

PROGRAMMABLE CONTROLLER
FP0 Analog I/O Unit
Technical Manual

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.

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.

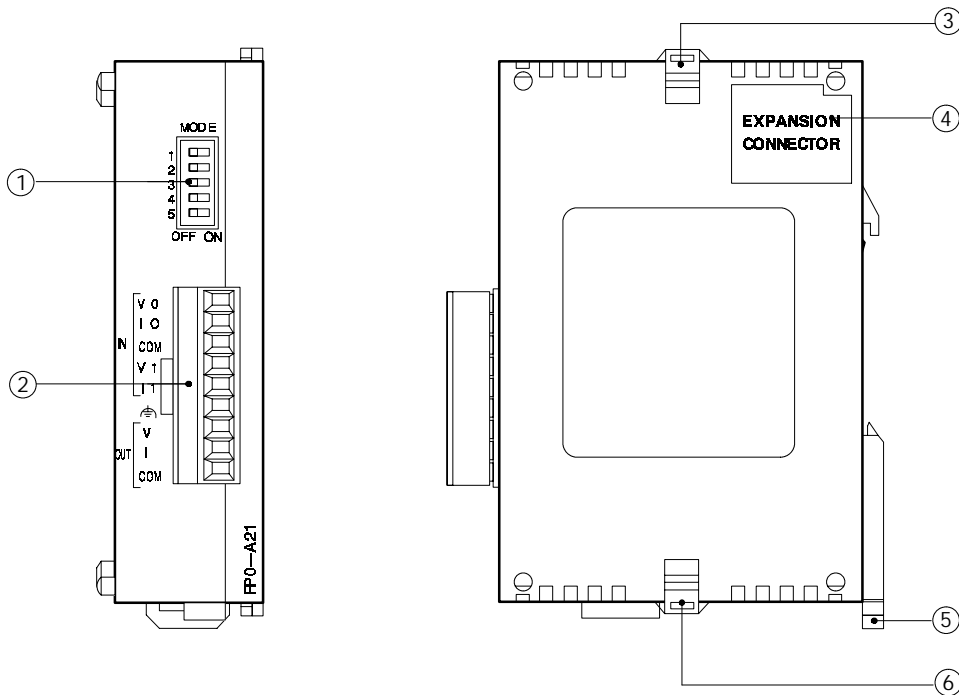
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1 Parts and Terminology



① Analog mode switch

is used to switch between input and output modes (voltage/current). With the analog I/O unit, both input channels are operated in the same range (*section 1.1.).

② Analog I/O terminal (9-pin)

Use a terminal block socket made by Phoenix Contact Co. (product number: 1840434) (*section 1.2 and See FP0 User's Manual).

③ ⑥ Expansion hook

is used to secure expansion units.

④ Expansion connector

connects an expansion unit to the internal circuit of the analog I/O unit (See FP0 User's Manual).

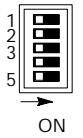
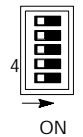
⑤ DIN rail attachment lever

allows simple attachment to a DIN rail. The lever is also used for installation on FP0 slim type mounting plate (AFP0803).

1 Parts and Terminology

1.1 Analog Mode Switch Setting

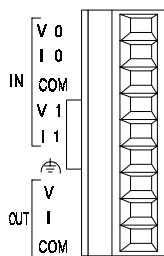
Analog mode switch


| Mode | Switch number | Range | | | | | | | | |
|-------------------------------|---|----------------------------|------------------------------|----------------------------|-----------------------------------|------------------------------------|------------------------------------|-----------------------------------|------------------------------------|-----------------------------------|
| Analog input range switching | 1 to 3, 5 | 0 to 5V 0 to 20mA | - 10 to +10V | | K type thermocouple (* Note 3) | | J type thermocouple (* Note 3) | | T type thermocouple (* Note 3) | |
| | | No averaging (* Note 1) | With averaging (* Note 2) | No averaging (* Note 1) | With averaging (* Note 2) | Temperature of terminal to 1000 °C | -100 °C to temperature of terminal | Temperature of terminal to 750 °C | -100 °C to temperature of terminal | Temperature of terminal to 350 °C |
| |  | | | | | | | | | |
| Analog output range switching | 4 | 0 to 20mA | - 10 to +10V | | | | | | | |
| |  | | | | | | | | | |

Notes

- (*1): No averaging: Conversion data is set for the specified input contact point area for each A/D conversion, on each channel.
- (*2): With averaging: On each channel, for each A/D conversion, the maximum and minimum values from the data of the last ten times are excluded, and the data from the other eight times is averaged, and the result set. (* section 7.1)
- (*3): If a thermocouple setting is used, averaging is carried out, regardless of the switch settings. (* section 7.2)

1.2 Analog I/O Terminal



| Pin number | Name | Description |
|------------|---|---|
| 1 | IN/V 0 | Analog input (channel 0), voltage input |
| 2 | IN/I 0 | Analog input (channel 0), current input |
| 3 | IN/COM | Analog input (channel 0 and 1), analog input common |
| 4 | IN/V 1 | Analog input (channel 1), voltage input |
| 5 | IN/I 1 | Analog input (channel 1), current input |
| 6 |  | Ground for analog cable |
| 7 | OUT/V | Voltage output |
| 8 | OUT/I | Current output |
| 9 | OUT/COM | Analog output common |

