specified, programs will be disalbed to be read out. If the setting is cancelled forcibly, all programs and system registers will be deleted. Therefore, note that programs and system registers should be managed on your own responsibility.

Backup battery
Do not install the battery when it is not used.
There is a possibility of leak if the battery remains discharged.

Programming tools

(As of Feb, 2009)

Type		Restrictions	Instruction used/Function restrictions
Windows software	FPWIN GR Ver. 2	Available.	Available from Ver. 2.2 or higher. *1)
	FPWIN GR Ver. 1	Not available.	Not available.
Windows software conforms to IEC 61131-3	FPWIN Pro Ver. 6	Available	
	FPWIN Pro Ver. 5	Available	
	FPWIN Pro Ver. 4	Available	Available from Ver. 4.1 or higher. *2) The COM. port cannot be set to MODBUS S RTU.
MS-DOS software	NPST-GR Ver. 4	Not available.	Not available.
	NPST-GR Ver. 3		
Handy programming unit	AFP1113V2 AFP1114V2	Not available.	Instructions and functions described in *3 can not be used. Use FPWIN GR or FPWIN Pro.
	AFP1113 AFP1114	Not available.	Not available.
	AFP1111A AFP1112A AFP1111 AFP1112	Not available.	Not available.

Notes: Precautions concerning programming tools

*1) Customers who use FPWIN GR Ver. 2 can upgrade the version from our HP free of charge.
Use Ver. 2.3 or higher to set the COM. port to MODBUS S RTU.
(MODBUS S RTU is available from FP-e main unit Ver.1.2 or higher.)

*2) FPWIN Pro Ver. 4.0 can be upgraded free of charge at our web site.
FPWIN Pro Ver. 5.0 can be upgraded free of charge at our web site.
FPWIN Pro Ver. 6.0 can be upgraded free of charge at our web site.
Panasonic Electric Works SUNX website address:
http://industrial.panasonic.com/ac/e/dl_center/software/

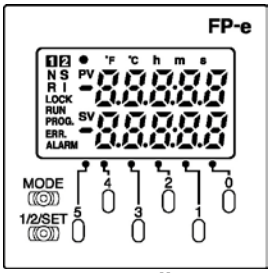
*3) Functions that can not be used using a handy programming unit (AFP1113V2 and AFP1114V2):
- Screen display registry instruction <F180 (SCR)>
- Screen display switch instruction <F181 (DSP)>
- Leading edge differential instruction (Initial execution type) <DFI>
- On-delay timer instruction <TML>
- Clear multiple steps instruction <SCLR>
- Floating-point type data instruction <F309> to <F338>
- PID processing instruction <F355>

Chapter 1

Features and Configurations

1.1 Features and Functions

1.1.1 Features



1. IP 66-compliant panel mounting type
Mounting panel front is waterproof and compliant with IP66, IEC standard.
Compact controller: 48 mm (H), 48 mm (W), 70 mm (D)

2. Indicator function
Simple characters and numerical values (with a minus sign) can be displayed up to 5 digits. *
4 modes (N, S, R, and I modes) can be selected.
Those 4 modes each have 2 selectable displays.
Data indication section can be displayed in red, green, or orange.

3. Operation switches
Set data can be changed.
This switch can be used as an input switch.

4. Control function
In addition to the functions of the programmable controller FP0 series, pulse output and high-speed counter functions are installed.
General-purpose communication COM port is included as standard unit.
FP-e units with the calendar timer or thermocouple input function are also provided.

*Numerical values are displayed only in 16-bit. The data can be displayed in a bit, decimal, or hexadecimal system.

1.1.2 Functions

Item	Description
Power supply	24V DC
Input	8 points *1) (24V DC)
Output	6 points (5 points : Tr. NPN 0.5A, 1 point : Ry 2A)
Program capacity	2.7 k step
Operation speed	0.9 µ/step (Basic instruction)
I/O update and Base time	2 ms *2)
Pulse catch/Interrupt input	6 points in total (High-speed counter included)
High-speed counter	Single phase: 4 points (10 kHz in total) Dual phase: 2 points (2 kHz in total) *3)
Pulse output	2 points (10 kHz in total) *4)
COM port	RS232C/RS485 (according to models) * Must be provided aside from tool ports

*1) Thermocouple input type: 6 points
*2) Thermocouple input type: 2 to 3 ms (Typical), Max: 15 ms. (The time takes longer every 250 ms.)
*3) Thermocouple input type: 5 kHz (Single phase), 1 kHz (Dual phase)
*4) Thermocouple input type: 5 kHz

1.2 Unit Name and Product Number

1.2.1 FP-e control unit

Name	Number of I/O points	Thermo-couple input	Calendar timer	COM port	Product No.
FP-e control unit (Standard type)	Input: 8/Output: 6 (Tr. NPN: 5, Ry: 1)	Not available	Not available	RS232C	AFPE224300
FP-e control unit (Calendar timer type)	Input: 8/Output: 6 (Tr. NPN: 5, Ry: 1)	Not available	Available	RS232C	AFPE224305
FP-e control unit (Thermocouple input type)	Input: 6/Output: 6 (Tr. NPN: 5, Ry: 1)	2 points	Available	RS232C	AFPE214325
FP-e control unit (Standard type)	Input: 8/Output: 6 (Tr. NPN: 5, Ry: 1)	Not available	Not available	RS485	AFPE224302
FP-e control unit (Thermocouple input type)	Input: 6/Output: 6 (Tr. NPN: 5, Ry: 1)	2 points	Not available	RS485	AFPE214322

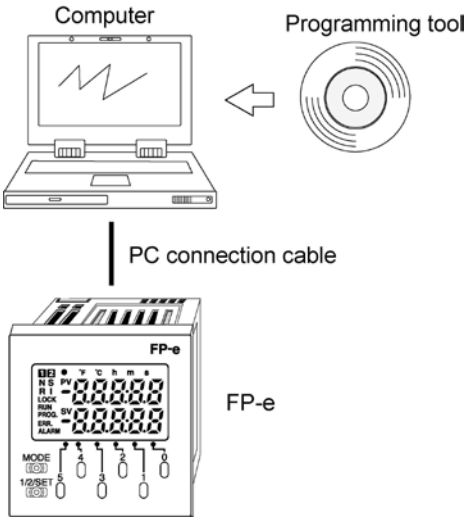
1.2.2 Related parts

Name	Description	Product No.
Terminal driver	Used for connecting a terminal	AFP0806
Rubber gasket	Used for a waterproof unit (included in a unit package)	ATC18002
Mounting frame	Used for mounting a unit. (included in a unit package)	ATA4811
Battery for FP Σ	Used for calendar timer and operation memory backup. (Included in calendar timer function-provided type and themocouple input type)	AFPG804
Protective cover	Oil resistant soft cover	AQM4803
Terminal socket set	Set of four types of terminal socket for FP-e (Maintenance parts)	AFPE804
Panel cover (20-pack)	Color: Black, with Brand name・FP-e mark	AFPE803
	Color: Ash gray, without Brand name・FP-e mark	AFPE805
	Color: Black, without Brand name・FP-e mark	AFPE806

1.3 Programming Tool

1.3.1 When using a tool software

- Tools needed for programming



1. Programming tool software

- The tool software can also be used with the FP series.
- The "FPWIN GR Ver. 2" or "FPWIN Pro Ver. 6" (for Windows) is used with FP-e controllers.
- Note that the earlier "FPWIN GR Ver. 1," "NPST-GR (DOS version), or "FP programmer" cannot be used.

2. PC connection cables

This cable is needed for connection between the FP-e unit and the computer.

Software environment and suitable cables

- Standard ladder diagram tool software "FPWIN GR Ver. 2"

Type of software		OS (Operating system)	Hard disc capacity	Product No.
FPWIN GR Ver. 2 English-language menu	Full type	Windows®98 Windows®Me Windows®2000 Windows®XP Windows Vista®	40 MB or more	AFPS10520
	Upgraded version			AFPS10520R
	Small type			AFPS11520

Note 1) To use the "FP-e," software Ver. 2.2 or higher is required.
The software Ver. 2.3 or higher is required to set the COM port to MODBUS S RTU.
Customers who use the Ver.2 software can upgrade it through our HP (http://industrial.panasonic.com/ac/e/dl_center/software/) free of charge.

Note 2) Customers who use the "FPWIN GR Ver.1" can use the "FPWIN GR Ver. 2" after purchasing the upgraded version software.
(The upgraded version software can be installed only when the "Ver.1.1" has been previously installed.

Note 3) Small type version can be used for the "FP-e," "FPΣ," "FP0," "FP1," and "FP-M" series.

- IEC61131-3-compliant programming tool software FPWIN Pro Ver.6

Type of software	OS (Operating system)	Hard disc capacity	Product No.
FPWIN Pro Ver.6 English-language menu	Windows®2000 Windows®XP Windows Vista®	100 MB or more	AFPS50560

Note 1) The small type is not available for Ver.6.

Note 2) To use the "FP-e software Ver. 6.1 or higher is required.
Customers who use the Ver. 6 software can upgrade it through our HP (http://industrial.panasonic.com/ac/e/dl_center/software/) free of charge.

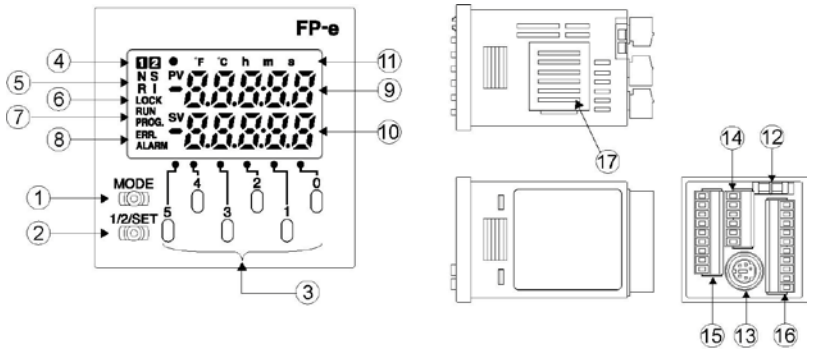
- Type of computer and suitable cables

Connecter	Connecter on PLC side	Product No.
D-Sub 9-pin	Mini DIN round 5-pin	AFC8503
	Mini DIN round 5-pin streight type	AFC8503S

Chapter 2

Functions and I/O specifications

2.1 Section Names and Functions



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①Display mode switch

Changes the display mode to N, S, R, or I.

When the switch is pressed for 2 seconds or longer, the front switch key is locked. Pressing the switch once more for 2 seconds or longer unlocks the key.

②Screen changeover switch

Changes the display to 1st Screen or 2nd Screen.

When the numerical data is changed, pressing the switch for one second or longer determines the data.

③Front operation switch

Changes the data. This switch is also used as the input switch.

Pressing a switch of the digit for which you would like to change the numerical value during the data change adds one to the numerical value displayed.

(Data display blinks during the data change.)

④Display screen No.

Indicates the screen number used currently. "1st" or "2nd" is displayed.

⑤Display mode

Indicates "N," "S," "R," or "I."

⑥LOCK display

Shows that the switch is locked.

(This display is lit when "LOCK" using the front switch or "ALL LOCK" using the program is selected.)

⑦RUN/PROG. display

Displays the operation mode (RUN or PROG.).

⑧ERR./ALARM display

Indicates when an error or an alarm occurs.

ERR. : Lights up if an error is detected during the self-diagnostic function.

ALARM : Lights up if a hardware error occurs, or if operation slows because of the program, and the watchdog timer is activated.

⑨Data display (Upper section)
N and S modes
- Display the data registered using the F180 (SCR) command.
- Display the data in red, green, or orange.

R mode
- Displays the address in the memory area in green.

I mode
- Displays the external input monitor in green.

⑩Data display (Lower section)
N and S modes
- Display the data registered using the F180 (SCR) command.
- Blink when the numerical value is changed.
- Display the data in red, green, or orange.

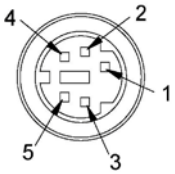
R mode
- Displays the data in the memory area in green.

I mode
- Displays the external output monitor in green.

⑪Setting display
Indications (e.g.●, ºF, ºC, h, m, s, SV, and PV) and dot between the digits can be displayed individually by the ladder program.

⑫Mode switch (RUN/PROG.)
Changes the mode of the FP-e unit to RUN or PROG. Modes can also be changed from the programming tool.
When performing remote switching from the programming tool, the position of the mode switch and the actual mode of operation may differ.
Verify the mode with the RUN/PROG. display on the front.
When power is supplied, the mode displayed is activated.

⑬Tool port (RS232C)
Used to connect a programming tool.
A commercial mini-DIN 5-pin connector is used for the tool port on the control unit.



Pin No.	Name	Abbr.	Signal direction
1	Signal ground	SG	-
2	Send data	SD	Unit → External device
3	Receive data	RD	Unit ← External device
4	(Not used)	-	-
5	+5V	+5V	Unit → External device

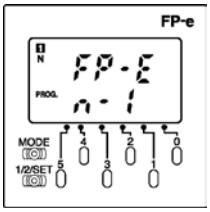
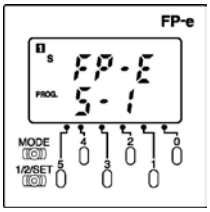
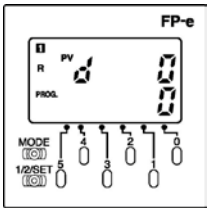
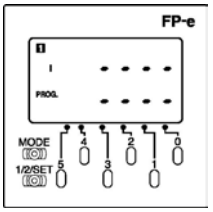
*The followings are default settings. Use the system register to change the settings.
Baud rate----------9600bps
Character bit length----------8 bit
Parity check----------Odd parity
Stop bit----------1 bit

⑭Power supply/COM port connector
⑮Input connector
⑯Output connector
⑰Battery cover

Note: Colors in the display section
④ to ⑦ and ⑪: green ⑧: red
⑨ and ⑩: red, green, or orange (N and S modes), green (R and I modes)

2.2 Display Modes and Functions

2.2.1 Display modes and functions

Mode	N mode (Normal mode)	S mode (Switch mode)	R mode (Register mode)	I mode (I/O monitor mode)
Screen	 Registered by F180 (SCR) command	 Registered by F180 (SCR) command	 Data monitor of the internal memory	 · External I/O monitor · Thermocouple input monitor
Number of screens	2	2	2	2
Display in the upper section	Arbitrary data display (Characters/Numerical values)	Arbitrary data display (Characters/Numerical values)	Address in the memory area	· Input status monitor ·Thermocouple input CH.0 monitor
Display in the lower section	Arbitrary data display (Characters/ Numerical values)	Arbitrary data display (Characters/ Numerical values)	Data in the memory area (Displayed in a decimal number system.)	· Output status monitor ·Thermocouple input CH.1 monitor
Operation switch	Used for changing numerical values	Used as the input switch	Used for changing numerical values	Used as the input switch
Example	Using the F180 (SCR) command, the elapsed value on the counter is displayed in the upper section, and the set value is displayed in the lower section. The set value can be changed with the front operation switch.	Using the F180 (SCR) command, the message is displayed in the upper section, and the data is displayed in the lower section. The display description can be changed with the input switch.	When program operation is checked, the data description can be checked by specifying the arbitrary memory area with the front operation switch. The data can also be changed with the front operation switch.	When program operation is checked, external I/O status is monitored. The front operation switch can be used as the input switch.(However, the input status of the front operation switch cannot be monitored.)

Note 1) Whenever the display mode switch is pressed, the mode displayed changes as follows: N→S→R→I→N. The display can also be switched from the program using the F180 (DSP) command.

Note 2) When the display mode switch is pressed for 2 seconds or longer, the front switch is locked. Pressing the switch once more for 2 seconds or longer unlocks the switch.

Note 3) Screen changeover switch changes the display to 1st Screen or 2nd Screen.

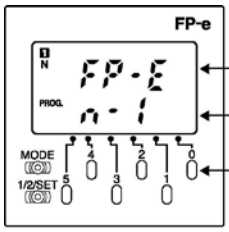
Note 4) When the numerical values are changed, pressing the screen changeover switch for one second or longer determines the data.

Note 5) The operation switches can also be used as input switches in all modes.

Reference: A.2 I/O Allocation

2.2.2 Mode Displays

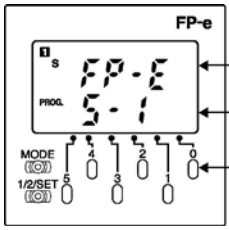
N (Normal) mode Screen is registered using the F180 (SCR) command.



Upper section: Arbitrary character data or numerical values *
(WX, WY, WR, SV, EV, DT, IX, IY)
Lower section: Arbitrary character data or numerical values *
(WY, WR, SV, EV, DT, IX, IY)
Operation switch: The numerical value in the lower section can be changed when displayed in a decimal or hexadecimal number system.

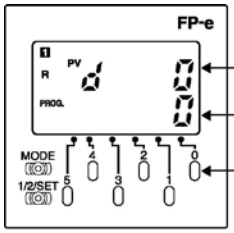
*Numerical values are displayed only in 16-bit. The data can be displayed in a bit, decimal, or hexadecimal system.

S (Switch) mode Screen is registered using the F180 (SCR) command.



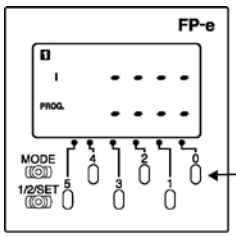
Upper section: Arbitrary character data or numerical values
(WX, WY, WR, SV, EV, DT, IX, IY)
Lower section: Arbitrary character data or numerical values
(WY, WR, SV, EV, DT, IX, IY)
Operation switch: Can be used as the input switch.

R (Register) mode Screen cannot be defined using the F180 (SCR) command.



Upper section: Device type (DT, WR, SV, or EV) and its address in the memory area
Lower section: Data in the memory area
Operation switch: Device type (DT, WR, SV, or EV), its address in the memory area, and data can be changed using this switch.

I (I/O monitor) mode Screen cannot be defined using the F180 (SCR) command.



1st Screen: Upper section: External input (WX0) monitor display
Lower section: External outnput (WY0) monitor display

2nd Screen: Upper section: Temperature display of the thermocouple input CH.0
Lower section: Temperature display of the thermocouple input CH.1

Operation Switch: Can be used as the input switch.

2.3 Input and Output Specifications

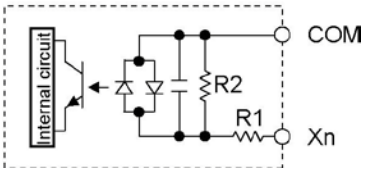
2.3.1 Input specifications

- DC input specifications (X0 toX7)

Item		Description
Number of input		8 points 6 points (thermocouple input type)
Insulation method		Optical coupler
Rated input voltage		24 V DC
Operating voltage range		21.6 to 26.4 V DC
Rated input current		Approx. 4.3 mA
Input points per common		8 points/common, 6 points/common (thermocouple input type) (Either the positive or negative of the input power supply can be connected to common terminal.)
ON voltage/ON current		19.2 V or less / 4 mA or less
OFF voltage/OFF current		2.4 V or more / 1 mA or more
Input impedance		Approx. 5.1 kΩ (X0, X1) Approx. 5.6 kΩ (X2 to X7)
Response time	**OFF to ON**	50 µs or less (X0, X1) Note) 100 µs or less (X2 to X5) Note) 2 ms or less (X6, X7)
	ON to OFF	50 µs or less (X0, X1) Note) 100 µs or less (X2 to X5) Note) 2 ms or less (X6, X7)
Operation indicator		LCD display (I/O monitor mode)

Note) X0 through X5 are inputs for the high-speed counter and have a fast response time. If used as normal inputs, you are recommend to insert a timer in the ladder program as chattering and noise may be interpreted as an input signal.
Also, the above specifications apply when the rated input voltage is 24V DC and the temperature is 25 ºC.