2 Specifications

2.1 General Specifications

| Item | Description |
|----------------------------------|---|
| Rated operation voltage | 24 V DC |
| Operating voltage range | 21.6 to 26.4 V DC |
| Rated current consumption | 100 mA or less (*see FP0 User's Manual) |
| Allowed momentary power off time | 10 ms |
| Ambient temperature | 0 °C to +55 °C/32 °F to +131 °F |
| Storage temperature | -20 °C to +70 °C/-4 °F to +158 °F |
| Ambient humidity | 30% to 85% RH (non-condensing) |
| Storage humidity | 30% to 85% RH (non-condensing) |
| Breakdown voltage | 500 V AC for 1 minute between I/O terminal and power supply/ground terminal 500 V AC for 1 minute between input and output terminals |
| Insulation resistance | min. 100 MΩ (measured with a 500 V DC megger) for between I/O terminal and power supply/ground terminal min. 100 MΩ (measured with a 500 V DC megger) for between input and output terminals |
| Vibration resistance | 10 Hz to 55 Hz, 1 cycle/min: double amplitude of 0.75 mm/0.030 in., 10 min on 3 axes |
| Shock resistance | Shock of 98 m/s ² or more, 4 times on axes |
| Noise immunity | 1,000 Vp-p with pulse widths 50 ns and 1μs (based on in-house measurements) |
| Operating condition | Free from corrosive gases and excessive dust |

2.1.1 Weight

| Type | Weight |
|------|-----------------------|
| A21 | approx. 100 g/3.53 oz |

2 Specifications

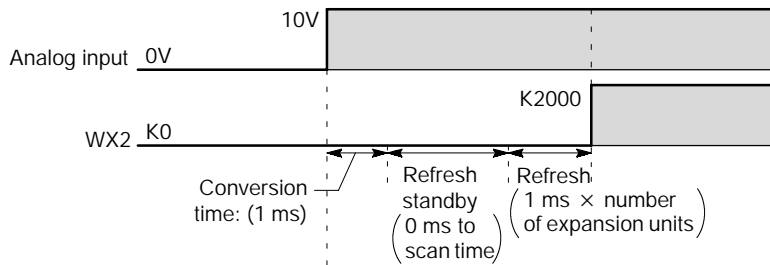
2.2 Analog Input Specifications

| Item | | Description | |
|--------------------------------|--|--|--|
| Number of input points | | 2 channels/unit | |
| Input range | Voltage range | 0 to 5 V/- 10 to +10 V | |
| | Current range | 0 to 20 mA | |
| | Thermocouple range | K, J and T type thermocouples | |
| Digital output | 0 to 5 V/ 0 to 20 mA | | |
| | - 10 to +10 V | | |
| | Thermo-couple (units in °C) | K type | K (temperature of terminal) to K1000 (* Note 1) K - 100 to K (temperature of terminal) (* Note 2) |
| | | J type | K (temperature of terminal) to K750 (* Note 1) K - 100 to K (temperature of terminal) (* Note 2) |
| | | T type | K (temperature of terminal) to K350 (* Note 1) K - 100 to K (temperature of terminal) (* Note 2) |
| When disconnected: K 20000 | | | |
| Resolution | | 1/4000 | |
| Conversion speed | Voltage/ current range Voltage/ current range | 1 ms/channel (*Note 3) | |
| | Thermocouple range | 560 ms (fixed) | |
| Overall precision | Voltage/ current range Voltage/ current range | ± 1% F.S. or less (0 to 55 °C/32 to 131 ° F) ± 0.6% F.S. or less (25 °C/77 ° F) | |
| | Thermocouple range | Offset error (0 to 55 °C/32 to 131 F°): ± 2 % F.S. or less (K type thermocouple) (* Note 4) ± 2.7 % F.S. or less (J type thermocouple) (* Note 4) ± 5.8 % F.S. or less (T type thermocouple) (* Note 4) Linearity error: ± 1 % F.S. or less(0 to 55 °C/32 to 131 ° F) | |
| Input impedance | Voltage range | 1 MΩ or more | |
| | Current range | 250Ω | |
| Absolute maximum input | Voltage range | ±15 V | |
| | Current range | +30 mA | |
| Insulation method (*Note 5) | | Between analog input terminal to FP0 internal circuit: photocoupler insulation (non-insulated between analog inputs) Between analog input terminal to analog I/O unit external power supply: insulation-type DC/DC converter Between analog input terminal to analog output terminal: insulation-type DC/DC converter | |
| Number of input contact points | | 32 input contact points: 16 points for 1st half: analog input CH0 data (WX2) (* Note 6) 16 points for last half: analog input CH1 data (WX3) (* Note 6) | |

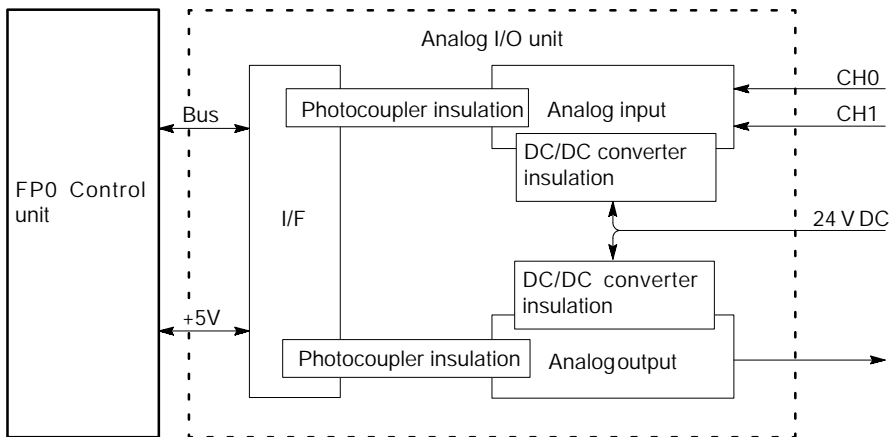
. next page

Notes

- (*1): The temperature lower than the temperature of terminal of the analog I/O unit cannot be measured.
- (*2): The temperature higher than the temperature of terminal of the analog I/O unit cannot be measured.
- (*3): The time noted below is required before the analog data is reflected in the control unit input.



- (*4): Refer to the *section 6 "Boosting the Precision of the Thermocouple Range."
- (*5): Refer to the schematic diagram of insulation methods below.



- (*6): The number for the input contact point being used varies depending on the expansion location.

| | I/O number | | |
|-------------------------------|------------------|------------------|------------------|
| | First expansion | Second expansion | Third expansion |
| Input channel 0: 16 points | WX2 (X20 to X2F) | WX4 (X40 to X4F) | WX6 (X60 to X6F) |
| Input channel 1: 16 points | WX3 (X30 to X3F) | WX5 (X50 to X5F) | WX7 (X70 to X7F) |
| Output: 16 points | WY2 (Y20 to Y2F) | WY4 (Y40 to Y4F) | WY6 (Y60 to Y6F) |

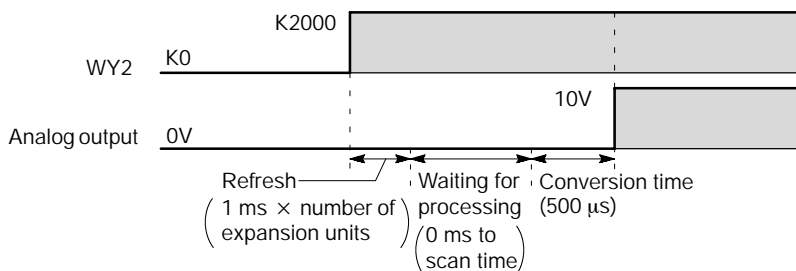
2 Specifications

2.3 Analog Output Specifications

| Item | | Description |
|----------------------------------|---------------|--|
| Number of output points | | 1 channel/unit |
| Output range | Voltage range | -10 to +10 V |
| | Current range | 0 to 20 mA |
| Digital input | -10 to +10 V | K - 2000 to K + 2000 (HF830 to H07D0) |
| | 0 to 20 mA | K0 to K4000 (H0 to H0FA0) |
| Resolution | | 1/4000 |
| Conversion speed | | 500 μ S (* Note 1) |
| Overall precision | | \pm 1% F.S. or less (0 to 55 °C/32 to 131 ° F) \pm 0.6% F.S. or less (25 °C/77 ° F) |
| Output impedance | Voltage range | 0.5 Ω |
| Maximum output current | Voltage range | \pm 10 mA |
| Allowable output load resistance | Current range | 300 Ω or less |
| Insulation method (* Note 2) | | Between analog output terminal to FP0 internal circuit: Photocoupler insulation Between analog output terminal to analog I/O unit external power supply: insulation-type DC/DC converter Between analog output terminal to analog input terminal: insulation-type DC/DC converter |
| Number of output contact points | | 16 output contact points: analog output data (WY2) (* Note 3) |

Notes

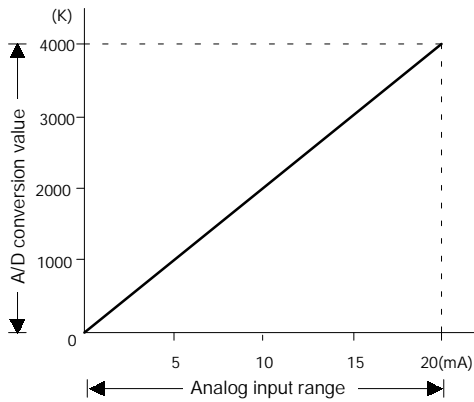
- (*1): The time noted below is required before the analog data is reflected in the control unit output.



- (*2): Refer to the schematic diagram of insulation methods on the previous page.
- (*3): The number for the output contact point being used varies depending on the expansion location (See 2.2 Analog Input Specifications Note *6).

3 A/D Conversion Characteristics

Current range: 0 to 20 mA DC input



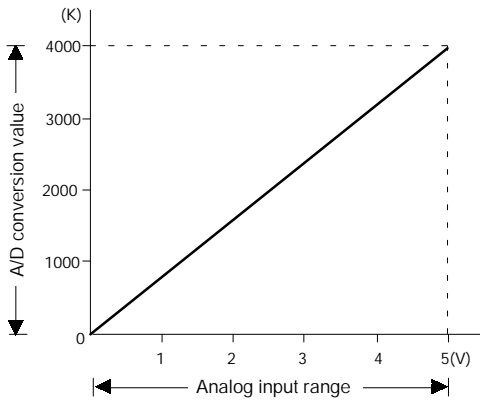
Correspondence table of A/D conversion values

| Input current (mA) | A/D conversion value |
|--------------------|----------------------|
| 0.0 | 0 |
| 2.5 | 500 |
| 5.0 | 1000 |
| 7.5 | 1500 |
| 10.0 | 2000 |
| 12.5 | 2500 |
| 15.0 | 3000 |
| 17.5 | 3500 |
| 20.0 | 4000 |

Processing if the range is exceeded

| Input value | Converted value |
|---|-----------------|
| 0 mA or less (including negative value) | 0 |
| 20 mA or more | 4000 |

Voltage range: 0 to 5 V DC input



Correspondence table of A/D conversion values

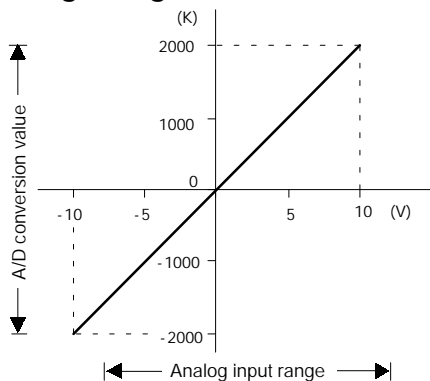
| Input voltage (V) | A/D conversion value |
|-------------------|----------------------|
| 0.0 | 0 |
| 0.5 | 400 |
| 1.0 | 800 |
| 1.5 | 1200 |
| 2.0 | 1600 |
| 2.5 | 2000 |
| 3.0 | 2400 |
| 3.5 | 2800 |
| 4.0 | 3200 |
| 4.5 | 3600 |
| 5.0 | 4000 |