Internal circuit diagram



	R_1	R_2
X0 and X1	5.1 kΩ	3 kΩ
X2 to X5	5.6 kΩ	2 kΩ
X6 and X7	5.6 kΩ	1 kΩ

- Thermocouple input specifications

Item	Specifications
Number of input	2 points (CH0: WX1, CH1: WX2)
Temperature sensor type	Thermocouple type K
Input range	- 30.0 to 300.0 ºC *1) (- 22 to 572 ºF)
Accuracy	±0.5%FS±1.5 ºC (FS = -30 to 300 ºC)
Resolution	0.1 ºC
Conversion time	250 ms/2CH *2)
Insulation method	Between internal circuit and thermocouple input circuit: noninsulated *3) Between CH0 and CH1 of thermocouple input: PhotoMos insulation
Detection function of wire disconnection	Available

*1)Temperature can be measured up to 330 ºC (626 ºF). When the measured temperature exceeds 330 ºC (626 ºF) or the thermocouple wiring is disconnected, “K20000” is written to the register.

*2)Temperature conversion for thermocouple input is performed every 250 ms. The conversion data is updated on the internal data register after the scan is completed.

*3)The internal circuit and thermocouple input circuit are not insulated. Therefore, use the nongrounding type thermocouples and sheath tubes.

Note:

- To prevent the influence of noise, use the shielded thermocouples and compensating lead wires after grounding them. When the shielding types are not used, thermocouples and compensating lead wires should be used less than 10 m.
- When the wire of the thermocouple is extended, be sure to use compensating lead wires according to the thermocouple type.
- It takes about 2 seconds until the input processing is completed after the power is supplied. Therefore, the input data is necessary to be valid after the temperature input completion flags X4E (CH0) and X4F (CH1) turn ON.
  After that, the temperature input completion flags turn on for only one scan at every time that the temperature conversion process has been completed (every 250ms approx).
- 1 to 50 times (Average) can be set using the system register 409. The initial setting is “0.” (Average: 20 times)
  Set the value to 20 or more to prevent the fluctuation of the thermocouple input value.
- For accurate temperature measurement, we recommend to warm up the unit for 30 minutes after the power is supplied.
- Connecting/disconnecting the thermocouple input terminal block while the thermocouple unit is ON will lower accuracy temporarily. In that case, it is recommended to warm up the unit for at least 15 minutes.
- A rapid temperature change in the thermocouple unit might change the temperature data temporarily.
- Prevent a direct air (wind) from the cooling fan built in the control panel etc. The direct air (wind) to the thermocouple unit will lower accuracy.

Example of Input temperature and internal data processing

Input temperature	Internal data (WX1 and WX2)
- 30.0 ºC (- 22.0 ºF)	K-300 (K-220)
25.0 ºC (77.0 ºF)	K 250 (K 770)
200.0 ºC (392.0 ºF)	K2000 (K3920)

To display the temperature in the Fahrenheit scale (ºF), turn Y37 contact ON.

F = C x 9/5 + 32

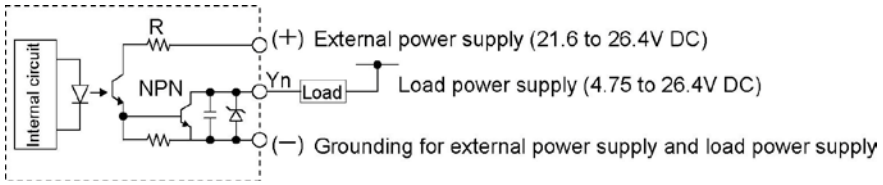
F: Fahrenheit, C: Celsius, 0 ºC = 32 ºF, 100 ºC = 212 ºF

2.3.2 Output specifications

-Transistor output specifications (For Y0 to Y4)

Item		Description (NPN)
Number of output		5 points
Insulation method		Optical coupler
Output type		Open collector
Rated load voltage		5 to 24 V DC
Operating load voltage range		4.75 to 26.4 V DC
Max. load current		0.5 A
Max. surge current		1 A
Output points per common		5 points/common
OFF state leakage current		100 μA or less
ON state voltage drop		1.5 V or less
Response time	**OFF to ON**	50 μs or less (For Y0 and Y1) 1 ms or less (For Y2,Y3 and Y4)
	ON to OFF	50 μs or less (For Y0 and Y1) 1 ms or less (For Y2,Y3 and Y4)
External power supply (For driving internal circuit)	**Voltage**	21.6 to 26.4 V DC
	Current	6 mA/point (For Y0 and Y1) 3 mA/point (For Y2, Y3, and Y4)
Surge absorber		Zener diode
Operation indicator		LCD display (I/O monitor mode)

Internal circuit diagram



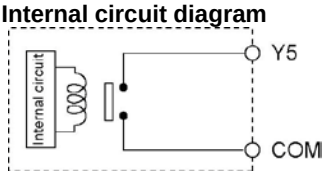
- Relay output specifications (Y5)

Item		Description
Number of output		1 point
Output type		Normally open (1 Form A)
Rated control capacity		2 A 250 V AC, 2 A 30 V DC Note1)
Output points per common		1point/common
Response time	**OFF to ON**	Approx. 10 ms
	ON to OFF	Approx. 8 ms
Life time	**Mechanical**	Min. 20,000,000 operations
	Electrical	Min. 100,000 operations Note2)
Surge absorber		None
Operation indicator		LCD display (I/O monitor mode)

Note1) Resistance load

Note2) Open/Close frequency: 20 times/min (at the rated control capacity)

Internal circuit diagram



2.4 Display/Front Operation Switch Specifications

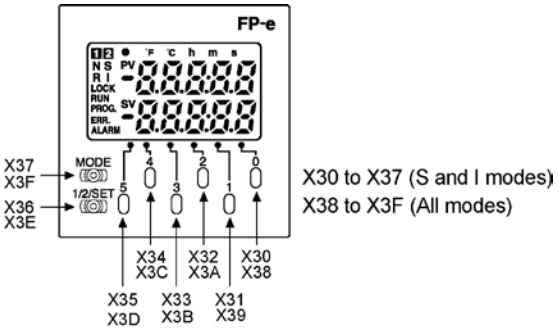
- Display section specifications

Item	Description
Data display	5 digits with a decimal point. (Minus sign can also be used.) Note) 7-segment, color selectable display (Green, red, or orange)
Mark display	PV SV (Green, red, or orange) ● ºF ºC h m s (Green)
Display mode	4 modes (Green) N : Normal mode---Simple characters, data display, data setting/data input switch S : Switch mode----Simple characters, data setting/PLC external input switch R : Register mode---Internal data, timer/counter value reading and writing modes I : I/O monitor mode---I/O status display/PLC external input switch
Screen No.	1 2 (Green)
Status display	LOCK, RUN and PROG. (Green) ERR ALARM (Red)
Switch input	8 points For mode switching 1 point For screen switching 1 point For data setting or external input 6 points *Refer to the input address (below) for external input.
Display	Negative backlight LCD (Colors in the numerical section can be changed: green, red, or orange
Size of the characters	7-segment 6.7 mm LOCK PV SV 1.6 mm ERR 1.4 mm N S R I 1.7 mm ALARM ● ºF ºC h m s 1.6 mm

Note: Numerical values are displayed only in 16-bit. The data can be displayed in a bit, decimal, or hexadecimal system.

- Front operation switch (External input address)

When the front operation switch is used for external input, use the allocated addresses as shown below.



Example: When “0” is pressed during the S mode, “X30” and “X38” turn ON at the same time.

Reference: A.2 I/O allocation

2.5 Calendar timer

2.5.1 Area for calendar timer

With the clock/calendar function, data indicating the hour, minute, second, day, year and other information stored in the special data registers DT9053 to DT9057 can be read using the transmission instruction and used in sequence programs.

Special data Register No.	Upper byte	Lower byte	Reading	Writing
DT9053	Hour data H00 to H23	Minute data H00 to H59	Available	Not available
DT9054	Minute data H00 to H59	Second data H00 to H59	Available	Available
DT9055	Day data H01 to H31	Hour data H00 to H23	Available	Available
DT9056	Year data H00 to H99	Month data H01 to H12	Available	Available
DT9057	—	Day- of - the-week data H00 to H06	Available	Available

Note:

1. The area above is available for the FP-e unit with a calendar timer function.
2. The value is not fixed initially when the battery is connected. Set the appropriate value to the calendar timer.
   Lithium battery is included in the FP-e unit, but it is not connected to the unit. Connect the battery to the unit before using the FP-e controller.
3. Put in a new battery within a minute after removing the old battery.
4. A calendar timer is available only when a battery is installed.

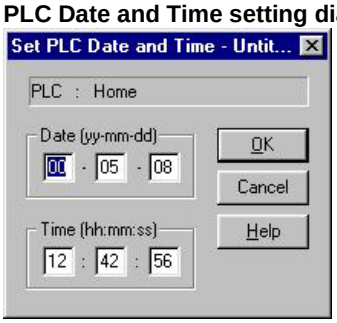
2.5.2 Setting of calendar timer function

There are two ways to set the calendar timer function as described below.

- Setting using FPWIN GR

1. Press the **[CTRL]** and **[F2]** keys at the same time, to switch the screen to **[Online].**
2. Select “Set PLC Date and Time” under “Tool” on the menu bar.

PLC Date and Time setting dialog box



The above steps display the “Set PLC Date and Time dialog box” shown on the left. Input the date and time, and click on the “OK” button.

- Setting and changing using program

1. The values written to the special data registers DT9054 to DT9057, which are allocated as the calendar timer setting area, are transferred.
2. A value of H8000 is written to DT9058.

Example: showing the date and time being written

Set the time to 12:30:00 on the 5th day of October, 2002 when the X0 turns ON.

2.5.3 Accuracy of calendar timer

Accuracy

200 s / month (0 ºC)

70 s / month (25 ºC)

240 s /month (55 ºC)

2.6 Limitations in data hold/non-hold function

Setting a system register can expand the data hold area. In this case, however, a back-up battery must be previously installed.

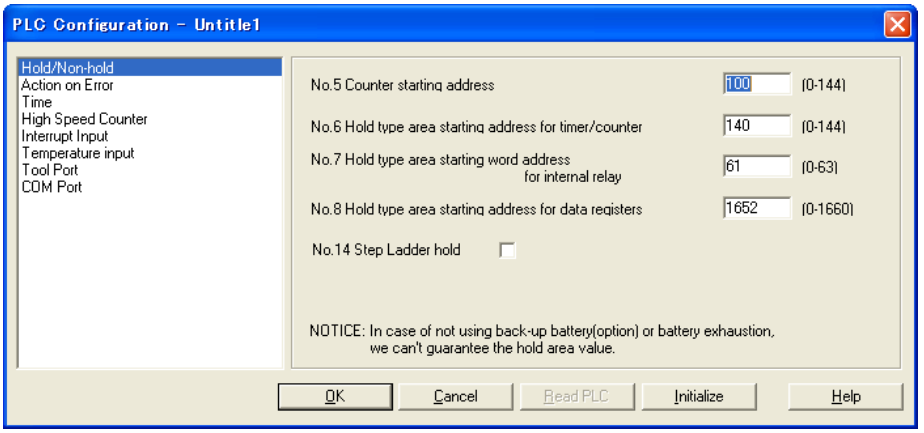
Product No.	Settings Note 1	Data
AFPE224300 AFPE224302 AFPE224322 Note 2	System register setting	Non-hold
AFPE224305	System register setting with a back-up battery	Hold
AFPE214325	System register setting without a back-up battery	Non-hold

Note 1: System register settings are effective only when a back-up battery is installed in the FP-e control unit.(A set value will be returned to the default value.)

Note 2: A back-up battery cannot be installed in this type of product.

System register setter setting screen – (Hold/Non-hold)

Areas for Nos. 6, 7, 8 and 14 can be expanded.



Note: “NOTICE” in the screen above is described for the FPWIN GR Ver. 2.24 or higher.

Note: System register initial values on Hold/Non-hold tab are within the ones that can be backed up with a ROM.

Chapter 3

Installation and Wiring

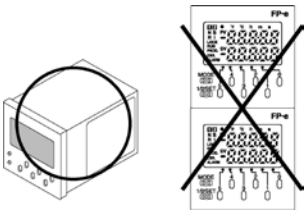
3.1 Installation

3.1.1 Operating environment

Operating environment (Use the unit within the range of the general specifications when installing)
*Ambient temperatures:0 ~ +55℃
*Ambient humidity: 30% to 85% RH (at 25°C, non-condensing)
*For use in pollution Degree 2 environment.
*Do not use it in the following environments.
-Direct sunlight
-Sudden temperature changes causing condensation.
-Inflammable or corrosive gas.
-E-xcessive airborne dust, metal particles or saline matter.
-Benzine, paint thinner, alcohol or other organic solvents or strong alkaline solutions such as ammonia or caustic soda.
-Direct vibration, shock or direct drop of water.
- Influence from power transmission lines, high voltage equipment, power cables, power equipment, radio transmitters, or any other equipment that would generate high switching surges. (Min.100mm or less)

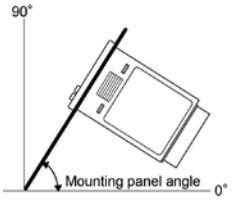
Static electricity
-Before touching the unit, always touch a grounded piece of metal in order to discharge static electricity.
-In dry locations, excessive static electricity can cause problems.

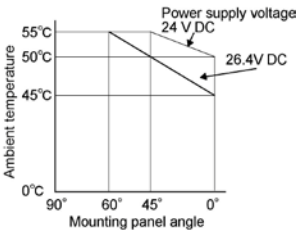
Measures regarding heat discharge:
-Always amount the unit oriented with the LCD facing upward in order to prevent the generation of heat. Do not amount the units vertically as shown below.



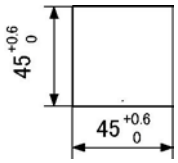
-Do not install the unit as shown below.

-Do not amount the unit above which generate large heat such as heaters, transformers, or large scale resisters.
Note that the ambient temperature and electrical voltage are restricted when the mounting panel is installed at the angle of 0 (horizontal) to 60.



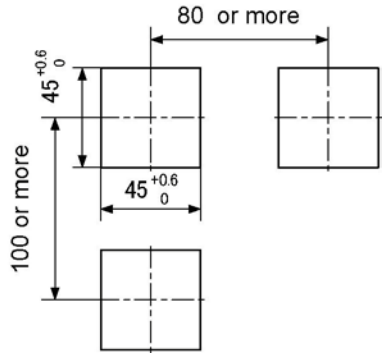


Mounting panel cut size (Unit: mm)
- Standard mounting panel cut size



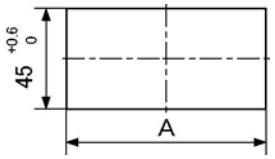
Mounting panel cut size is shown in the diagram on the left.
(Panel thickness: 1 to 5 mm)

-When using two or more units:



Make holes in the specified size as shown in the diagram on the left.

-When mounting units in a row

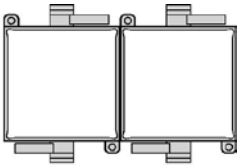


Units can be mounted horizontally in a row. In that case, however, waterproofing property on the unit will be lost.

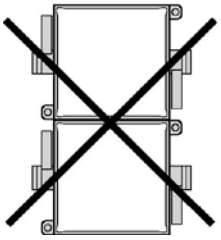
When "n" units are mounted in a row, "A" should be:

$$A=(48\times n-2.5)\ {}^{+0.6}_{0}$$

Note: When mounting the units horizontally in a row:



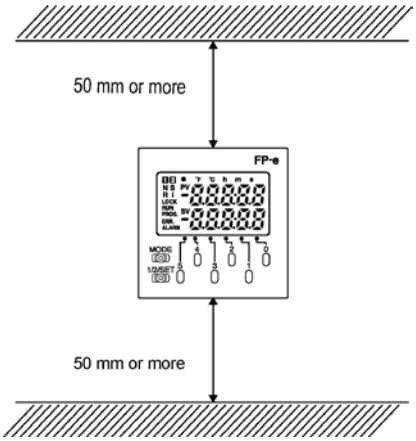
Mount the units oriented with the molded spring sections of the mounting flame facing upward and downward.



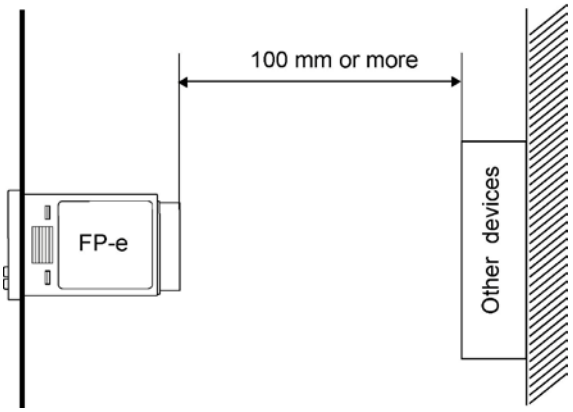
Do not mount the units vertically in a row in order to prevent the generation of heat.

Installation space

- Leave at least 50 mm of space between the wiring ducts of the unit and other devices to allow heat radiation and unit replacement.



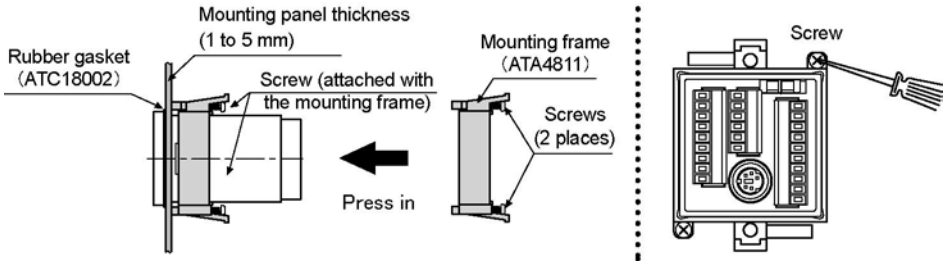
- Maintain 100 mm or more space between the unit and other devices in order to allow room for programming tool connections and wiring, or to avoid radiated noise and heat from other devices.



3.1.2 Mounting and Removing the Unit

Mounting the unit

Insert the unit into the mounting panel opening from its front and mount the mounting frame from the unit's rear all the way not to have any space with the mounting panel. In addition, secure the mounting frame using screws.

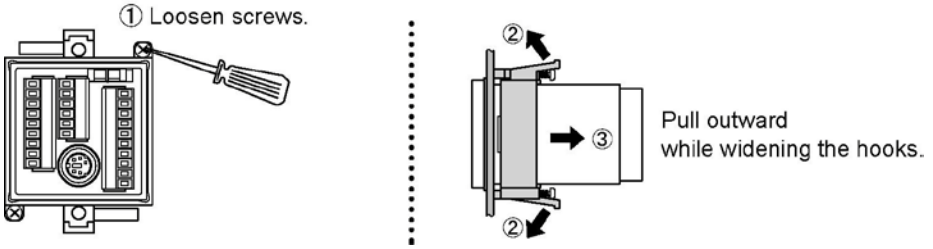


Precautions for mounting

The front of the unit is waterproof, but do not forget to fix the mounting frame using screws to make coherent a unit, rubber gasket and panel front sufficiently.
(Check the both screws are tightened to the same extent and are stable. Tightening too much might remove the mounting frame.)
Always mount a unit with a rubber gasket to keep the unit front section's waterproof.

Removing the unit

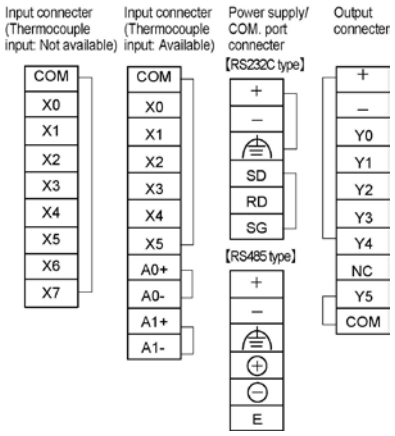
Loosen the screws for the mounting frame. Then, pull outward the frame while widening the hooks.