Processing if the range is exceeded

| Input value | Converted value |
|--|-----------------|
| 0 V or less (including negative value) | 0 |
| 5 V or more | 4000 |

3 A/D Conversion Characteristics

Voltage range: -10 to +10 V DC input



Correspondence table of A/D conversion values

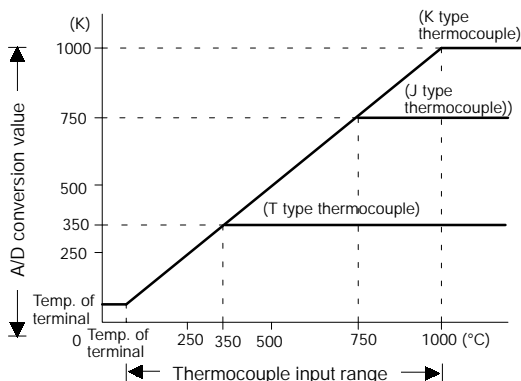
| Input voltage (V) | A/D conversion value |
|-------------------|----------------------|
| -10.0 | -2000 |
| -7.5 | -1500 |
| -5.0 | -1000 |
| -2.5 | -500 |
| 0.0 | 0 |
| +2.5 | +500 |
| +5.0 | +1000 |
| +7.5 | +1500 |
| +10.0 | +2000 |

Processing if the range is exceeded

| Input value | Converted value |
|---------------|-----------------|
| -10 V or less | -2000 |
| +10 V or more | +2000 |

Thermocouple input:

Setting a temperature higher than the temperature of terminal using the analog mode switch (*section 1.1)



Correspondence table of A/D conversion values

| Temperature (°C) | A/D conversion value |
|-------------------------|-------------------------|
| Temperature of terminal | Temperature of terminal |
| 25 | 25 |
| 250 | 250 |
| 350 | 350 |
| 500 | 500 |
| 750 | 750 |
| 1000 | 1000 |

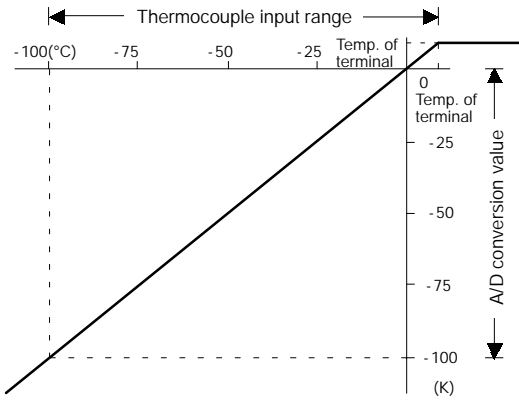
Processing if the range is exceeded

| Input value | Converted value | |
|---------------------------------|--|------|
| Temperature of terminal or less | Temperature of terminal | |
| Upper limit | 350 °C or more (with T type thermocouple) | 350 |
| | 750 °C or more (with J type thermocouple) | 750 |
| | 1000 °C or more (with K type thermocouple) | 1000 |
| Disconnected | 20000 | |

If the measured temperature exceeds the upper limit of the range, a value higher than the upper limit value is not output.

Thermocouple input:

Setting a temperature lower than the temperature of terminal using the analog mode switch (*section 1.1)

**Correspondence table of A/D conversion values**

| Temperature (°C) | A/D conversion value |
|-------------------------|-------------------------|
| Temperature of terminal | Temperature of terminal |
| 0 | 0 |
| -25 | -25 |
| -50 | -50 |
| -75 | -75 |
| -100 | -100 |

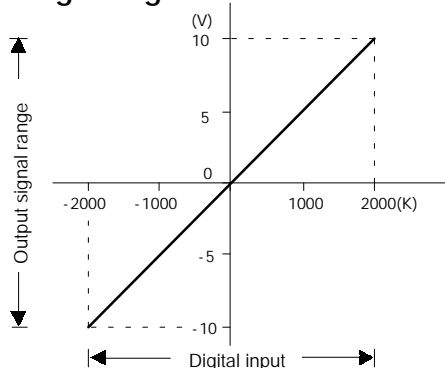
Processing if the range is exceeded

| Input value | | Converted value |
|---------------------------------|--------------------------|-------------------------|
| Temperature of terminal or more | | Temperature of terminal |
| Lower limit | with T type thermocouple | -250 |
| | with J type thermocouple | -200 |
| | with K type thermocouple | -250 |
| Disconnected | | 20000 |

A value is output even if the boundary of the measured value (-100 °C) is exceeded, but the measurement accuracy cannot be guaranteed.