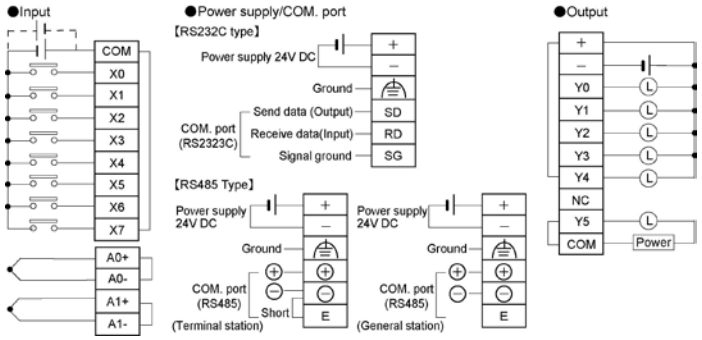


3.2 Terminal Layout Diagram and Terminal Block Wiring

3.2.1 Terminal layout diagram

-Terminal layout diagram **-Wiring diagram**

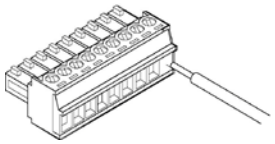




3.2.2 Terminal block wiring

Terminal block used and suitable wire

A screw-down terminal block (from Phoenix Contact Co.) or equivalent is used. The suitable wires are shown below.



-Suitable wires

Size	Nominal cross-sectional area
AWG#24 to 16	0.2 mm^2 to 1.25mm^2

For the COM port and analog input section of the thermocouple input type, the suitable wire size is AWG#28 to 16 (0.08 mm^2 to 1.25 mm^2).

-Pole terminal with a compatible insulation sleeve

When a pole terminal is used, use the following models from Phoenix Contact Co.

Manufacturer	Cross-sectional area	Size	Parts No.	
			With insulating sleeve	Without insulating sleeve
Phoenix Contact Co.	0.25 mm^2	AWG#24	AI 0,25-6BU	A 0,25-7
	0.34 mm^2	AWG#22	AI 0,34-6TQ	A 0,34-7
	0.50 mm^2	AWG#20	AI 0,5-6WH	A 0,5-6
	0.75 mm^2	AWG#18	AI 0,75-6GY	A 0,75-6
	1.00 mm^2	AWG#18	-	A 1-6
	0.5 mm^2 X 2	AWG#20 X 2	AI-TWIN 2X 0,5-8WH	-

-Pressure welding tool for pole terminals

Manufacturer	Model No.	
	Parts No.	Product No.
Phoenix Contact Co.	CRIMPFOX 6	1212034

Suitable screwdriver

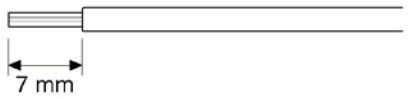
When tightening the terminals of the terminal block, use a screwdriver (Phoenix Contact Co. Product No.1205037) with a blade size of 0.4 X 2.5 (Model No. SZS 0,4 X 2,5)

The tightening torque should be 0.22Nm to 0.25 Nm (2.3 kgfcm to 2.5 kgfcm)

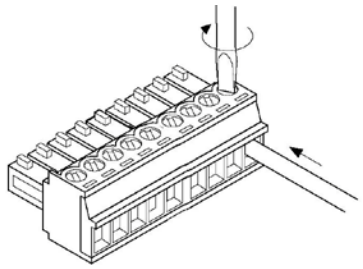
Manufacturer	Model No.		Order product No.
	Parts No.	Product No.	
Phoenix Contact Co.	SZS0,4 X 2,5	1205037	AFP0806

Wiring

1. Remove a portion of the wire's insulation.

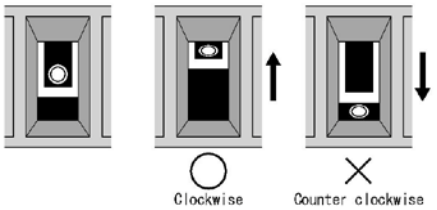


2. Insert the wire into the terminal block until it contacts the back of the terminal block. Then, tighten the screw clockwise to fix the wire in place.



Notes

-When removing the wire's insulation, be careful not to scratch the core wire.
-Do not twist the wires to connect them.
-Do not solder the wires to connect them. The solder may break due to vibration.
-After wiring, make sure stress is not applied to the wire.
-In the terminal block socket construction, if the wire closes upon counter-clockwise rotation, the connection is faulty. Disconnect the wire, check the terminal hole, and then re-connect the wire.



3.3 Power Supply Wiring

3.3.1 Power supply wiring

Power supply wire

To minimize adverse effects from noise, twist the wires of the power supply cable.

Power supply type

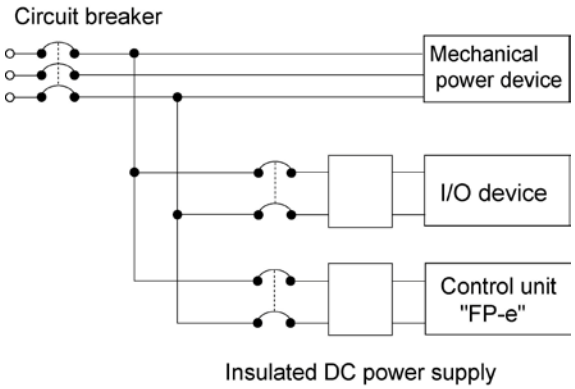
-To protect the system against erroneous voltage from the power supply line, use an insulated power supply with an internal protective circuit.
-The regulator on the FP-e is a non-insulated type.
-When using a power supply device without an internal protective circuit, male sure power is supplied to the unit through a protective element such as a fuse.

Power supply voltage

Rated voltage	24 V DC
Operating voltage range	21.6 V DC to 26.4V DC

Wiring system

Isolate the wiring systems to the control unit, input/output devices, and mechanical power devises.



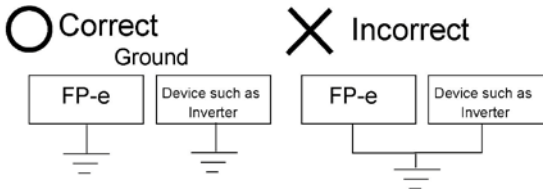
Power supply sequence

-The power supply sequence should be set so that power to the FP-e is tuned off before the input/output power turns off.
-If the input/output power supply turns off before the power to the FP-e turns off, the FP-e will detect the input fluctuations and may start an unscheduled sequential operation.

3.3.2 Grounding

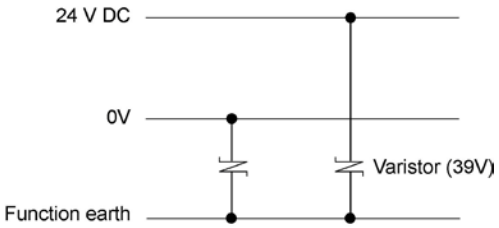
Grounding to prevent noise
Under normal conditions, the inherent noise resistance is sufficient. However, in situations of excessive noise, ground the instrument to increase noise suppression.

Use an exclusive ground
- For grounding purpose, use wiring with a minimum of 2 mm^2. The grounding connection should have a resistance of less than100Ω.
- The point of grounding should be as close to the FP-e unit as possible. The ground wire should be as short as possible.
- If two devices share a single ground point, it may produce an adverse effect. Be sure to use an exclusive ground for each device.



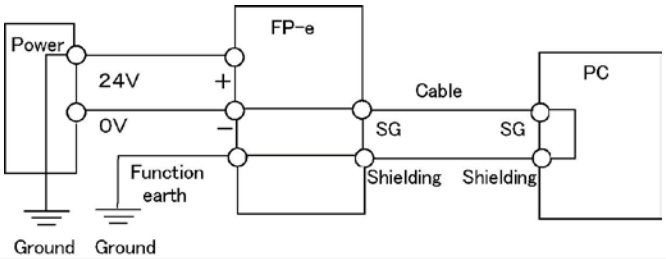
Note: Depending on the surroundings in which the FP-e unit is used, grounding may cause problems.

Example: The power supply line of the FP-e unit is connected to the function earth through a varistor. If there is an irregular potential between the power supply line and the earth, the varistor may be shortened.



FP-e power supply line

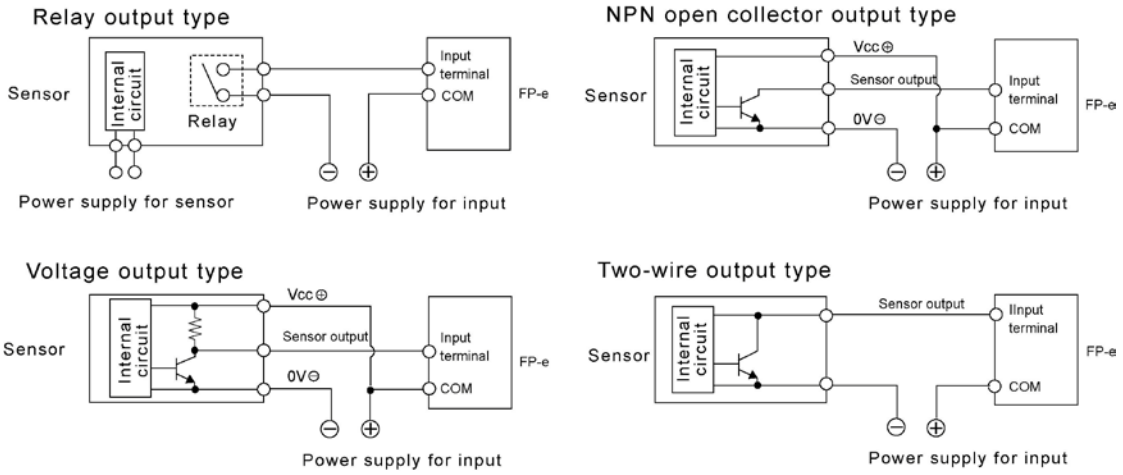
Do not ground an FP-e function earth terminal when grounding a plus (+) terminal of the power
The FP-e tool port shielding and function earth terminal are connected.
In some computers, the SG terminal of RS232C port and connector shielding are connected.
When the FP-e is connected to a computer with a plus (+) terminal grounded, therefore, an FP-e's minus (-) terminal is connected with the function earth terminal. As a result, short circuit occurs which may lead to the breakage of FP-e and its neighboring parts.



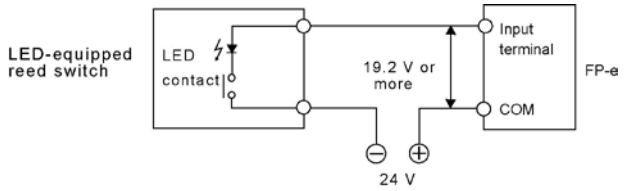
3.4 Wiring of Input and Output

3.4.1 Input wiring

- Connection of photoelectric sensor and proximity sensor

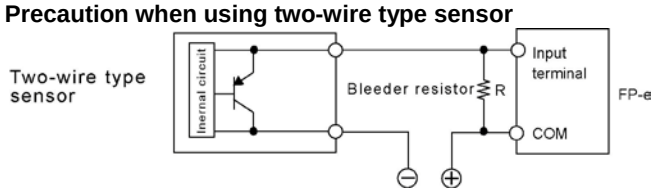


- Precaution when using LED-equipped reed switch



When a LED is connected in series to an input contact such as LED-equipped reed switch, make sure that the ON voltage applied to the FP-e input terminal is greater than 19.2V DC. In particular, take care when connecting a number of switches in series.

- Precaution when using two-wire type sensor



When the input of FP-e does not turn off because of leakage current from the two-wire type sensors (e.g. photoelectric sensor and proximity sensor), the use of a bleeder resistor is recommended, as shown in the diagram on the left.
The formula below is based on an input impedance of 5.6 kΩ The input impedance varies depending on the input terminal number.

I : Sensor's leakage current (mA)
R: Resistance of the bleeder resistor (kΩ)

The OFF voltage of the input is 2.4V. Determine the value of bleeder resistor "R" so that the voltage between the COM terminal and the input terminal will be less than 2.4V.

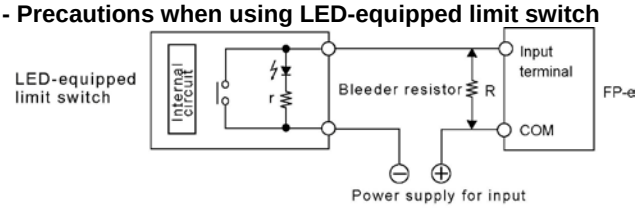
$$I \times \frac{5.6R}{5.6+R} \leqq 2.4 \qquad R \leqq \frac{13.44}{5.6I-2.4} \quad (k\Omega)$$

The wattage (W) of the resistor is:

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

Normally, use a value that is 3 to 5 times determined for the value of "W."

- Precautions when using LED-equipped limit switch



If the input of FP-e does not turn off because of the leakage current from the LED-equipped limit switch, the use of a bleeder resistor is recommended as shown in the diagram on the left.

r : Internal resistor of limit switch (kΩ)
R : Resistance of the bleeder resistor (kΩ)

The OFF voltage of input is 2.4V. When the power supply voltage is 24V, determine the value for the bleeder resistor "R" so that the current will be greater than "I" as shown below:

$$I = \frac{24-2.4}{r} \text{ or more}$$

"R" of the bleeder resistor is:

$$R \leqq \frac{13.44}{5.6I-2.4} \quad (k\Omega)$$

The wattage (W) of the resistor is:

$$W = \frac{(\text{Power supply voltage})^2}{R} \times (3 \text{ to } 5 \text{ times})$$

Normally, use a value that is 3 to 5 times determined for the value of "W."

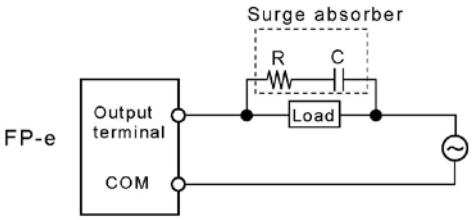
3.4.2 Output wiring

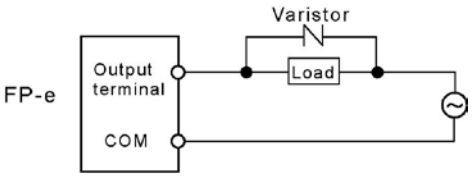
Protective circuit for inductive loads

-With an inductive load, a protective circuit should be installed in parallel with the load.

-When switching DC inductive loads with relay output type, be sure to connect a diode across the ends of the load.

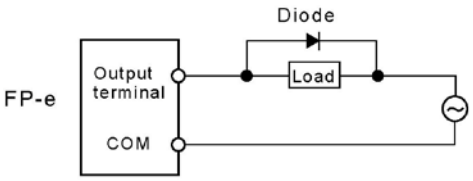
When using an AC inductive load (Relay output)





Example of surge absorber R: 50Ω
C: 0.47μF

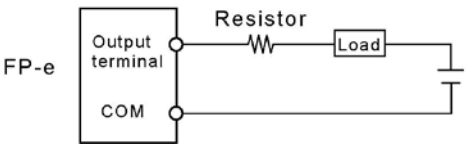
When using a DC inductive load

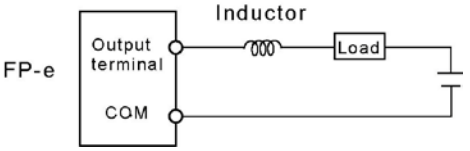


Diode
Reverse voltage: 3 times the load voltage
Average rectified forward current: Load current or more

Precautions when using capacitive load

When connecting large rush current loads, install a protection circuit (below) to minimize their effect.





Provide over-load protection with an external fuse

There is no fuse protection built into the output circuit. Therefore, in order to protect against overheating of the output circuit by possible short circuit, install an external fuse at each point. However, in cases such as short circuits, the control unit itself may not be able to be protected.

3.4.3 Common precautions for input and output wiring

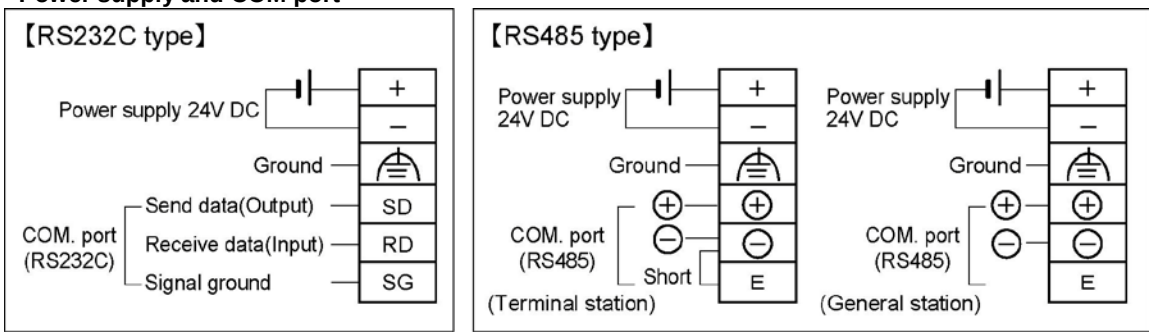
Separate the input, output, and power wiring

- Be sure to select the thickness (dia.) of the input and output wires while taking into consideration the required current capacity.
- Arrange the wiring so that the input and output wiring are separated, and these wiring are separated from the power wiring, as much as possible. Do not route them through the same duct or bind them together.
- Separate the input or output wire from the power's high voltage wire by at least 100 mm /3.937 in.

3.5 Wiring COM Port

Terminal layout

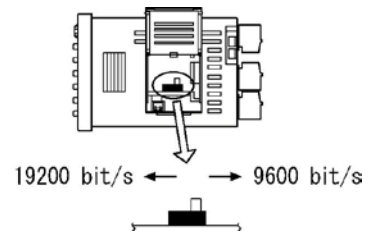
- Power supply and COM port



- COM Port specifications

COM port type	RX232C *Note 2	RS485
Isolation status with the internal circuit	Non-isolated	Isolated
Transmission distance	15 m	1200 m
Baud rate	300, 600, 1200, 2400, 4800, 9600, 19200 bit/s	9600, 19200 bit/s *Note 3, 4
Terminal resistance value	–	120 Ω
Communication method	Half-duplex	
Synchro system	Synchronous communication method	
Transmission data format	Stop bit: 1-bit/2-bit	
	Parity: None/Even/Odd	
	Data length: 7-bit/8-bits	
	Beginning code: STX available/STX not available	
	Ending code: CR/CR+LF/None/ETX	
Data output order	Starting from 0 bit per character	
No. of connected units	–	99 *Note 5, 6
Communication mode	- General-purpose communication - Computer link - MODBUS S RTU *Note7	

Note1) When communicating between FP-e and other device, it is recommnedable to perform resend Processing as it may be affected by excessive noise depending on the environments installed.
Note2) For RS232C wiring, be sure to use shield wires for higher noise immunity.
Note3) Set the baud rate of RS485 to both FP-e system register and FP-e internal switch. Set the baud rate of RS232C to FP-e system register.
Note4) After sending a command from the FP-e in RS485 communication, send a response from the receiving device to the FP-e after the following time has been elapsed.
9600 bit/s: 2 ms or longer
19200 bit/s: 1 ms or longer
It takes at least 1 scan time (at least 2 ms) for the FP-e to send back a response after receiveing the command.



Note5) When our C-NET Adapter or other RS485 device than recommended is connected in the system, the maximum connection number is limited to 32 units.
Note6) For a RS485 converter on the computer side, SI-35 (from LINE EYE Co., Ltd.) is recommended. (When SI-35 is used in the system, up to 99 units can be connected.)
Note7) MODBUS S RTU (binary communication) is available with FP-e Ver. 1.2 or higher.