4 D/A Conversion Characteristics

Voltage range: -10 to +10 V DC output



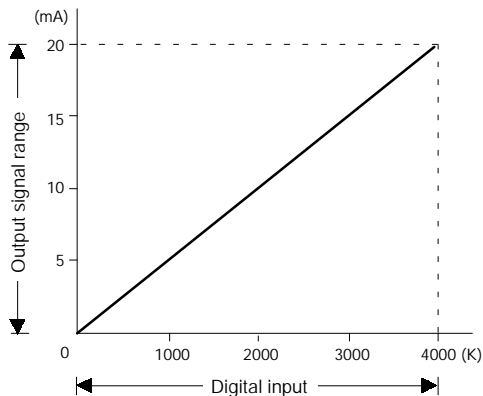
Correspondence table of D/A conversion values

| Digital input value | Output voltage (V) |
|---------------------|--------------------|
| -2000 | -10.0 |
| -1500 | -7.5 |
| -1000 | -5.0 |
| -500 | -2.5 |
| 0 | 0.0 |
| +500 | +2.5 |
| +1000 | +5.0 |
| +1500 | +7.5 |
| +2000 | 10.0 |

Processing if the range is exceeded

| Digital input value | Analog output value |
|---------------------|---|
| -2001 or less | Constant (value just before -2001 is input) |
| +2001 or more | Constant (value just before +2001 is input) |

Current range: 0 to 20 mA output



Correspondence table of D/A conversion values

| Digital input value | Output current (mA) |
|---------------------|---------------------|
| 0 | 0.0 |
| 500 | 2.5 |
| 1000 | 5.0 |
| 1500 | 7.5 |
| 2000 | 10.0 |
| 2500 | 12.5 |
| 3000 | 15.0 |
| 3500 | 17.5 |
| 4000 | 20.0 |

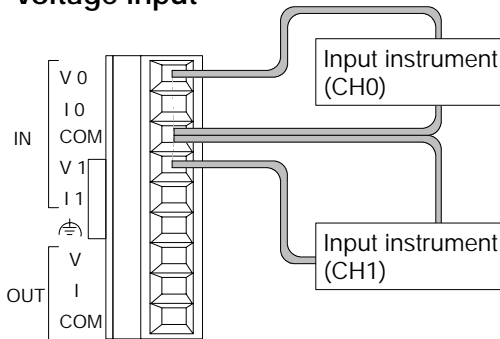
Processing if the range is exceeded

| Digital input value | Analog output value |
|---------------------|--|
| Negative value | Constant (value just before negative value is input) |
| 4001 or more | Constant (value just before 4001 is input) |

5 Wiring

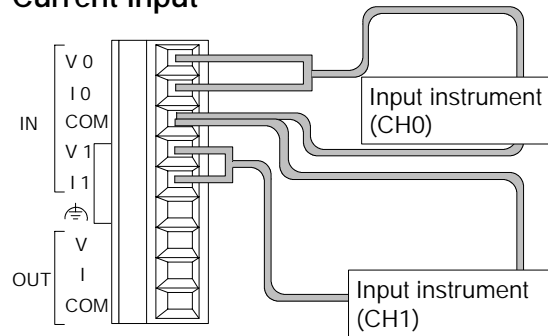
5.1 Analog Input Wiring

Voltage input



Connect input instrument between IN/V and IN/COM terminal.

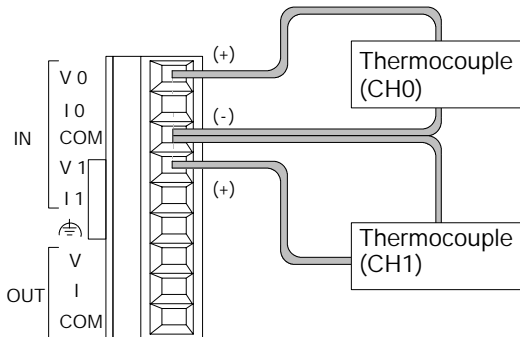
Current input



First, connect both IN/V terminal and IN/I terminal. And then connect input instrument between it and IN/COM terminal.

Thermocouple input

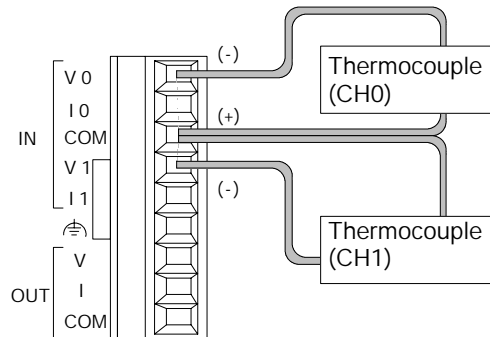
(when measured at temperature higher than the temperature of terminal)



Connect IN/V terminal to the (+) side of the thermocouple, and connect IN/COM terminal to the (-) side of the thermocouple.

Thermocouple input

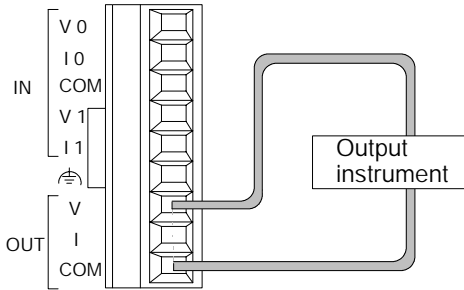
(when measured at temperature lower than the temperature of terminal)



Connect IN/V terminal to the (-) side of the thermocouple, and connect IN/COM terminal to the (+) side of the thermocouple.

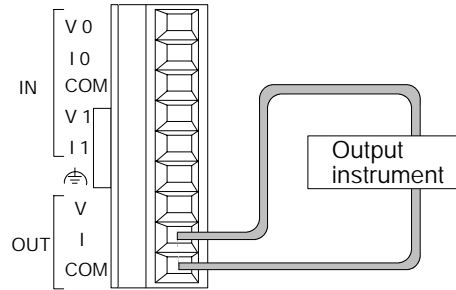
5.2 Analog Output Wiring

Voltage output



Connect output instrument between OUT/V and OUT/COM terminal.

Current output



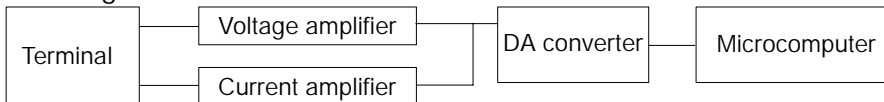
Connect output instrument between OUT/I and OUT/COM terminal.