- Settings when shipped from factory

System register	Description
No.412	Computer Link
No.413	Character bit: 8 bits Parity check: odd Stop bit: 1 bit Header: STX not exist Terminator: CR
No.414	Baud rate: 9600 bit/s
No.415	Unit No.: 1
No.416	Modem: Not enable

 **Reference:** 11.1.1 System register list

- Suitable wires (twisted wire)

Size	Conductor cross-sectional area
AWG#28 to 16	0.08 mm^2 to 1.25 mm^2

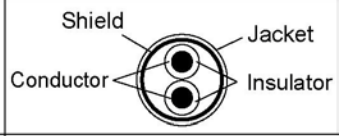
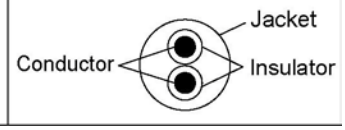
Use a shielded wire of the above wiring. It is recommend to ground the shield section.

 **Reference:** 3.2 Terminal layout and terminal block wiring

- Recommended cables for RS485 communication

Use the transmission cables shown below for the FP-e RS485 communication system.

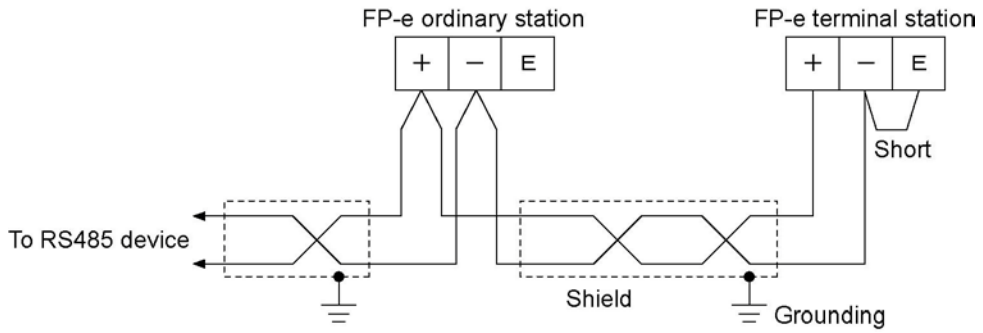
Cable	Conductor		Insulator		Cable Diameter	Applicable cables
	Size	Resistance (at 20 °C)	Material	Thickness		
Twist pair with shield	0.5 mm^2 (AWG20) or more	Max. 33.4 Ω/km	Polyethylene	Max. 0.5 mm	Approx. 7.8 mm	HITACHI KPEV-S0.5 mm^2 × 1P Belden Inc. 9207
VCTF	0.75 mm^2 (AWG18) or more	Max. 25.1 Ω/km	PVC	Max. 0.6 mm	Approx. 6.6 mm	VCTF0.75 mm^2 × 2C (JIS)

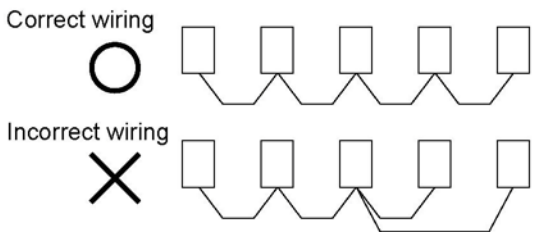
Cable	Section
Twist pair with shield	
VCTF	

*1. Use shielded type twist cables.
*2. Use only one type of the transmission cables.
Do not mix different types of the cables.
*3. Use twist pair cables under a bad noise environment.
*4. When connecting two cables to the "+" and "–" terminals of the COM port (RS485), use the above cables of which conductor cross section is 0.5 to 0.75 mm^2, and the cross sections of two cables should be the same.

- RS485 wiring and terminal station setting

1. For the FP-e unit at RS485 terminal station, wire the transmission line (–) terminal and E-terminal using a short circuit.
2. For RS485 transmission line, three or more pairs of cables should not be connected to one station. When using shielded cables for RS485 transmission line, connect one end of the shielded cable to the ground. Provide an exclusive ground for each FP-e power supply section and RS485 transmission shield line. Do not share a ground with other lines.





3.6 Safety Measures

3.6.1 Safety measures

System design
In applications in which FP-e is used, malfunctions may occur for the following reasons:
-Power on timing difference between the FP-e system and input/output or mechanical power devices.
-Response time lag when a momentary power failure occurs.
-Abnormality in the FP-e unit, external power supply, or other devices.

In order to prevent a malfunction resulting in system shutdown, take the adequate safety measures as listed below:

- Interlock circuit
When a motor clockwise/counter-clockwise operation is controlled, provide an interlock circuit on the outside of the FP-e unit.

- Emergency stop circuit
Add an emergency stop circuit on the outside of the FP-e unit to turn off the output devices in order to prevent a system shutdown or an irreparable accident when malfunction occurs.

- Start up sequence
The FP-e should be operated after all of the input/output devices and power devices are energized.

Procedure:
-After power is supplied to the FP-e unit, switch the mode from PROG. to RUN.
-Install the timer circuit to delay the FP-e startup.

 **Note:** When stopping the FP-e unit, the I/O devices should be turned off after the unit has stopped operating.

- Secure grounding
When grounding the FP-e unit next to an inverter, or other such device that produces high-voltage due to switching, avoid common grounding. Use an exclusive ground connection for each device.

3.6.2 Momentary power failures

Operation of momentary power failures

If the duration of the power failure is less than 10 ms, the FP-e unit continues to operate. If the power is turned off for 10 ms or longer, operation changes depending on the combination of units, the power supply voltage, and other factors. (In some cases, operation may be the same as that for a power supply reset.)

3.6.3 Protection of power supply and output sections

Power supply

An insulated power supply with an internal protective circuit should be used. The power supply for the control unit operation is a non-insulated circuit, so if an incorrect voltage is directly applied, the internal circuit may be damaged or destroyed. If using a power supply without a protective circuit, power should be supplied through a protective element such as a fuse.

Protection of output

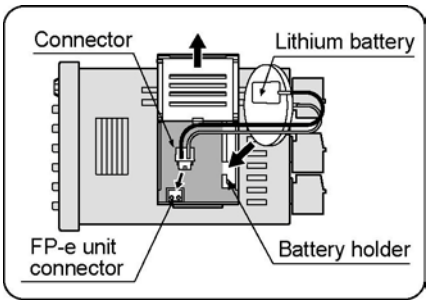
If current exceeding the rated control capacity is being supplied in the form of a motor lock current or a coil shorting in an electromagnetic device, a protective element such as a fuse should be attached externally.

3.7 Memory backup battery

3.7.1 Installation of memory backup battery (For FP-e unit with a calendar timer function)

Although FP-e units with a calendar timer have a built-in lithium battery, a lithium battery connector is not connected to an FP-e unit connector. Follow the procedure as shown below to connect them.

1. Open the battery cover on the top of the FP-e unit.
2. Connect the lithium battery connector to the FP-e unit connector.
3. Place a lithium battery in the battery holder in the FP-e unit.
4. Close the battery cover.



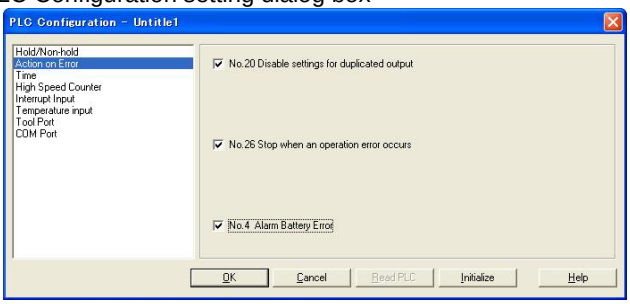
Note: A calendar timer is available only when a battery is installed.
Install a new battery within a minute after removing the old battery.

3.7.2 System register setting (For FP-e unit with a calendar timer function)

- Setting the battery error alarm

In the system register default settings, “No.4 Alarm Battery Error” is set to “OFF.” When using the battery, set system register No. 4 of the control unit so that the battery error alarm is turned on.

PLC Configuration setting dialog box



- Setting procedure using FPWIN GR

1. Select “PLC Configuration” on the “Option (O)” menu, and click on “Action on Error” tab.
2. Turn on “No. 4 Alarm Battery Error” check box.

- Specifying the hold area

In order to use backup functions such as data registers, settings must be entered for system registers Nos. 6 to 12.

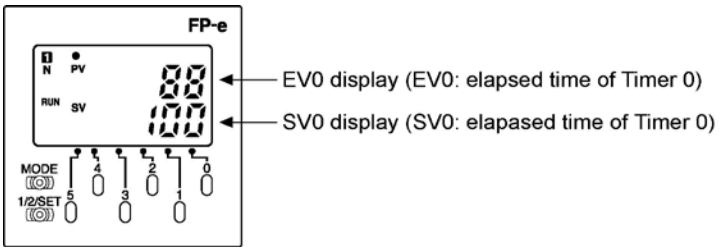
For hold area setting using FPWIN GR, select “PLC Configuration” on the “Option (O)” menu, and click on “Hold/Non-hold.”

Note: Be sure to install a lithium battery when changing the hold area with the system register or using the calendar timer function.

Chapter 4

Display and Settings in N (Normal) Mode

4.1 Display and operation in N (Normal) mode



Operation examples

- Values of EV0 and SV0 are displayed in the upper and lower sections of the controller screen respectively, using the F180 (SCR) instruction.

- Pressing the operation switches (“0” to “5”) when the value (indicated in decimal or hexadecimal system) is displayed in the lower section changes the value in each digit.
  When the ASCII code or bit is displayed in the lower section, however, it cannot be changed.

- In the data change mode after the operation switch “0” to “5” is pressed, the data in the lower section blinks.

- For writing the changed data, press the screen changeover switch “1/2/SET” for about one second. Then, the blinking stops and the data is written.

- For canceling the data change process before the data is not completely changed, press the operation switch “5” for about one second. Then, blinking the display data stops.

- Pressing the operation switch “5” adds or deletes a minus sign. (when displayed in a decimal system.)

- Pressing the “MODE” switch for about 2 seconds displays “LOCK.” In this mode, the data cannot be changed even if the operation switch is pressed.
  The “LOCK” status cannot be cancelled even if the power turns ON/OFF.

- For canceling the “LOCK” status, press the “MODE” switch for about 2 seconds again.

Notes:

1. Arbitrary characters and data (WX, WY, WR, SV, EV, DT, IX, or IY) can be displayed in the upper section of the screen.

2. Arbitrary characters and data (WY, WR, SV, EV, DT, IX, or IY) can be displayed in the lower section of the screen.

3. Numerical values are displayed only in 16-bit. (The data can be displayed in a bit, decimal, or hexadecimal system.
   - In a decimal system display: K-32768 to K32767
   - In a hexadecimal system display: H0000 to HFFFF

4. The front switches can be used as the input contact switches “X38” to “X3F.” (Available in the “LOCK” mode as well.)

5. Switching the power ON/OFF or RUN/PROG. mode cancels the data changed using the front switches.

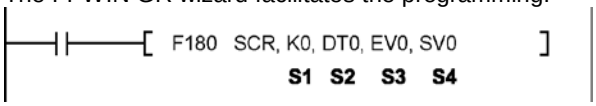
6. Only the data displayed in the lower section can be changed with the operation switches “0” to “5”.

4.2 Instructions to control the display

4.2.1 F180 (SCR): Screen display instruction, Number of steps: 9

Screen display instructions in the N and S modes of FP-e unit

The FPWIN GR wizard facilitates the programming.



S1: Used to specify the registration screen.
S2: Used to specify the head of the screen display control data (3 words).
S3: Used to specify the data displayed in the upper section
(Numerical values are displayed only in 16-bit.)
S4: Used to specify the data displayed in the lower section.
(Numerical values are displayed only in 16-bit.)

Example:
F180 (SCR), K0, DT0, EV0, SV0
Registration of N mode 1st screen
Control data: DT0, DT1, DT2
Upside display data: EV0
Downside display data: SV0

- Available memory areas A: Can be specified N/A: Cannot be specified (Unit: Word)

		WX	WY	WR	SV	EV	DT	IX	IY	K	H	Index modifier
S1	Display mode and No. (0 to 3 can be specified.)	A	A	A	A	A	A	A	A	A	A	A
S2	Head address of the area to specify the display measure.	A	A	A	A	A	A	N/A	N/A	N/A	N/A	A
S3	Area which stores the data to be displayed in the upper section.	A	A	A	A	A	A	A	A	N/A	N/A	A
S4	Area which stores the data to be displayed in the lower section.	N/A	A	A	A	A	A	A	A	N/A	N/A	A

Note: Special register “DT9***” cannot be specified for the lower section display data “S4.”
This instruction cannot be used in the interrupt program.

- Specifying the “S1” registration screen

Display type of the FP-e unit can be specified.

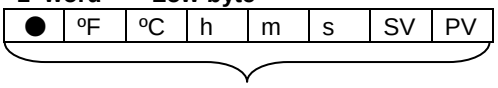
Values for “S1”	Display type
K0	N mode 1 st screen
K1	N mode 2 nd screen
K2	S mode 1 st screen
K3	S mode 2 nd screen

- Flag conditions

R9007 R9008 (ER)	Turns ON when the area specified using the Index modifier exceeds the limit.
	Turns ON when the “S1” or “S2” value is outside of the range specified.

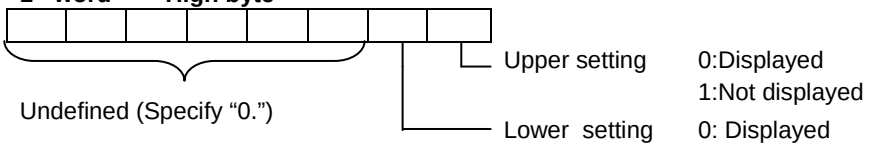
- Configuration of “S2” screen display control data

1st word Low byte



0: Not displayed, 1: Displayed

1st word High byte



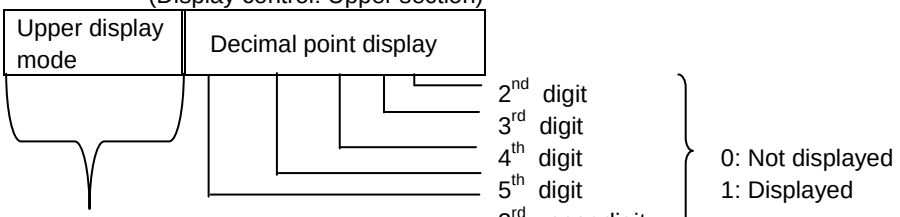
Undefined (Specify “0.”)

Upper setting 0:Displayed 1:Not displayed

Lower setting 0: Displayed 1:Not displayed

2nd word Low byte

(Display control: Upper section)



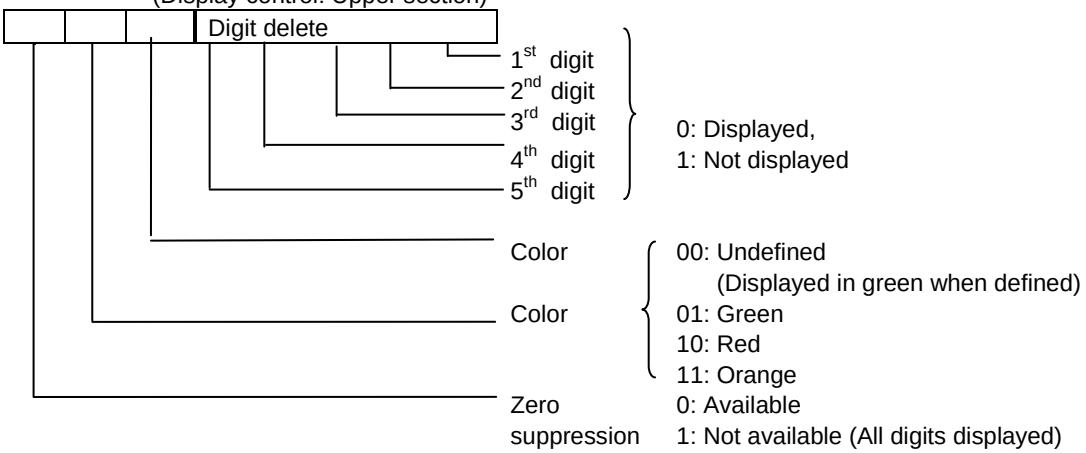
000: Signed Dec 5 digits
001: Hex 4digits or BCD 4digits
010: Bit
011: ASCII code of five characters
100: 7-segment Data
101: Undefined
110: Undefined
111: Undefined

101 and later: Undefined.
Error occurs when the undefined data is specified.

Reference: “ASCII code of five characters” and “7 segment Data. ” (See the following page.)

2nd word **High byt High byte**

(Display control: Upper section)



* When a value with a decimal point is to be displayed in the “Signed Dec 5 digits” mode, the value(s) before the decimal point should be displayed.

3rd word **Low byte**

(Display control: Lower section)

Same as the low byte display control data for 2nd word

3rd word **High byte**

(Display control: Lower section)

Same as the high byte display control data for 2nd word

- Examples of control register

1st word

"0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 1" = H83

Upper/Lower section display ● SV PV

2nd word

"0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0" = H4000

Zero suppression Red All digits Decimal point: Not displayed

3rd word

"0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0" = H6000

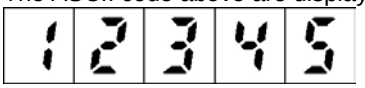
Zero suppression Orange All digits Decimal point: Not displayed

- ASCII code and its display

When 5 characters from DT0 are displayed (for 5 bytes from DT0):

DT0	H32	H31	(H32:2, H31:1)
DT1	H34	H33	(H34:4, H33:3)
DT2	H36	H35	(H36:6, H35:5)

The ASCII code above are displayed as follows.

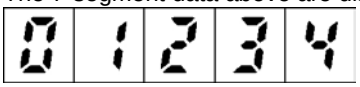


- 7-segment data and its display

When the data of 5 digits from DT0 are displayed (Lower byte in 1 word stores the data of 1 digit.):

DT0		H3F	(7-segment display data H3F: 0)	5th digit (highest-order digit)
DT1		H6	(7-segment display data H6: 1)	4th digit
DT2		H5B	(7-segment display data H5B: 2)	3rd digit
DT3		H4F	(7-segment display data H4F: 3)	2nd digit
DT4		H66	(7-segment display data H66: 4)	1st digit (lowest-order digit)

The 7-segment data above are displayed as follows:



Note) An arbitrary segment can be displayed using this function.