Notes

- Always make sure the switch settings and the terminal base wiring connections match. For output, in particular, if the settings and the wiring connections are wrong, the control unit will output values like those shown below, even in the PROG. mode. (For information on switch settings, see * section 1.1.)

| Item | Output terminal (OUT) | |
|--|-----------------------|----------------------|
| | Current terminal (I) | Voltage terminal (V) |
| 0 mA output based on current range setting | 0 mA | -10 V |
| 0 V output based on voltage range setting | 10 mA | 0 V |

- DA internal block diagram
A voltage amplifier and current amplifier are connected in parallel to a single DA converter IC.



Also, the digital value that is sent to the DA converter IC to achieve a voltage output of 0 V is different from that input to the DA converter IC to achieve a current output of 0 mA.

As a result, if the voltage output is set to 0 V, 10 mA is output from the current output terminal, and conversely, if the current output is set to 0 mA, -10 V is output from the voltage output terminal (see tables the next page).

next page

- For voltage output

| Value of WY | K - 2000 | K0 | K2000 |
|-------------------------------|----------|------|-------|
| Digital value to DA converter | 0 | 2047 | 4095 |
| Analog output | -10 V | 0 V | +10 V |

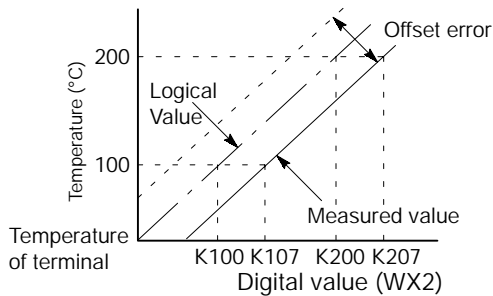
- For current output

| Value of WY | K0 | K2000 | K4000 |
|-------------------------------|------|-------|-------|
| Digital value to DA converter | 0 | 2047 | 4095 |
| Analog output | 0 mA | 10 mA | 20 mA |

6 Boosting the Precision of the Thermocouple Range

When a high degree of precision is required, we recommend correcting the offset using the program (we recommend initiating correction using the offset value taken approximately 5 minutes after power is turned ON in order to take has been supplied, taking into consideration the heat generated by the unit itself).

Example



In the above case, seven should be subtracted from the value of WX2.

Program example

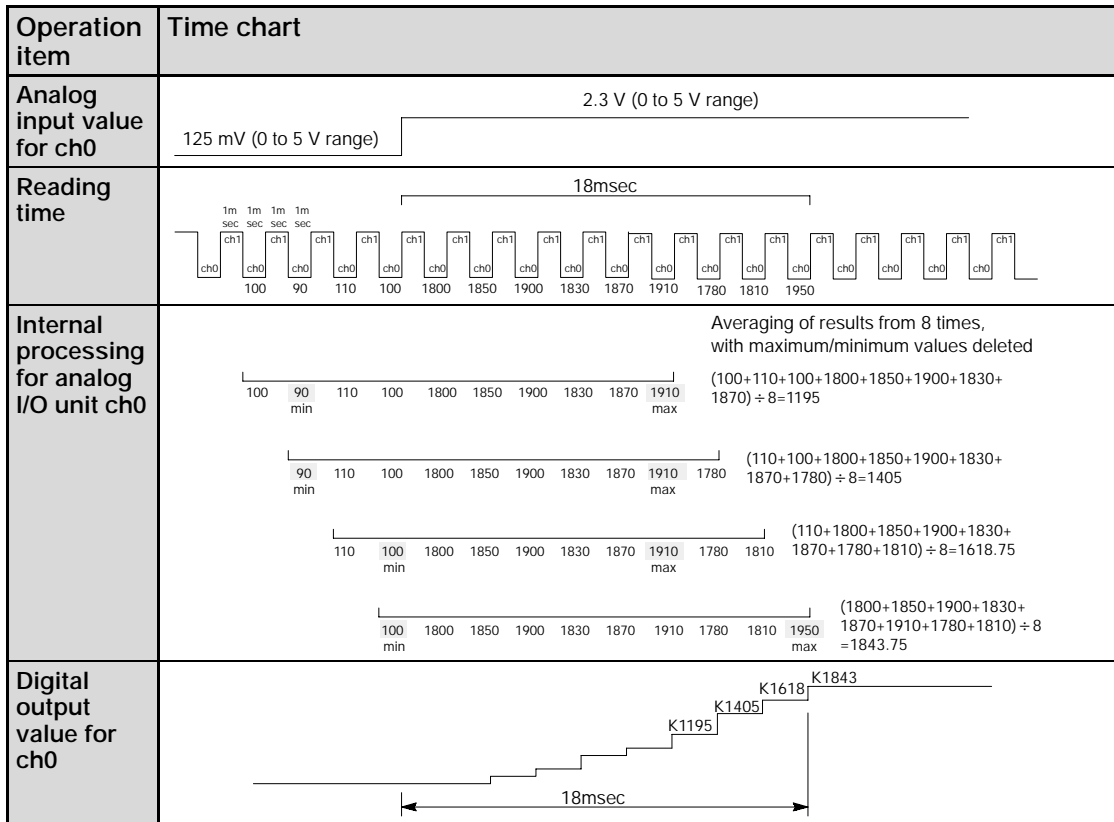
```
R9010
┌──┬──[ F27 (-), WX2, K7, DT100 ]──┬──┘
```

The value with the offset value of "7" subtracted is stored at DT100.

7 Averaging Function

7.1 Averaging for Voltage Ranges and Current Ranges

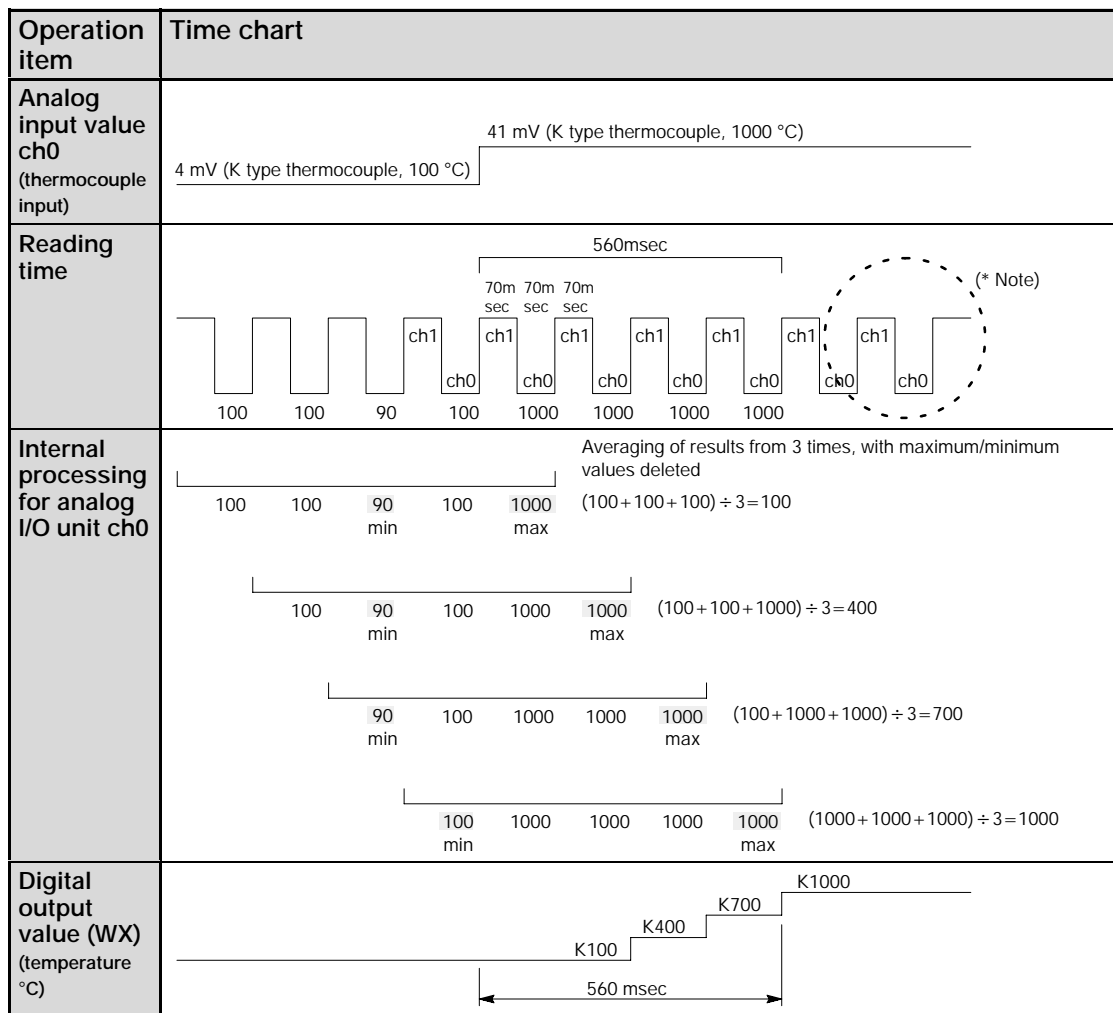
When the input range is set to a voltage range or current range, processing like that shown below is carried out internally of analog I/O unit.



Starting from the most recent data, the data from the last ten times is taken. The maximum and minimum values are deleted, and then averaging is carried out on the remaining eight items. The value obtained from the most recent averaging is normally used as the value output at this time. (If a fraction results from the calculation, it is rounded off.)

7.2 Averaging for a Thermocouple Range

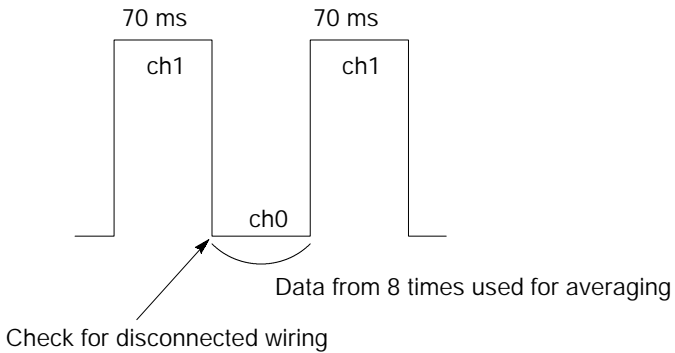
When the input range is set to a thermocouple (K, J or T type), processing like that shown below is carried out internally in the analog I/O unit.



Starting from the most recent data, the data from the last five times is taken. The maximum and minimum values are deleted, and then averaging is carried out on the remaining three items. The value obtained from the most recent averaging is normally used as the value output at this time. (If a fraction results from the calculation, it is rounded off.)

Note

In the read timing, the minimum and maximum values are subtracted from the data from the last ten times, just as in averaging processing of section 7.1, and the data from the remaining eight times is used for the averaging.



If a disconnected wire is detected, a value of K20000 is output.