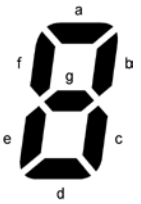
- Display description and data

Value	Conversion data (for 1 digit)				7-segment display data (for 1 digit)								7-segment display
					/	g	f	e	d	c	b	a	
0	0	0	0	0	0	0	1	1	1	1	1	1	
1	0	0	0	1	0	0	0	0	0	1	1	0	
2	0	0	1	0	0	1	0	1	1	0	1	1	
3	0	0	1	1	0	1	0	0	1	1	1	1	
4	0	1	0	0	0	1	1	0	0	1	1	0	
5	0	1	0	1	0	1	1	0	1	1	0	1	
6	0	1	1	0	0	1	1	1	1	1	0	1	
7	0	1	1	1	0	0	1	0	0	1	1	1	
8	1	0	0	0	0	1	1	1	1	1	1	1	
9	1	0	0	1	0	1	1	0	1	1	1	1	
A	1	0	1	0	0	1	1	1	0	1	1	1	
B	1	0	1	1	0	1	1	1	1	1	0	0	
C	1	1	0	0	0	0	1	1	1	0	0	1	
D	1	1	0	1	0	1	0	1	1	1	1	0	
E	1	1	1	0	0	1	1	1	1	0	0	1	
F	1	1	1	1	0	1	1	1	0	0	0	1	

LSB

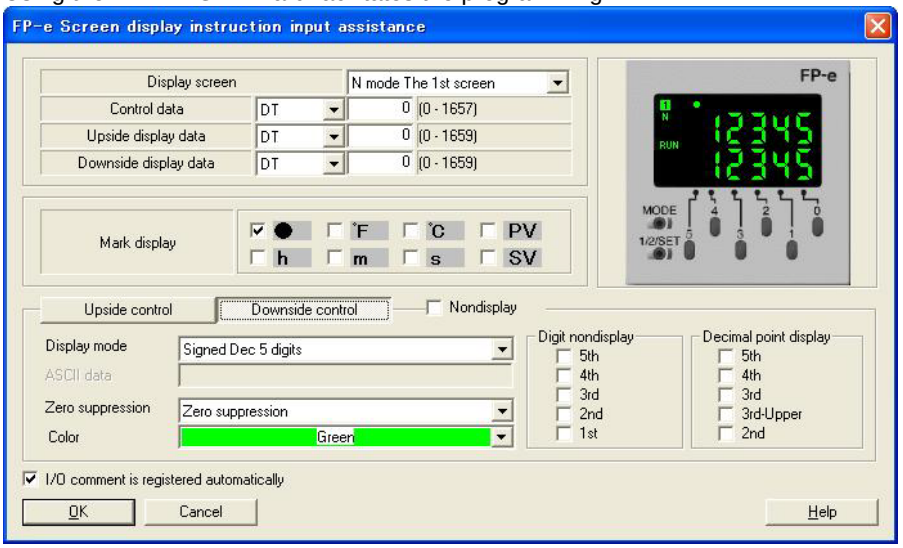
a
b
c
d
e
f
g
/

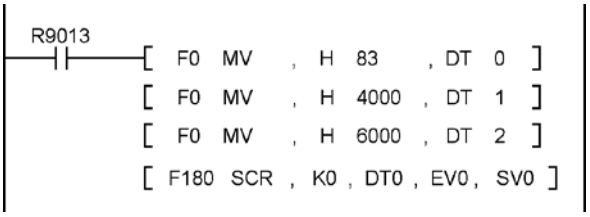
MSB



4.2.2 F180 (SCR) instruction: FPWIN GR Wizard

Using the FPWIN GR wizard facilitates the programming.

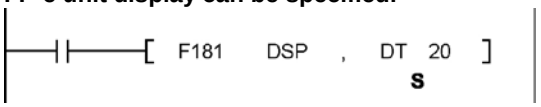




* FPWIN GR Ver. 2.2 or higher can be used with the FP-e unit.
  Customers who use the FPWIN GR Ver.2 software can upgrade it through our HP (http://industrial.panasonic.com/ac/e/dl_center/software/) free of charge.

4.2.3 F181 (DSP) : Screen change instruction Number of steps: 3

FP-e unit display can be specified.



- Available memory areas A: Can be specified N/A: Cannot be specified (Unit: Word)

		WX	WY	WR	SV	EV	DT	IX	IY	K	H	Index modifier
S	Display mode and No. (0 to 7 can be specified.)	A	A	A	A	A	A	A	A	A	A	A

- Operation

The FP-e display mode is changed to the one specified using “S.”

- Specifying the “S1” registration display

Display type of the FP-e unit can be specified.

Values for “S”	**Display type**
K0	N mode 1st screen
K1	N mode 2nd screen
K2	S mode 1st screen
K3	S mode 2nd screen
K4	R mode 1st screen
K5	R mode 2nd screen
K6	I mode 1st screen
K7	I mode 2nd screen

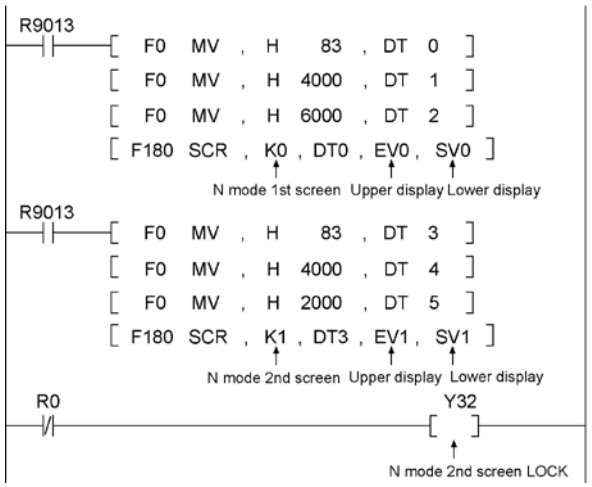
- Flag conditions

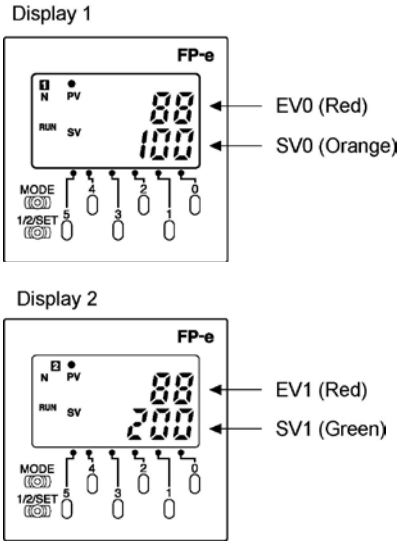
R9007 R9008 (ER)	Turns ON when the area specified using the index modifier exceeds the limit.
	Turns ON when the value “S” is not “0” to “7.”

Notes: 1. If the value other than “0” to “7” is specified for “S,” an operation error will occur.
2. The F181 (DSP) instruction cannot be used during the interrupt program.

4.3 N mode sample program

- Sample program





- Screen display

On N mode 1st screen, EV0 (red) and SV0 (orange) are displayed in the upper and lower sections respectively.
On N mode 2nd screen, EV1 (red) and SV1 (green) are displayed in the upper and lower sections respectively.

- Front switches

Pressing the operation switch “0” to “4” on N mode 1st screen changes the mode to the change mode for SV0.
Note: Data blinks in the change mode.

When the display selection switch “1/2/SET” is pressed for about one second, the data for the SV0 is changed and the blinking of the data stops.

Note: Data which is out of the specified range (16-bit) cannot be written.

When the display selection switch “1/2/SET” is pressed, the current screen changes to 2nd screen.
The operation switches (“0” to “5”) are locked by the program on 2nd screen. (Y32 is ON.)
Even when the operation switch is pressed, therefore, SV1 cannot be changed.

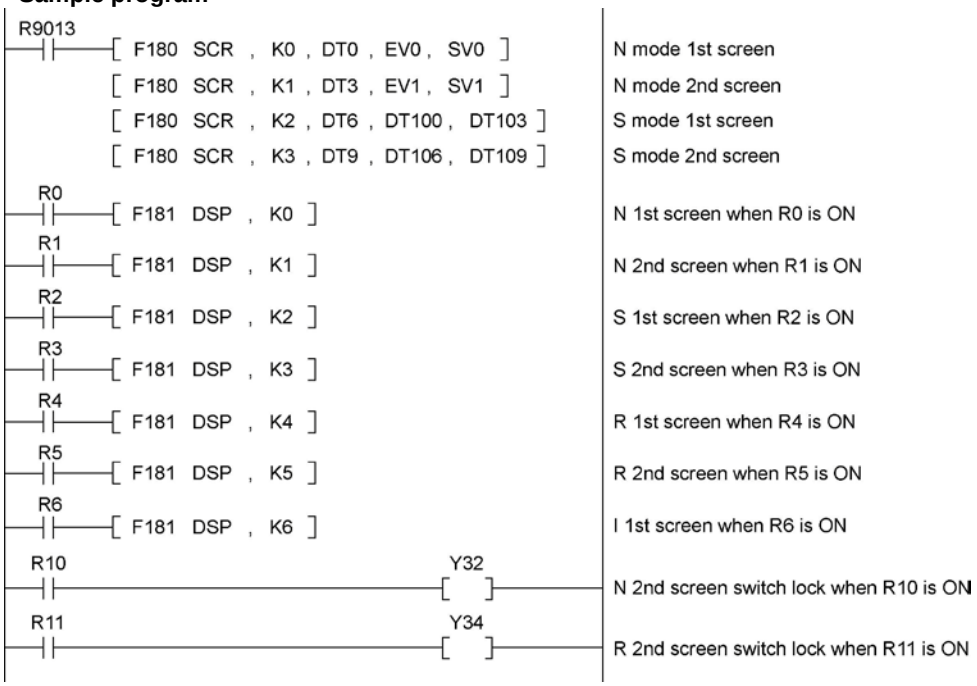
Reference: For further information, see “Locking the Switch” in A.2 I/O Allocation.”

Pressing the “MODE” switch for about 2 seconds locks both display selection switch and operation switch. In this “LOCK” status, the display and data cannot be changed. In addition, the “LOCK” status is not cancelled even when the power turns ON/OFF.

Pressing the “MODE” switch for about 2 seconds again unlocks the “LOCK” status. At this time, the “LOCK” display turns off.

4.4 Display screen and lock with the program

- Sample program



- Program operation

Turning ON the “R0” to “R6” switches the screen to be displayed.

Note: Even if the “MODE” switch or the “1/2/SET” switch is pressed under the condition that the “R0” is always set to ON using the sample program, the N1 screen cannot be switched to other screen. Using this function prevents operation mistake of the front switch.

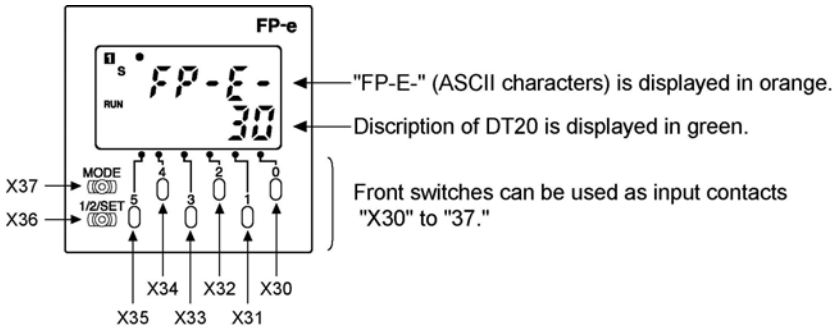
Setting the “Y30” to “Y34” to ON locks the front switch. Using this function prevents operation mistake of the front switch.

Reference: For further information, see “Locking the Switch” in A.2 I/O Allocation.

Chapter 5

Data Display and Settings in S (Switch) Mode

5.1 Display and operation in S (Switch) mode



The ASCII characters “FP-E-“ and the description of the “DT20” are displayed in the upper and lower sections of the controller screen respectively, using the F180 (SCR) instruction.

The front switches can be used as the input contacts “X30” to “X37.” The switch can also be used to change the display description, and so on depending on the program.

Note: 1. The front switches are allocated as the input contacts “X30” to “X37” and “X38” to “X3F.”
“X30” to “X37”: The switch can be locked using the program.
“X38” to “X3F”: The switch cannot be locked using the program.

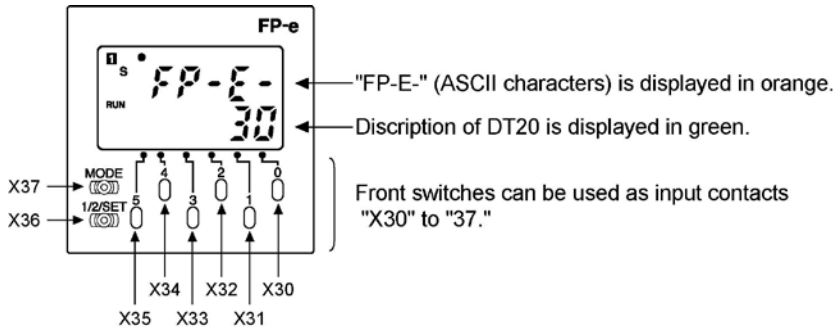
Reference: For further information, see “Locking the Switch” in A.2 “I/O Allocation.”

2. Pressing the “MODE” switch for about 2 seconds displays the “LOCK.”
In this condition, the input contacts “X30” to “X37” cannot be used, but “X38” to “X3F” can be used.

3. The input contacts “X30” to “X3F” do not turn ON during the first scanning after the mode is switched to RUN mode.

4. Pressing the MODE switch turns on “X37” and changes the screen mode.

5.2 S mode sample program



- Sample program

```
R9013
 ─┤├──[ F0  MV   , H  80   , DT  0  ]
        [ F0  MV   , H  6060 , DT  1  ]
        [ F0  MV   , H  2000 , DT  2  ]
        [ F0  MV   , H  5046 , DT  10 ]
        [ F0  MV   , H  452D , DT  11 ]
        [ F0  MV   , H  2D   , DT  12 ]
        [ F180 SCR , K2 , DT0 , DT10 , DT20 ]
                     ↑ S 1st screen  ↑ Upper display  ↑ Lower display
        [ F181 DSP , K2 ] ← S mode 1st screen

X30
 ─┤├──( DF )──[ F0  MV , K  30 , DT  20 ]
X31
 ─┤├──( DF )──[ F0  MV , K  31 , DT  20 ]
X32
 ─┤├──( DF )──[ F0  MV , K  32 , DT  20 ]
X33
 ─┤├──( DF )──[ F0  MV , K  33 , DT  20 ]
X34
 ─┤├──( DF )──[ F0  MV , K  34 , DT  20 ]
X35
 ─┤├──( DF )──[ F0  MV , K  35 , DT  20 ]
```

"FP-E-" (ASCII character)

K30 is transferred to DT20 when X30 (switch "0") is ON.

K31 is transferred to DT20 when X31 (switch "1") is ON.

K32 is transferred to DT20 when X32 (switch "2") is ON.

K33 is transferred to DT20 when X33 (switch "3") is ON.

K34 is transferred to DT20 when X34 (switch "4") is ON.

K35 is transferred to DT20 when X35 (switch "5") is ON.

- Screen display

On S mode 1st screen, the ASCII character “FP-E-“ is displayed in the upper section in orange.

Reference: See “ASCII character and 7-segment display” in Appendix A of this manual.

On 2nd screen, the data of “DT20” is displayed in green.

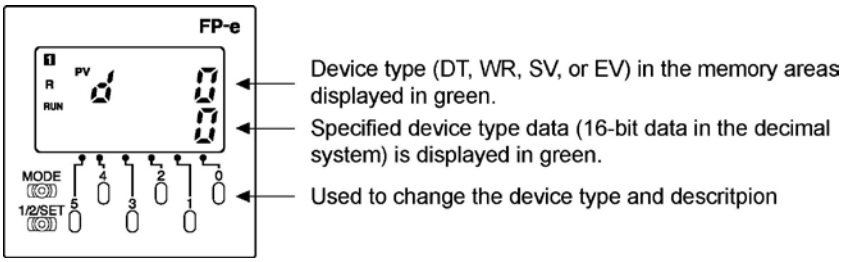
- Front switches

- When the front switch “0” is pressed, “X30” turns ON and “30” is displayed in the lower section of the screen.
- When the front switch “1” is pressed, “X31” turns ON and “31” is displayed in the lower section of the screen.
- Pressing the “MODE” switch for about 2 seconds locks all the front operation switches and “LOCK” is displayed. In this “LOCK” status, the display cannot be changed even if the front operation switch “0” to “5” is pressed.

Chapter 6

Data Display and Settings in R (Register) Mode

6.1 Display and operation in R (Register) mode



1. When the device type (DT, WR, SV, or EV) in the memory area is specified using the front operation switch, the specified device type data is displayed.

- When “PV” blinks, the device type in the memory area can be specified.
- The device No. can be specified using the switches “0” to “3.” The device type can be switched using the switch “4” in the following order: DT→WR→SV→EV

Note: When specifying the No. which is out of the designated range, the display color in the upper section switches from green to red and the display in the lower section turns off.

2. The specified device data can be changed using the front switch.

- When the switch “5” is pressed for about 1 second, “SV” blinks. In this status, the data can be changed.
- When the switch “0” to “5” is pressed, the data in the lower section is changed and then blinks.
- When the “1/2/SET” switch is pressed for about 1 second, the blinking stops and the data change completes.
- For canceling the data change process before the data is not yet completely changed, press the operation switch “5” for about one second. Then, blinking the display data stops.
- For changing to the device specification mode after the data change has completed, press the operation switch “5” for about one second. When the mode changes to the device specification mode, “PV” blinks.
- The mode cannot be changed to the device specification mode before the data is not yet completely changed. Wait for the completion of the data change process or cancel the data change process to hange the mode to the device specification mode.

Note: If you try to change the data to the one which is out of the specified range, the data is displayed in red only when the “1/2/SET” switch is pressed, and blinking does not stop.
When the power ON/OFF or RUN/PR OG. mode switching is performed, the data which is not yet completely changed using the front switch will be cancelled.
The data change can also be cancelled by turning Y38 ON.
(This is available for Ver. 1.1 or higher.)

3. Pressing the “1/2/SET” switch changes the current screen to 1st screen or 2nd screen.

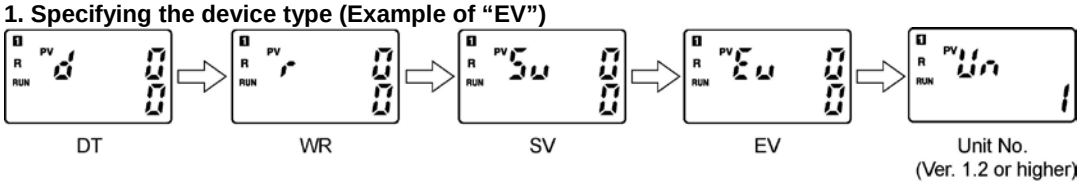
4. When “MODE” switch is pressed for about 2 seconds, “LOCK” is displayed. In this ”LOCK” status, the display cannot be changed even if any switches are pressed.

6.2 Operation in R (Register) mode

6.2.1 Specifying the device type

When “PV” blinks, the device type and No. can be changed.

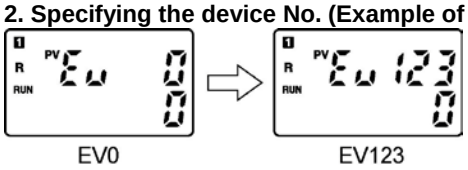
1. Specifying the device type (Example of “EV”)



Press the switch “4” until “EV” is displayed as shown above.

Note: At this moment, the “EV0” data is displayed in the lower section.

2. Specifying the device No. (Example of “EV123”)

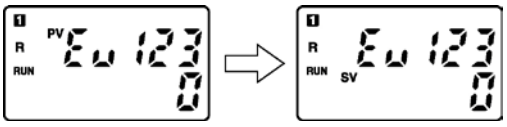


Specify the device No. “EV123” using the switches “0” to “3.”

Note: When specifying the No. which is out of the designated range, the display color in the upper section changes from green to red and the data display in the lower section turns off.

6.2.2 Changing the data

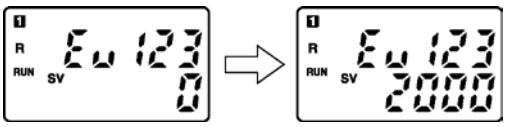
1. Switching to the data change mode



- When the switch “5” is pressed for about 1 second, the “PV” display turns off and then the “SV” blinks. While the “SV” is blinking, data can be changed.

Note: When the switch “5” is pressed for about 1 second again, the “SV” display turns off and the “PV” display blinks. While the “PV” is displayed, the device type can be specified.

2. Changing the data



- Pressing the switch “0” to “5” changes the data displayed. The changed data blinks.
- Pressing the switch “1/2/SET” for about 1 second stops blinking. At this point, data change completes.

……

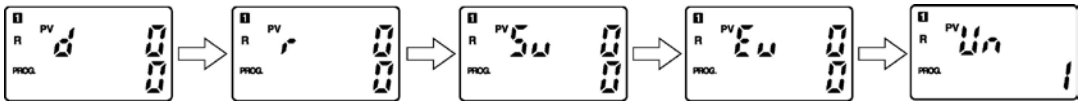
Notes:

1. Press the operation switch “5” for about one second when the data display is blinking to cancel the data under change.
   The data change can also be cancelled by turning Y38 ON.
   (This is available for Ver. 1.1 or higher.)
2. If you try to change the data to the one which is out of the specified range, the data is displayed in red only when the “1/2/SET” switch is pressed, and blinking does not stop.
3. When the power ON/OFF or RUN/PROG. mode switching is performed, the data under change will be cancelled.