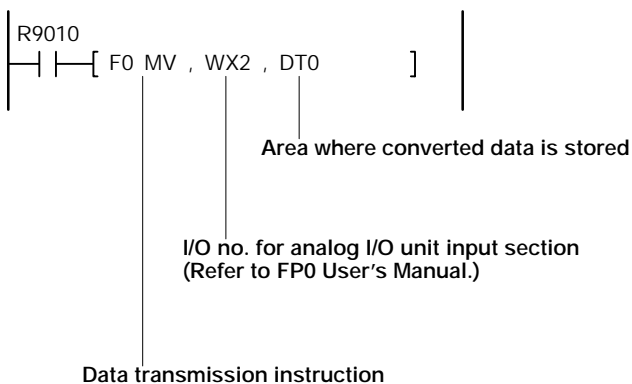
8 Analog I/O Unit Programs

The data transmission instruction **F0 (MV)** is used to read data from the analog I/O unit, and to write it to the unit.

Analog input

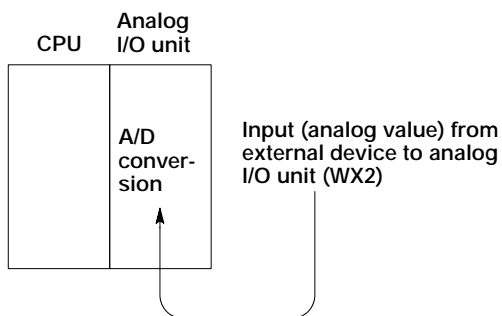
Program example

Digital values which have been converted in the analog I/O unit are stored in any desired data register.



If "0 to 20 mA DC input" has been specified for the input range in the above program, the values of K0 to 4000 are stored in DT0.

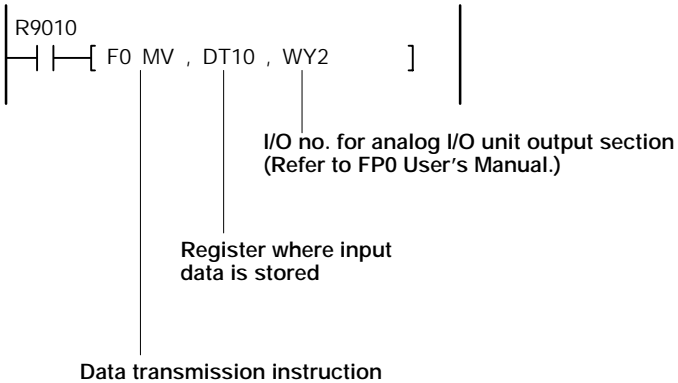
Configuration diagram



Analog output

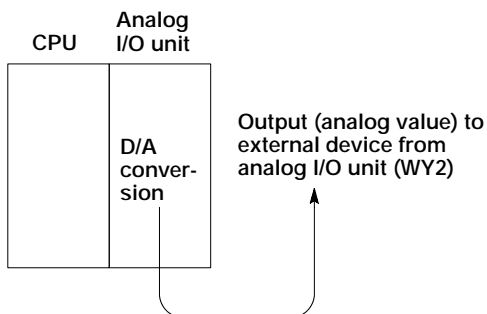
Program example

Digital values which have been stored in any desired data register are transferred to the analog output area.



If "0 to 20 mA DC output" has been specified for the output range in the above program, writing data of range of K0 to 4000 to DT10 causes 0 to 20 mA DC to be output from the analog I/O unit.

Configuration diagram



Precautions during programming

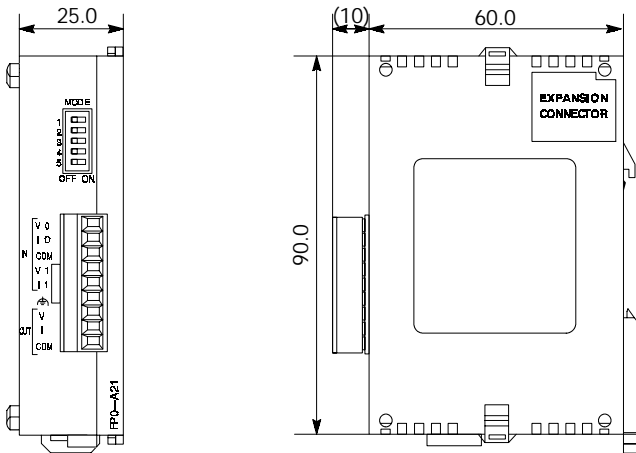
The I/O numbers for the specified analog I/O unit input and output sections vary depending on the installed position of the analog I/O unit. Refer to the FP0 User's Manual for the I/O numbers.

Data values undergoing A/D and D/A conversion vary depending on the range used. Refer to the "FP0 User's manual" for the range.

9 Dimension

Analog I/O Unit FP0 - A21 (AFP0480)

(Unit: mm)



Record of changes

| Manual No. | Date | Description of changes |
|--------------|----------|--|
| ARCT1F390E | FEB.2004 | First edition - This manual was transferred from the FP0 hardware manual (ACG-M0084-3). |
| ARCT1F390E-1 | NOV.2008 | Second edition - Change in Corporate name |
| ARCT1F390E-2 | AUG.2011 | Third edition - Change in Corporate name - Fixed Errors |



Please contact

Panasonic Electric Works SUNX Co., Ltd.

■ Overseas Sales Division (Head Office): 2431-1 Ushiyama-cho, Kasugai-shi, Aichi, 486-0901, Japan
■ Telephone: +81-568-33-7861 ■ Facsimile: +81-568-33-8591
panasonic-electric-works.net/sunx

Europe Headquarter: Panasonic Electric Works Europe AG

■ Head Office: Rudolf-Diesel-Ring 2, D-83607 Holzkirchen, Germany
■ Telephone: +49-8024-648-0

US Headquarter: Panasonic Electric Works Corporation of America

■ Head Office: 629 Central Avenue New Providence, New Jersey 07974 USA
■ Telephone: +1-908-464-3550