6.2.3 Changing the unit No. of COM. port

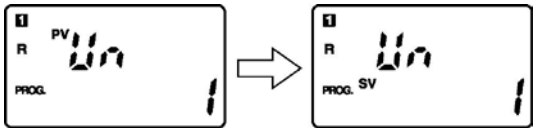
The unit No. specified in the system register can be changed by the front switch (for Ver. 1.2 or higher).

1. Displaying the unit No.



- Press the switch “4” to display the unit No.

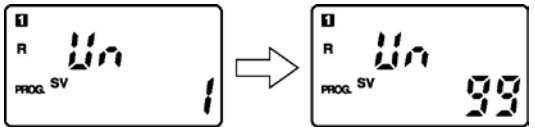
2. Switching to the unit No. change mode



- When the switch “5” is pressed for about 1 second, the “PV” display turns off and then the “SV” blinks. While the “SV” is blinking, data can be changed.

Note: When the switch “5” is pressed for about 1 second again, the “SV” display turns off and the “PV” display blinks. While the “PV” is displayed, the device type can be specified.

3. Changing the unit No.



- Pressing the switch “0” and “1” changes the unit No. displayed. The changed No. blinks.
- Pressing the switch “1/2/SET” for about 1 second stops blinking. At this point, data change completes.

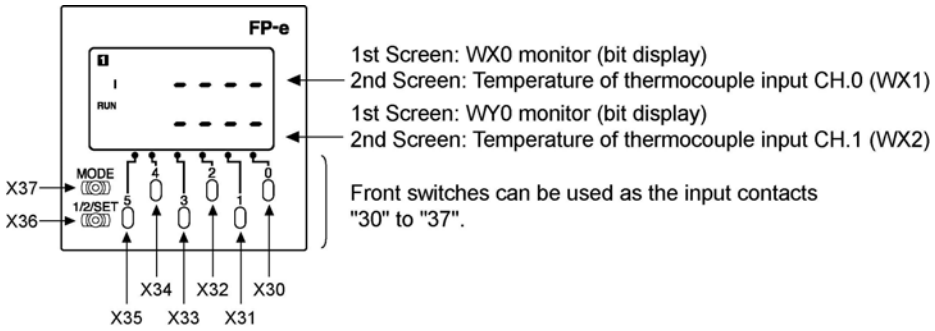
Notes:

1. Change the unit No. in PROG. mode.
   The unit No. cannot be changed in RUN mode.
2. Press the operation switch “5” for about one second when the unit No. display is blinking to cancel the unit No. under change.
3. If you try to change the data to the one which is out of the specified range (1 to 99), the changing process of the unit No. is cancelled by pressing the “1/2/SET” switch.
4. When the power ON/OFF or RUN/PROG. mode switching is performed, the data under change will be cancelled.

Chapter 7

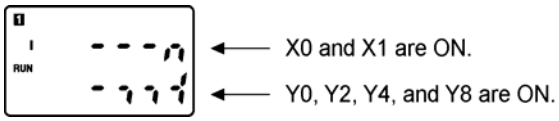
I (I/O Monitor) Mode

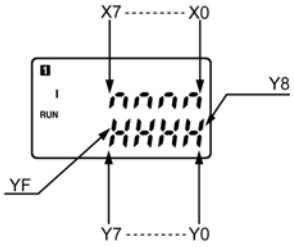
7.1 I/O monitor



1. I/O status of "WX0" and "WY0" can be monitored using 1st screen.

- Example:

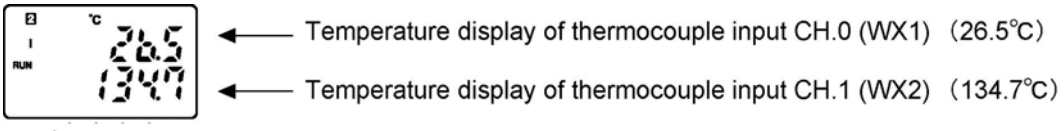




Note: 1. "Y6" or higher does not exist for the FP-e external output, but it can be used as the contact on the program.
2. In case of forced input/output, the monitoring of the forced input contact is not available.

2. Temperature display of the thermocouple input can be monitored using 2nd Screen.

- Example:



Note: Turning Y37 contact ON displays the Fahrenheit degree. (ºF)

3. The front switches can be used as the input contacts "X30" to "X37."

Note: 1. The front switches are allocated as the input contacts "X30" to "X37" and "X38" to "X3F."
"X30" to "X37": The switch can be locked using the program.
"X38" to "X3F": The switch cannot be locked using the program.

2. Pressing the "MODE" switch for about 2 seconds displays the "LOCK."
In this condition, the input contacts "X30" to "X37" cannot be used, but "X38" to "X3F" can be used.

3. Pressing the MODE switch turns on "X37" and changes the screen mode.

Chapter 8

PID Control

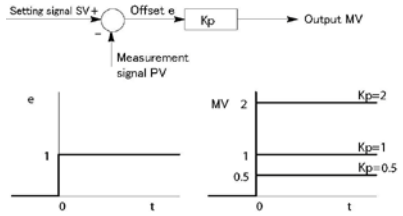
8.1 PID Control

8.1.1 Operation of PID control

PID is a control method widely used in the instrumentation field involving feedback control of process quantities such as temperature, pressure, flow, and fluid level.

- Proportional operation

Proportional operation generates an output which is proportional to the input.

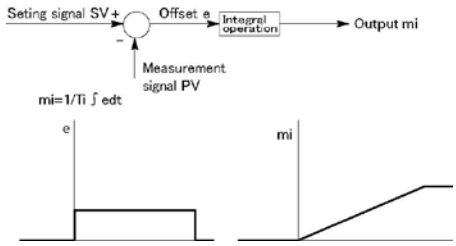


The amount of control is held constant.
An offset (steady-state deviation) remains.
Proportional control grows stronger as “Kp” is increased.

Kp: Proportional gain

- Integral operation

Integral operation generates an output which is proportional to the integral time of the input.

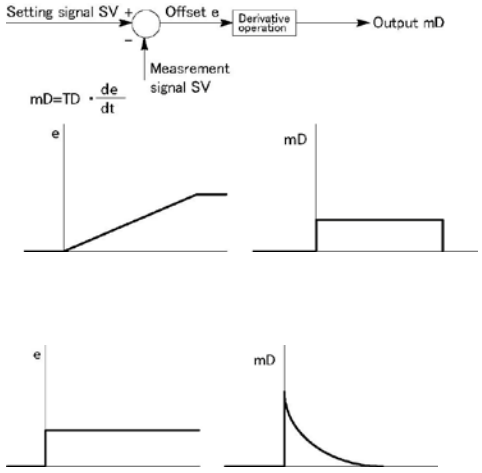


In combination with proportional operation or proportional-derivative operation, integral operation removes the offset produced by these methods.
Integral operation grows stronger as the integral time “Ti” is shortened.

Ti: Integral time

- Derivative operation

Derivative operation generates an output which is proportional to the derivative time of the input.

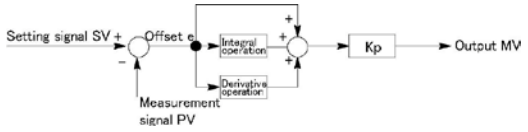


The advancing characteristic of derivative operation alleviates the adverse effect that the delaying characteristic of the process exerts on control.
Derivative control grows stronger as the derivative time “Td” is increased.
In the case of pure derivative operation, control can temporarily become ineffective if noise is input, and this can have an adverse effect on the process being controlled. For this reason, incomplete differential operation is executed.

Td: Derivative time

- PID operation

PID operation is a combination of proportional, integral, and derivative operations.



If the parameters are set to the optimum values, PID control can quickly bring the amount of control to the target value and maintain it there.

8.2 PID control instruction

8.2.1 F355 (PID)

- PID control

- Operands (Unit: Word)

		WX	WY	WR	WL	SV	EV	DT	I	Constant			Index modifier
										K	H	f	
S	Starting number of PID parameter area (31 words)	N/A	N/A	N/A	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A

(A: Available, N/A: Not Available)

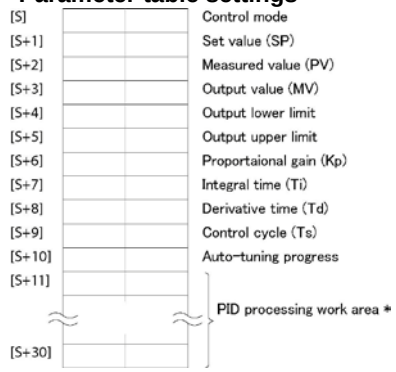
- Descriptions

· PID processing is performed to hold the measured value specified by [S+2] at the set value [S+1], and the result is output to [S+3].
· Derivative control or proportional-derivative control can be selected for the PID processing type.
· Set the PID processing coefficients (proportional gain, integral time and derivative time) and the processing mode and cycle in the parameter table. PID processing will be performed based on these settings.

- Types of PID processing

1. Reverse and forward operations
   When a process has been changed, whether the output will be increased or decreased can be selected.
   · When the measured value decreases, “Reverse operation” is specified to boost the output (heating, etc.).
   · When the measured value increases, “Forward operation” is specified to boost the output (cooling, etc.).
2. Derivative type (PI-D) and Proportional-derivative type (I-PD)
   Derivative type (PI-D): When a set value is changed, fluctuation in the output is large, however convergence is fast.
   Proportional-derivative type (I-PD): When a set value is changed, fluctuation in the output is small, however convergence is slow.

- Parameter table settings



* For FP-e, [S+11] to [S+30] (20 words) are used as the PID processing work area.

- Flag conditions

R9007	Turns ON when the value set for the parameter is out of range.
R9008 (ER)	The area specified using the index modifier exceeds the limit.

- Descriptions of parameters

1. Control mode: [S]

Select the type of PID processing and auto-tuning ON/OFF using the H constants.

Control mode		Value of [S]	
		Auto-tuning: Not executed	Auto-tuning: Executed
Derivative type (PI-D)	Reverse operation	H0	H8000
	Forward operation	H1	H8001
Proportional-derivative type (I-PD)	Reverse operation	H2	H8002
	Forward operation	H3	H8003

Auto-tuning

The optimum values for the Kp, Ti, and Td of the PID parameters can be measured by checking the process response. When auto-tuning is executed, the estimated results are reflected in the parameter area after auto-tuning has been completed. (There may be cases in which auto-tuning cannot be executed, depending on the process. If this happens, a value returns to the original parameter operation value.)

Reverse and forward operations

When a process has been changed, whether the output will be increased or decreased can be determined.

Reverse operation: When the measured process value decreases, the output will be boosted. (Example: heating, etc.)
Forward operation: When the measured process value increases, the output will be boosted. (Example: cooling, etc.)

Derivative type (PI-D) and Proportional-derivative type (I-PD)

When the set value is changed, the output changes.

Derivative type (PI-D): When a set value is changed, fluctuation in the output is large, however, convergence is fast.
Proportional-derivative type (I-PD): When a set value is changed, fluctuation in the output is small, however, convergence is slow.

2. Set value (SP): [S + 1]

Set the target value (temperature set value) within the following range which determines the amount of process control.
K0 to K10000

3. Measured value (PV): [S + 2]

Set the current process control value (temperature data WX1 and WX2) within the following range.
K0 to K10000

4. Output value (MV): [S + 3]

The result of PID processing is stored. Use the PWM output function to output it to the process.
K0 to K10000

5. Output lower limit value: [S + 4]

K0 to K9999 (< upper limit value)

6. Output upper limit value: [S + 5]

K1 to K10000 (> lower limit value)
Specify the range of the output value (MV). The values specified for the range are output.
The limits should be as follows;
0 ≤ Output lower limit value < Output upper limit value ≤ 10000

7. Proportional gain (Kp): [S + 6]
Specify the coefficient used for PID processing.
The set value × 0.1 will be the actual proportional gain.
The setting range is K1 to K9999 (0.1 to 999.9, Specify the range in increments of 0.1.)
When the auto-tuning is selected for the specified control mode, the set value is automatically adjusted and rewritten.

8. Integral time (Ti): [S + 7]
Specify the coefficient used for PID processing.
The set value × 0.1 will be the actual integral time.
The setting range is K1 to K30000 (0.1 to 3000 sec., Specify the range in increments of 0.1 sec.)
When the set value is "0," the integration is not executed.
When the auto-tuning is selected for the specified control mode, the set value is automatically adjusted and rewritten.

9. Derivative time (Td): [S + 8]
Specify the coefficient used for PID processing.
The set value × 0.1 will be the actual derivative time.
The setting range is K0 to K10000 (0 to 1000 sec., Specify the range in increments of 0.1 sec.)
When the auto-tuning is selected for the specified control mode, the set value is automatically adjusted and rewritten.

10. Control cycle (Ts): [S + 9]
Specify the cycle for executing PID processing.
The set value × 0.01 will be the actual control cycle.
The setting range is K1 to K6000 (0.01 to 60.00 sec., Specify the range in increments of 0.01 sec.)

11. Auto-tuning progress: [S + 10]
When the auto-tuning is specified in the control mode, the progress of the auto-tuning is indicated.
The values for K1 to K5 are stored based on the progress from the default value of "0."
When the auto-tuning has been completed, the value returns to the default value.

12. PID processing work area: [S + 11] to [S + 30]
This work area that is necessary for PID processing is used in the system.

Note:

- Precautions when executing auto-tuning

When “Execute auto-tuning” is specified using the parameter table (control mode [S]), attention should be paid to the following points.

· Before the auto-tuning is executed for the first time, confirm the range of the set values for [S] to [S + 30].
· After the auto-tuning has been completed, the control mode [S] area is automatically rewritten from H8000-H8003 to H0-H3. Make sure the mode is not rewritten again in the program.
· After the auto-tuning has been completed, the optimum values are stored for the proportional gain (Kp), the integral time (Ti) and derivative time (Td). Before executing the auto-tuning, however, the appropriate values (e.g. the lower limit value) within the specified setting range must be set.
· After the auto-tuning has been completed, the optimum values are stored for the proportional gain (Kp), the integral time (Ti) and derivative time (Td). Be careful that the stored values are not inadvertently rewritten.
· In the auto-tuning, the optimum values for Kp, Ti and Td are calculated for the set value (SP) by checking the fluctuations of the measured values (PV) when the output value (MV) is the upper limit and lower limit.

During this process, the set value (SP) can exceed the measured value (PV).

· The output value (MV) in the auto-tuning fluctuates at least three times:
  Upper limit output – Lower limit output – Upper limit output
  If the value for the auto-tuning progress remains “0” after the fluctuation is performed more than twice, shorten the control synchronization period (Ts) and then execute the auto-tuning once more.

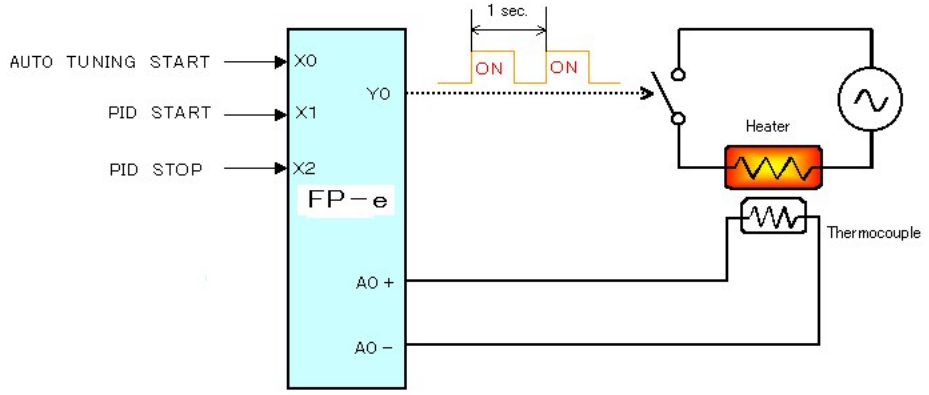
- Precautions during programming

· A 31-word area is required for the parameter table, including the work area for processing. Take care that other instructions do not overwrite the values in this area.
· An error will not be detected even if the parameter table exceeds its area. When specifying [S], select a number at least 31 words before the last number.
· Take care that the area is not exceeded due to index modification. An error will not be detected even if the area is exceeded.
· For the current measured value [S+2], input the temperature data (WX1 and WX2).
· Output the result of PID processing [S+3] to the process using the PWM output function.
· For FP-e, this instruction F355 (PID) cannot be programmed in the interrupt program.

8.3 PID control sample program

- PID control

When a K-type thermocouple is connected with the thermocouple input of FP-e, PID temperature control can be easily conducted. (In addition, parameter setting can be automatically selected using “AUTO TUNING.”)



- Thermocouple input specifications

Item	Description
Number of input point	2 points (CH0: WX1, CH1: WX2)
Temperature sensor type	K-type thermocouple
Input temperature range	- 30.0 to 300.0 ºC (- 22 to 572 °F)
Accuracy	±0.5 %FS±1.5 ºC (FS = - 30 to 300 ºC)
Resolution	0.1 ºC
Conversion time	250 ms/2CH
Insulation method	Between internal circuit and thermocouple input circuit: noninsulated Between CH0 and CH1 of thermocouple input: PhotoMos insulation
Detection function of wire disconnection	Available

Reference: Description of the specifications <2.3.1 Input specifications>

- Thermocouple

A thermocouple is the sensor that measures the temperature using the thermo-electromotive force generated by the temperature difference between two metal wires connected, whose materials are different.

- (1) Screen display setting sample program

Sample program

```
0   PV = DT202, SV = DT201
R9013
 |  |-[F0 MV    ,  H 23    ,  DT 0    ]
    [F0 MV    ,  H 6001  ,  DT 1    ]
    [F0 MV    ,  H 2001  ,  DT 2    ]
    [F180 SCR ,  K 0     ,  DT 0    ,  DT 202  ,  DT 201  ]
```

Screen display setting: K0 (N mode 1st screen)
Display control data: D0 to D2

Upper section display data: DT202
Lower section display data: DT201

Screen display

Screen display setting	: K0: N mode 1st screen
Display control data	: DT0: H23: ºC, PV, SV display
	DT1: H6001: Signed Dec 5 digits, 2nd decimal place display, Orange
	DT2: H2001: Signed Dec 5 digits, 2nd decimal place display, Green
Upper display data	: DT202: Measured temperature
Lower display data	: DT201: Set temperature

- (2) PID parameter setting sample program

Sample program

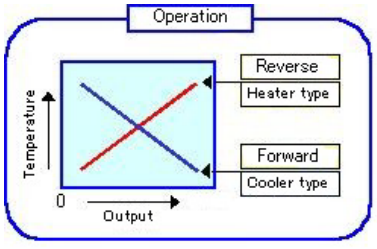
```
25  ********** PID data table settings **********
R9013
 |  |-[F0 MV    ,  H 0     ,  DT 200  ] Control code
    [F0 MV    ,  K 550   ,  DT 201  ] Set temperature (SP)
R9010
36  |-[F0 MV    ,  WX 1    ,  DT 202  ] Current temperature (PV)
R9013
42  |-[F0 MV    ,  K 0     ,  DT 203  ] PID output value (MV)
    [F0 MV    ,  K 0     ,  DT 204  ] PID output lower limit
    [F0 MV    ,  K 10000 ,  DT 205  ] PID output upper limit
    [F0 MV    ,  DT 1652 ,  DT 206  ] Proportional gain (Kp)
    [F0 MV    ,  DT 1653 ,  DT 207  ] Integral time (Ti)
    [F0 MV    ,  DT 1654 ,  DT 208  ] Derivative time (Td)
    [F0 MV    ,  K 100   ,  DT 209  ] PID cycle (Ts)
    [F0 MV    ,  K 0     ,  DT 210  ] Auto-tuning progress
```

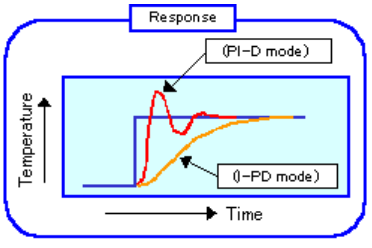
DT200: Control code (H0: Reverse operation PI-D mode)
DT201: Set temperature = 55 ℃ (550∗0.1 ℃)
(Use the same unit as the one for the current temperature.)
DT202: Current temperature (Reading from WX1, unit: 0.1 ℃)
DT203: PID processing output value (automatically calculated)
DT204: PID output lower limit value (Normally, 0 %)
DT205: PID output upper limit value (Normally, 100.00 %)
DT206: Proportional gain
DT207: Integral time
DT208: Derivative time
} These are automatically selected in the auto-tuning process. Write them in the program.
DT209: Processing interval (Approx. 1 sec. in temperature control. Use the same interval as the one for heater PWM cycle.)
DT210: Auto-tuning progress

Note: DT211 to DT230 are used for the PID processing work area. Therefore, do not use them for other uses.

- Control code

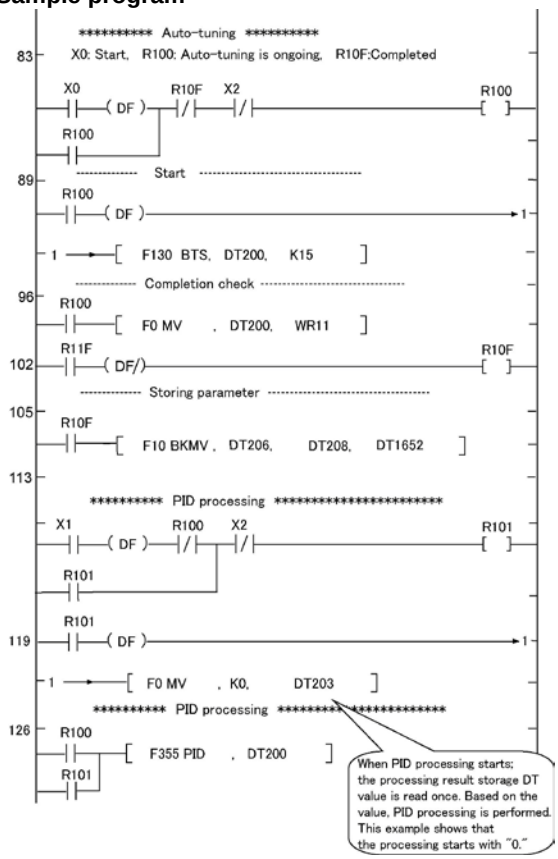
Control code	H0	H1	H2	H3
Control operation	Reverse	Forward	Reverse	Forward
Response characteristics	PI-D		I-PD	





- (3) PID processing sample program

Sample program



Program

X0 : Auto-tuning start
(Auto-tuning is executed only once.)

R100 : Auto-tuning is being executed.

R130 : 16-bit data bit set
When the most significant digit bit (K15) of the DT200 is “1”, auto-tuning starts.
When the most significant bit (R11F) of the DT200 is “0”, auto-tuning completes.

R10F : Auto-tuning completes.

F10 : Block transfer instruction
Parameters (Kp, Ti, Td), which are automatically adjusted in auto-tuning, are stored.

X1 : PID control starts.

R101 : PID control is being executed.

X2 : PID control stops.

F355 : PID processing instruction
Always turn to “ON” while PID control.

Notes:

1. Before starting the auto-tuning for the first time, set the parameters (Kp, Ti, Td) specified for the PID control.
   (Using the FPWIN GR data monitor facilitates the setting.)

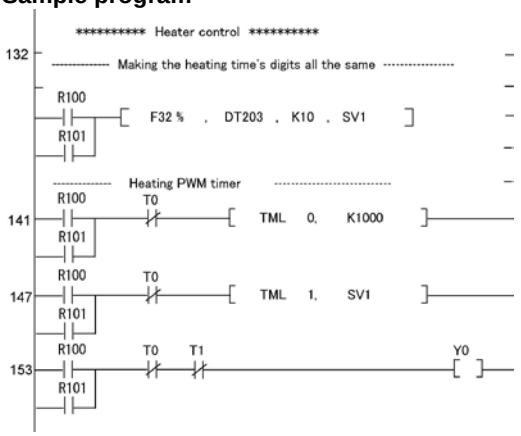
   Setting example
   · DT1652: K1 Proportional gain (Kp)
   · DT1653: K1 Integral time (Ti)
   · DT1654: K0 Derivative time (Td)

2. To store the PID control parameters obtained in the auto-tuning, write them in the storage type data area (e.g., DT 1652 to DT1653) when the auto-tuning is completed.

3. An operation error will occur if the PID processing instruction is executed with a parameter that is out of the setting range.

- (4) Heater PWM control sample program

Sample program



Program

DT203 : PID processing output

SV1 : Heating time setting
Heater control depending on PID processing result. To turn the heater ON (100 %) when the PID processing output DT203 is 100 % (K10000), divide the PID processing output DT203 (K10000) by 10 and write 100 % (1000 ms) into SV1 of heating timer.

TML0 : PWM output cycle setting

TML1 : Heating time setting

Y0 : Heater control

Setting the input timing

Set the input timings as shown below so that the temperature conversion cycle (250 ms for FP-e), PID control cycle (DT209) and PWM output cycle (TM0) are all equal, or PID control cycle takes longer than other two cycles.

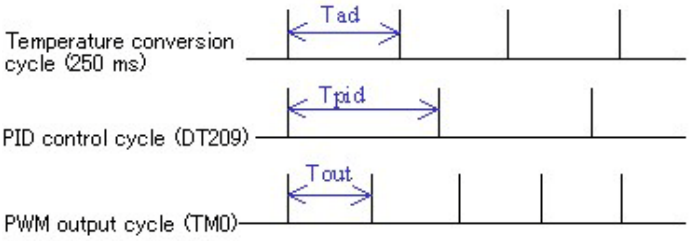
Correct:

· Tad = Tpid = Tout

· Tad < Tpid > Tout

Incorrect:

· Tad > Tpid < Tout

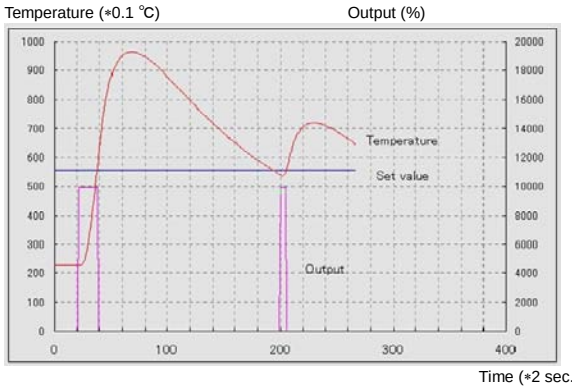


8.4 Example of temperature control

- Example of auto-tuning

Control cycle: Ts = K100 (1 s)

Selected parameter: Proportional gain (Kp) = K171 (17.1), Integral time (Ti) = K600 (60 s),
Derivative time (Td) = K150 (15 s)

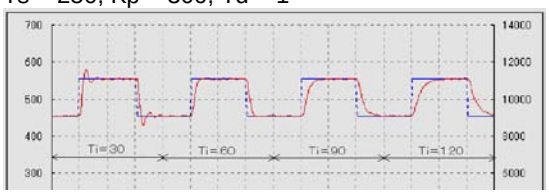


· The temperature input conversion for FP-e is performed every 250 ms. The average cycle (1 to 50 times) can be set using the system register 409. The initial setting is “0.” (Average: 20 times)
When the heat capacity of the control system is small and heating/cooling is performed at high speed, set a value for the average time to a smaller one.

· Executing the auto-tuning sets the parameters suitable for any control system automatically.
Optimum control can be conducted by changing the values (1/2 to 2 times).
Generally, Kp (proportional gain) affects on the response characteristics. As the value of Kp becomes larger, the response error becomes smaller. When the value is too large, however, it may cause the hunting. Ti (Integral time) greatly affects on the response characteristics. As the value of Ti becomes smaller, the response becomes faster. When the value is too small, however, it may cause the overshoot.

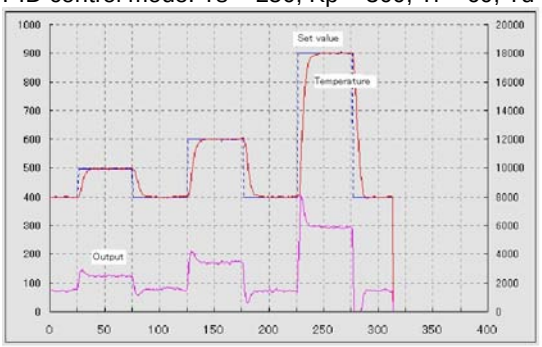
- Example of PID parameter characteristics

When Ti is changed to 30, 60, 90, and 120 under the conditions as follows:
Ts = 250, Kp = 300, Td = 1



- Example of PID processing

PID control mode: Ts = 250, Kp = 300, Ti = 60, Td =



Chapter 9

Specifications

9.1 Specifications

9.1.1 General specifications

Item	Description	
Rated voltage	24V DC	
Operating voltage range	21.6 to 26.4V DC	
Allowed momentary power off time	10 ms	
Ambient temperature	0 to +55ºC	
Storage temperature	-20 to +70ºC	
Ambient humidity	30 to 85%RH (at 25 ºC, non-condensing)	
Storage humidity	30 to 85%RH (at 25 ºC, non-condensing)	
Breakdown voltage	Between insulated circuits: 500V AC, 1 min However, between 3) Output terminal (Y5, COM) and other insulated circuits: 1500V AC, 1 min (Cut-off current: 10mA, excluding the barrister for protection)	Insulated circuit 1) Power supply terminal, function earth, Input terminal (A0,A1), COM.(RS232C)Terminal 2) Input terminal (COM, X0 to Xn) 3) Output terminal (+, –, Y0 to Y4) 4) Output terminal (Y5, COM) 5) COM. (RS485) terminal
Insulation resistance	Between insulated circuits: 100 MΩ or higher (measured with 500V DC)	
Vibration resistance	10 to 55 Hz, 1 cycle/min. Double amplitude: 0.75 mm, 10 min. on X, Y , and Z axes	
Shock resistance	98 m/s^2 , 4 times on X, Y, and Z axes	
Noise resistance	1000V (p-p) with pulse widths 50 ns 1 µs (based on in-house measurements)	
Operating condition	Free from corrosive gases and excessive dust	
Electric current	200 mA or less (24V DC), surge current: 20 A	
Protection	IP66-compliant front section (Only when a rubber packing is used.)	
Weight	Approx. 130 g (Weight of the mounting frame and unit package is not included.)	

9.1.2 Performance specifications

Item \ Model	AFPE224300 (Standard type) RS232C	AFPE224302 (Standard type) RS485	AFPE224305 (Calendar timer type) RS232C	AFPE214325 (Thermocouple input type) RS232C	AFPE224322 (Thermocouple input type) RS485
Programming method/ Control method	Relay symbol/Cyclic operation				
Number of controllable I/O points — **Control unit**	14 points [Input: 8, Output: 6 (Tr. NPN: 5/Ry 1)]			12 points [Input: 6, Output: 6]	
Number of controllable I/O points — **Front switch input**	8 points For mode switching 1 point For screen switching 1 point For data setting or external input 6 points				
Program memory — **Built-in memory**	Built-in EEP-ROM				
Program capacity	2,720 steps				
Number of instruction — **Basic**	83				
Number of instruction — **High-level**	168 Note1)				
Operation speed	0.9 μs/step (Basic instruction)				
I/O update and Base time	2 ms			Typical 2 to 3 ms Max. 15 ms Note2)	
Operation memory points — **Relays** — **Internal relay (R)**	1,008 points (R0 to R62F)				
Operation memory points — **Relays** — **Special internal relay (R)**	64 points (R9000 to R903F)				
Operation memory points — **Relays** — **Timer/Counter (T/C)**	144 points (Initial setting: 100 timer points, T0 toT99/44 counter points, C100 to C143 Note 3) Timer range (1 ms, 10ms, 100ms, 1 s): selected by instruction				
Operation memory points — **Memory areas** — **Data register (DT)**	1,660 words (DT0 to DT1659)				
Operation memory points — **Memory areas** — **Special data register (DT)**	112 words (DT9000 to DT9111)				
Operation memory points — **Memory areas** — **Index registers (IX. IY)**	2 points				
Differential points	Unlimited number of points				
Master control relay points (MCR)	32 points				
Number of labels (JP and LOOP)	64 labels				
Number of step ladders	128 stages				
Number of subroutines	16 subroutines				
Number of interrupt programs	7 programs (external: 6, internal 1)				
Self-diagnostic function	Watchdog timer, program syntax check, etc.				
Clock/calendar function Note 4)	Not available		Available (year, month, day, hour, minute, second and day of week) However, this can only be used when a battery has been installed.		Not available
Battery life	No battery		220 days or more (actual usage value: approx. 870 days (25 ºC) (Periodic replacement interval: 1 year) (Value applies when no power is supplied at all.)		No battery
Pulse catch input / **Interrupt input**	6 points in total (X0 and X1: 50 μs, X2 to X5: 100 μs)				
COM. port Note 5)	RS232C	RS485	RS232C	RS232C	RS485
Periodical interrupt	0.5 ms to 30 s				
Constant scan	Available				
Password	Available				

Note 1) High-level instructions are available for Ver1.2 or higher.
Note 2) The time takes longer every 250 ms.
Note 3) The proportion of timer points to counter points can be changed using a system register.
Note 4) Precision of calendar timer:
- At 0 ºC/32 ºF, less than 200 seconds error per month
- At 25 ºC/77 ºF, less than 70 seconds error per month
- At 55 ºC/131 ºF, less than 240 seconds error per month

Note 5) When using the COM. port to communication with other devices, retransmission is recommended as it may be affected by excessive noise depending on the environments installed. The driver IC for the RS232C port conforms to EIA/TIA-232E and CCITT V. 28 standards.

Item / Model			AFPE224300 (Standard type) RS232C	AFPE224302 (Standard type) RS485	AFPE224305 (Calendar timer type) RS232C	AFPE214325 (Thermocouple input type) RS232C	AFPE224322 (Thermocouple input type) RS485
Special functions	**High-speed counter function** *** The combinations 1-phase x 2 ch. and 2-phase x 1 ch. are also possible for the high-speed counter.** *** For details and limitations on the high-speed counter, see the following pages.**		Counter mode: Addition/subtraction (1-phase) Note 6) - Input points: 4 ch. (Max.) - Max. speed: 10 kHz (total of 4 ch.) :Max. 5 kHz - Input contact: X0: count input (ch. 0), X1: count input (ch. 1), X2: reset input Note 7); X3: count input (ch. 2), X4: count input (ch. 3), X5: reset input Note 7) - Min. input pulse width: X0, X1: 50µs(10 kHz) X0, X1: 100µs (5 kHz) X3 and X4: 100 µs (5kHz)				
			Counter mode: 2-phase/individual/direction decision (2-phase) - Input points: 2 ch (Max.) - Max. speed: 2 kHz (total of 2 ch.) :Max. 1 kHz - Input contact: X0: count input (ch. 0), X1: count input (ch. 0), X2: reset input; X3: count input (ch. 2), X4: count input (ch. 2), X5: reset input - Min. input pulse width: X0, X1: 50µs(10 kHz) X0, X1: 100µs (5 kHz) X3 and X4: 100 µs (5 kHz)				
	Pulse output function *** For details and limitations on the high-speed counter, see the following pages.**	**Output points**	2 independent points (Y0 and Y1) (No interpolation function)				
		Output frequency	40 Hz to 10 kHz (Y0/Y1: 1-point) Note 8) 40 Hz to 5 kHz (Y0/Y1:2-point)			40Hz to 5kHz (1-point) 40Hz to 2.5kHz (2-point)	
	PWM output function *** For details and limitations on the high-speed counter, see the following pages.**	**Output points**	2 points (Y0 and Y1)				
		Output frequency	Frequency: 0. 15 Hz to 1 kHz, Duty: 0.1 to 99.9 %				
Memory backup Note 9)	**Timer**		Non-hold (all points)				
	Counter	**Non-hold type**	From set value to C139				
		Hold type	C140 to C143, EV140 to EV143 (elapsed values)				
			SV: Non-hold Note 10)		SV: Hold		SV: Non-hold Note 10)
	Internal relay	**Non-hold type**	976 points (R0 to R60F)		61 words (WR0 to WR60)		
		Hold type	32 points (R610 to R62F)		2 words (WR61 to WR62)		
	Data register	**Non-hold type**	1652 words (DT0 to DT1651)				
		Hold type	8 words (DT1652 to DT1659)				

Note 6) The max counting speed (10 kHz) is the counting speed with a rated input voltage of 24 V DC and an ambient temperature of 25 ºC. The counting speed (frequency) will decrease depending on the voltage and temperature.

Note 7) If the unit is equipped with both reset inputs X0 and X1, X2 serves as the reset input for X1. If X3 and X4 are used, X5 serves as the reset input for X4.

Note 8) When the positioning control instruction “F168” is performed, the maximum output frequency is 9.5 kHz.

Note 9) The program, system registers and the hold type area (internal relay, data register, and timer/ counter) are backed up by the built-in EEP-ROM. Data can be written 10000 times or less with the EEP-ROM writing instruction. When a battery is replaced with a new one in the FP-e unit with a calendar timer function, settings can be changed using the system register. If a battery is not installed, the data cannot be stored even when the settings of the system register are changed.

Note 10) Use the following methods for holding the SV data:
1. Set the transfer instruction for the special data register (DT) to hold the data. Then, perform the setting so that the data can be transferred from DT to SV after the RUN mode starts.
2. Use the FP-e model with a battery.

9.1.3 Specifications (High-Speed Counter/Pulse Output/PWM Output)

Table of high-speed counter function specifications

Input/Output counter number being used			Built-in high-speed counter channel No.	Memory area used			Performance specifications			Related Instructions
On/Off output	Count mode	Input contact No (value in parenthesis is reset input) (Note 1)		Control flag	Elapsed value area	Target value area	Min. of input pulse width	Max. counting speed		
								Using only 1 channel	Using multiple channels	
Specify the desired output from Y0 to Y5	Incremental input Decremental input	X0 (X2)	CH0	R903A	DT9044 DT9045	DT9046 DT9047	50 µs Note 2)	Max. 10 kHz Note 3)	Total of 4 CH with Max. 10 kHz Note 3)	F0 (MV), F1 (DMV), F166 (HC1S, F167 (HC1R)
		X1 (X2)	CH1	R903B	DT9048 DT9049	DT9050 DT9051		Max. 10 kHz Note 3)		
		X3 (X5)	CH2	R903C	DT9104 DT9105	DT9106 DT9107	100 µs	Max. 5 kHz		
		X4 (X5)	CH3	R903D	DT9108 DT9109	DT9110 DT9111		Max. 5 kHz		
Specify the desired output from Y0 to Y5	2-phase input Incremental /decremental input Directional distinction	X0 X1 (X2)	CH0	R903A	DT9044 DT9045	DT9046 DT9047	250 µs Note 4)	Max. 2 kHz Note 5)	Total of 2 CH with Max. 2 kHz Note 5)	
		X3 X4 (X5)	CH2	R903C	DT9104 DT9105	DT9106 DT9107	500 µs	Max. 1 kHz		

Note 1) Reset input X2 can be set to either CH0 or CH1. Reset input X5 can be set to either CH2 or CH3.
Note 2) Thermocouple input type: 100 µs
Note 3) Thermocouple input type: Max. 5 kHz.
Note 4) Thermocouple input type: 500 µs
Note 5) Thermocouple input type: Max. 1 kHz

Table of pulse output function specifications

Input/Output contact number being used				Built-in high-speed counter channel No.	Memory area used			Performance specifications for maximum output frequency	Related Instructions
Pulse Output	Directional output	Home input	Near home input		Control flag	Elapsed value area	Target value area		
Y0	**Y2**	**X0**	**DT9052 <bit 2>**	CH.0	R903A	DT9044 DT9045	DT9046 DT9047	Max. 10 kHz for 1-point output Max. 5 kHz for 2-point output	**F0 (MV), F1 (DMV), F168 (SPD1), F169 (PLS)**
Y1	**Y3**	**X1**	**DT9052 <bit 6>**	CH1	R903B	DT9048 DT9049	DT9050 DT9051		

Notes: - The maximum 1-point output for instruction F168 (SPD1) is 9.5 kHz.
- For the thermocouple input type, the maximum output frequency is 5 kHz (1-point output) and 2.5 kHz (2-point output).

Table of PWM output specifications

Output number being used	Built-in high-speed counter channel No.	Memory area used	Performance specifications for output frequency	Related instructions
		Control flag		
Y0	CH0	R903A	Frequency: 0.15 Hz to 1kHz Duty: 0.1% to 99.9%	**F0 (MV), F1 (DMV), F170 (PWM)**
Y1	CH1	R903B		

9.1.4 Functions and Restrictions (High-Speed Counter/Pulse Output/PWM Output)

Channel
The same channel cannot be used by more than one function.

Example of prohibited application:
You cannot share CH.0 with the high-speed counter and pulse output functions.

I/O number (input/output contact point)
The number allocated to each function cannot be used for normal inputs or outputs.

Example of prohibited application
When using CH.0 for 2-phase inputting with the high-speed counter function, you cannot allot X0 and X1 to normal inputs.

When using Y0 for the pulse output function, you cannot allot origin input X0 to a normal input.

When using Y0 for the pulse output (with directional output operating) function, you cannot allot Y2 (directional output) to a normal input or output.

When using the high-speed counter with a mode that does not use the reset input, you can allot the inputs listed in parenthesis in the specifications table to a normal input.

Example of allowable application
When using the high-speed counter with no reset input and 2-phase input, you can allot X2 to a normal input.

Restrictions on the execution of related instructions (F166 to F170)
When any of the instructions related to the high-speed counter (F166 to F170) are executed, the control flag (special internal relay: R903A to R903D) corresponding to the used channel turns on.

When the flag for a channel turns on, another instruction cannot be executed using the same channel.

Example of prohibited application
While executing F166 (target value match on instruction) and flag R903A is in the on state, F167 (target value match off instruction) cannot be executed with CH.0.

Restrictions for maximum counting speed/pulse output frequency

The counting speed when using the high-speed counter function will differ depending on the counting mode as shown in the table.

Example 1:

While in the incremental input mode and using the two channels CH.0 and CH.1, if CH.0 is being used at 8 kHz, then CH.1 can be used up to 2 kHz.

Example 2:

While in the 2-phase input mode and using the two channels CH.0 and CH.2, if CH.0 is being used at 1 kHz, then CH.2 can be used up to 1 kHz.

The maximum output frequency when using the pulse output function will differ depending on the output contact number as shown in the table.

Example 1:

When using either only Y0 or only Y1, the maximum output frequency is 10 kHz.

Example 2:

When using the two contacts Y0 and Y1, the maximum output frequency is 5 kHz.

When using the high-speed counter function and pulse output function, specifications will differ depending on the conditions of use.

Example:

When using one pulse output contact with a maximum output frequency of 5 kHz, the maximum counting speed of the high-speed counter being used simultaneously is 5 kHz with the incremental mode and 1 kHz with the 2-phase mode.

9.2 I/O Allocation

- I/O Allocation of FP-e control unit

Contact	Description	Note
X0 X1 X2 X3 X4 X5 X6 X7	External input External input External input External input External input External input External input External input	X0 to X5: Used for thermocouple input type. X6, X7: Not used. (Thermocouple input type)
X8 ⋮ XF	Not used.	
X10 ⋮ X1F	CH.0 Temperature data (WX1)	Used only for thermocouple input type.
X20 ⋮ X2F	CH.1 Temperature data (WX2)	Used only for thermocouple input type.
X30 X31 X32 X33 X34 X35 X36 X37	Front switch input "0" switch Front switch input "1" switch Front switch input "2" switch Front switch input "3" switch Front switch input "4" switch Front switch input "5" switch Front switch input "1/2/SET" switch Front switch input "MODE" switch	Available when the mode is set to S or I mode (Not available when the mode is set to "LOCK.") Note: X30 to X3F do not turn ON in the 1st scanning after the mode is set to RUN.
X38 X39 X3A X3B X3C X3D X3E X3F	Front switch input "0" switch Front switch input "1" switch Front switch input "2" switch Front switch input "3" switch Front switch input "4" switch Front switch input "5" switch Front switch input "1/2/SET" switch Front switch input "MODE" switch	Available in all modes (Available even when the mode is set to "LOCK.") Note: X30 to X3F do not turn ON in the 1st scan after the mode is set to RUN.
X40 X41 X42 X43 X44 X45 X46 X47 X48 X49 X4A X4B X4C X4D X4E X4F	Data setting error (Out of the specified 16-bit) Determination of N mode 1st screen data Determination of N mode 2nd screen data Determination of R mode 1st screen data Determination of R mode 2nd screen data Not used. Not used. Not used. Not used. N mode 1st screen data is being changed. N mode 2nd screen data is being changed. R mode 1st screen data is being changed. R mode 2nd screen data is being changed. Not used. CH. 0 Temperature conversion completion flag CH. 1 Temperature conversion completion flag	When the data change starts: 0 When the data is determined: 1 When the data is being changed: 1 Date is determined or cancelled: 0 Note 1)

Note 1) To cancel the data change, press the operation switch "5" for 1 second, or switch the mode using the RUN/PROG. switch.
The data change can also be cancelled by turning Y38 ON. (Ver.1.1 or higher)

Contact	Description	Note
Y0	External output	
Y1	External output	
Y2	External output	
Y3	External output	
Y4	External output	
Y5	External output	
Y6	Not used.	
Y7	Not used.	
Y8	Not used.	
Y9	Not used.	
YA	Not used.	
YB	Not used.	
YC	Not used.	
YD	Not used.	
YE	Not used.	
YF	Not used.	
Y30	"Mode", "1/2/SET", "0" to "5" switches: Locked.	Switch is locked: 1 Switch is available: 0
Y31	Switch lock ("0" to "5") of N mode 1st screen	
Y32	Switch lock ("0" to "5") of N mode 2nd screen	
Y33	Switch lock ("0" to "5") of R mode 1st screen	
Y34	Switch lock ("0" to "5") of R mode 2nd screen	
Y35	Not used.	
Y36	Not used.	
Y37	Temperature data unit change (Ver.1.1 or higher)	ºF: 1, ºC: 0
Y38	Data change cancellation (Ver.1.1 or higher)	Cancellation: Yes:1, No: 0
Y39	Not used.	
Y3A	Not used.	
Y3B	Not used.	
Y3C	Not used.	
Y3D	Not used.	
Y3E	Not used.	
Y3F	Not used.	

9.3 Relays,memory Areas and Constants

Item		Number of points	Memory area available for use Matsushita	IEC	Function
Relay	External input relay (See Note 3.)	208	X0 - X12F	%IX0.0 - %IX12.15	Turns on or off based on external input.
	External output relay (See Note 3.)	208	Y0 - Y12F	%QX0.0 - %QX12.15	Outputs on or off state externally.
	Internal relay (See Note 2.)	1008	R0 - R62F	%MX0.0 - %MX0.62.15	Turns on or off only within a program.
	Timer (See Notes 1 and 2.)	100	T0 -T99/ C100 - C143	%MX1.0 - %MX1.99/ %MX2.100 - %MX2.143	Turns on when the timer reaches the specified time. Corresponds to the timer number.
	Counter (See Notes 1 and 2.)	44	C100 -C143/ T0 - T99	%MX2.100 - %MX2.143/ %MX1.0 - %MX1.99	Turns on when the counter increments. Corresponds to the counter number.
	Special internal relay	64	R9000 - R903F	%MX0.900.0 - %MX0.903.15	Turns on or off based on specific conditions. Used as a flag.
Memory area (words)	External input relay (See Note 3.)	13 words	WX0 - WX12	%IW0 - %IW12	Code for specifying 16 external input points as one word (16 bits) of data.
	External output relay (See Note 3.)	13 words	WY0 - WY12	%QW0 - %QW12	Code for specifying 16 external output points as one word (16 bits) of data.
	Internal relay (See Note 2.)	63 words	WR0 - WR62	%MW0.0 - %MW0.62	Code for specifying 16 internal relay points as one word (16 bits) of data.
	Data register (See Note 2.)	1660 words	DT0 - DT1659	%MW5.0 - %MW5.1659	Data memory used in a program. Data is handled in 16-bit units (one word).
	Timer/counter set value area	144 words	SV0 - SV143	%MW3.0 - %MW3.143	Data memory for storing a target value of a time and an initial value of a counter. Stores by time/counter number.
	Timer/counter elapsed value area (See Note 2.)	144 words	EV0 - EV143	%MW4.0 - %MW4.143	Data memory for storing the elapsed value during operation of a timer/counter. Stores by time/counter number.
	Special data register	112 words	DT9000 - DT9111	%MW5.9000 - %MW5.9111	Data memory for storing specific data. Various settings and error codes are stored.
	Index register	2 words	IX - IY	%MW6.0 - %MW6.1	Used as an address of memory area and constants modifier.

Item		Number of points	Memory area available for use Matsushita	IEC	Function
Memory area (double word) (See Note 4.)	External input relay (See Note 3.)	6 double words	DWX0 - DWX11	%ID0 -%ID11	Code for specifying 32 external input points as a double word (32 bits) of data.
	External output relay (See Note 3.)	6 double words	DWY0 - DWY11	%QD0 - %QD11	Code for specifying 32 external output points as double word (32 bits) of data.
	Internal relay (See Note 2.)	31 double words	DWR0 - DWR61	%MD0.0 - %MD0.61	Code for specifying 32 internal relay points as double word (32 bits) of data.
	Data register (See Note 2.)	830 double words	DDT0 - DDT1658	%MD5.0 - %MD5.1658	Data memory used in a program. Data is handled in 32-bit units (double words).
	Timer/counter set value area	72 double words	DSV0 - DSV142	%MD3.0 - %MD3.142	Data memory for storing a target value of a timer and an initial value of a counter. Stores by timer/counter number.
	Timer/counter elapsed value area (See Note 2.)	72 double words	DEV0 - DEV142	%MD4.0 - %MD4.142	Data memory for storing the elapsed value during operation of a timer/counter. Stores by timer/counter number.
	Special data register	56 double words	DDT9000 - DDT9110	%MD5.9000 - %MD5.9110	Data memory for storing specific data. Various settings and error codes are stored.
	Index register	1 double words	DI0	%MD6.0	Used as an address of memory area and constants modifier.

Item		Number of points
instruction	Master control relay points(MCR)	32 points
	Number of labels (JP and LOOP)	64 labels
	Number of step ladders	128 stages
	Number of subroutiones	16 subroutiones
	Number of interrupt programs	7 programs (external:6,internal:1)

Item		Range available for use Matsushita	IEC
Constant	Decimal constants (Integral type)	K – 32768 to K32767 (for 16-bit operation)	– 32768 to 32767 (for 16-bit operation)
		K – 2147483648 to K2147483647 (for 32-bit operation)	– 2147483648 to 2147483647 (for 32-bit operation)
	Hexadecimal constants	H0 to HFFFF (for 16-bit operation)	16#0 to 16#FFFF (for 16-bit operation)
		H0 to HFFFFFFFF (for 32-bit operation)	16#0 to 16#FFFFFFFF (for 32-bit operation)
	Decimal constants (monorefined real number)	F – 1.175494 $\times$ 10^{-38} to F – 3.402823 $\times$ 10^{38}	– 1.17549410E-38 to – 3.402823E38
		F1.175494 $\times$ 10^{-38} to F3.402823 $\times$ 10^{38}	1.17549410E-38 to 3.402823E38

Notes:

1. The points for the timer and counter can be changed by the setting of System register No.5. The number given in the table above are the numbers when System register No. 5 is at its default setting.
2. There are two unit types;
   the hold type that saves the conditions that exist just before turning the power off or changing from the RUN mode to PROG. mode, and the non-hold type that resets them.
   These areas can be specified as hold type or non-hold type by setting system register.
   For the FP-e, that area is fixed and allotted the numbers as shown in the table below. For the FP-e with clock/calendar function type, the selection of hold type and non-hold type can be changed by the setting of system register.
3. The number of points noted above is the number reserved in the system. For the actual number of points available for use, refer to “I/O Allocation” in Appendix A.
4. Double words cannot be specified with FPWIN GR.

Hold type and non-hold type areas [Note 1)]

Model		AFPE224300 (Standard type)	AFPE224305 (Calendar timer type)	AFPE214325 (Thermocouple input type)
Timer		Non-hold type: all points		
Counter	Non-hold type	From the set value to C139		
	Hold type	C140 to C143, EV140 to EV143 (elapsed value)		
		SV: non-hold [Note 2)]	SV: hold	
Internal relay	Non-hold type	976 points (R0 to R60F) 61 words (WR0 to WR60)		
	Hold type	32 points (R610 to R62F) 2 words (WR61 to WR62)		
Data register	Non-hold type	1652 words (DT0 to DT1651)		
	Hold type	8 words (DT1652 to DT1659)		

Notes:

1. When a battery is installed in a calendar timer type FP-e, the areas above can be changed using the system register.
   If a battery is not installed, the data cannot be stored even when the settings are changed using the system register.
   2. Use the following methods for holding the SV data:
   1. Set the transfer instruction for the special data register (DT) to hold the data. Then, perform the setting so that the data can be transferred from DT to SV after the RUN mode starts.
   2. Use the FP-e model with a battery.

9.4 ASCII characters displayed in the FP-e unit

9.4.1 Available ASCII characters

Available output characters using ASCII Code

	0xh	1xh	2xh	3xh	4xh	5xh	6xh	7xh
x0h	NUL	DEL	SPACE	0	@	P	`	p
x1h	SOH	DC1	!	1	A	Q	a	q
x2h	STX	DC2	”	2	B	R	b	r
x3h	ETX	DC3	#	3	C	S	c	s
x4h	EOT	DC4	$	4	D	T	d	t
x5h	ENQ	NAK	%	5	E	U	e	u
x6h	ACK	SYN	&	6	F	V	f	v
x7h	BEL	ETB	’	7	G	W	g	w
x8h	BS	CAN	(	8	H	X	h	x
x9h	HT	EM	)	9	I	Y	i	y
xAh	LF	SUB	*	:	J	Z	J	z
xBh	VT	ESC	+	;	K	[	k	{
xCh	FF	FS	,	<	L	¥	l	|
xDh	CR	GS	-	=	M	]	m	}
xEh	SO	RS	.	>	N	^	n	~
xFh	SI	US	/	?	O	_	o	DEL

Note 1) If specifying a characters which cannot be output, a blank is output.

Note 2) There is no discrimination between uppercase (41 h to 5Ah) and lowercase (61h to 7Ah) characters.
Therefore, “A” and a” is output in the same way.

9.4.2 ASCII code and display

Ascii code	Ascii character	Output image
20h	(SPACE)	
21h	!	
22h	"	
23h	#	
24h	$	
25h	%	
26h	&	
27h	'	
28h	(	
29h	)	
2Ah	*	
2Bh	+	
2Ch	,	
2Dh	−	
2Eh	.	
2Fh	/	

Ascii code	Ascii character	Output image
30h	0	
31h	1	
32h	2	
33h	3	
34h	4	
35h	5	
36h	6	
37h	7	
38h	8	
39h	9	
3Ah	:	
3Bh	;	
3Ch	<	
3Dh	=	
3Eh	>	
3Fh	?	

Ascii code	Ascii character	Output image
40h	@	
41h	A	
42h	B	
43h	C	
44h	D	
45h	E	
46h	F	
47h	G	
48h	H	
49h	I	
4Ah	J	
4Bh	K	
4Ch	L	
4Dh	M	
4Eh	N	
4Fh	O	

Ascii code	Ascii character	Output image
50h	P	
51h	Q	
52h	R	
53h	S	
54h	T	
55h	U	
56h	V	
57h	W	
58h	X	
59h	Y	
5Ah	Z	
5Bh	[	
5Ch	¥	
5Dh	]	
5Eh	^	
5Fh	_	

Ascii code	Ascii character	Output image
60h	`	
61h	a	
62h	b	
63h	c	
64h	d	
65h	e	
66h	f	
67h	g	
68h	h	
69h	i	
6Ah	j	
6Bh	k	
6Ch	l	
6Dh	m	
6Eh	n	
6Fh	o	

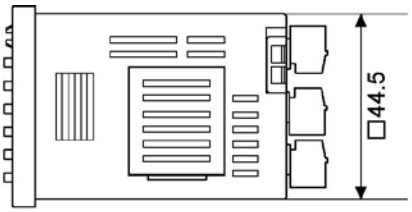
Ascii code	Ascii character	Output image
70h	p	
71h	q	
72h	r	
73h	s	
74h	t	
75h	u	
76h	v	
77h	w	
78h	x	
79h	y	
7Ah	z	
7Bh	{	
7Ch	|	
7Dh	}	
7Eh	~	
7Fh	(DEL)	

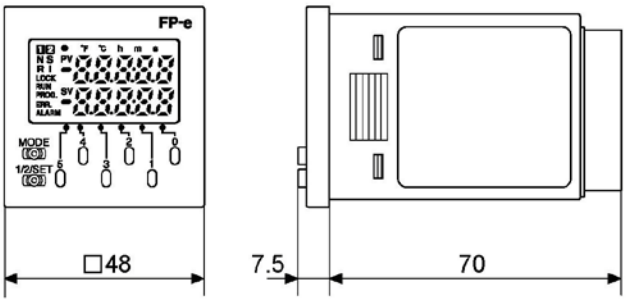
Note) When specifying the control code (00h to 1Fh, or 7Fh), a blank appears. (No display is turned on.)

Chapter 10

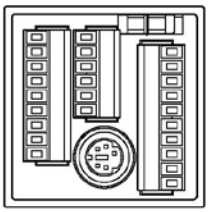
Dimensions

10.1 Dimensions



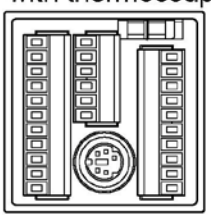


Analog input
without thermocouple



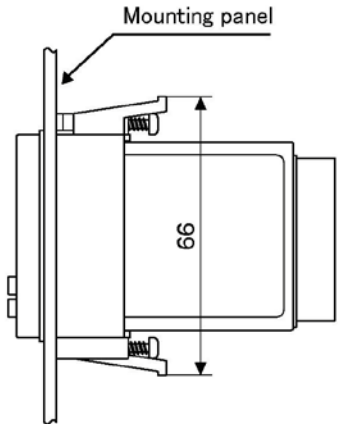
AFPE224300
AFPE224305
AFPE224302

Analog input
with thermocouple



AFPE214325
AFPE214322

– When FP-e is on a mounting panel



Record of changes

Manual No.	Date	Description of changes
ARCT1F369E	DEC., 2002	First edition
ARCT1F369E-1	JUL., 2003	2nd edition PDF Only Addition of Chapter 8 “PID Control”
AFCT1F369E-2	APR., 2003	3rd edition PDF Only Addition of functions available for Ver. 1.2 or higher Addition of new models (RS485 type) - AFPE224302 - AFPE214322
ARCT1F369E-3	FEB.2006	4th edition
ARCT1F369E-4	JAN.2007	5th edition
ARCT1F369E-5	NOV.2008	6th edition Change in Corporate name
ARCT1F369E-6	MAR.2009	7th edition
ARCT1F369E-7	AUG.2011	8th edition - Change in Corporate name - Fixed Errors
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