

PROGRAMMABLE CONTROLLER
FP0 D/A Converter 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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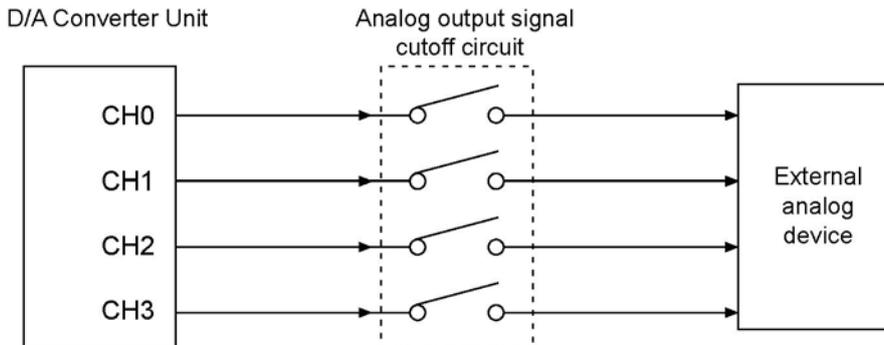
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Precautions before Usage

- When turning the power ON/OFF,

the analog output may be fluctuated temporarily.

If the fluctuation affects the external devices in the system configuration, take appropriate countermeasures, such as an external analog output signal cutoff circuit.



- Programming

- Write the data in the D/A Converter Unit after the “D/A Converter Unit power flag” of the status data turns to “1: Power ON.”
- Number of the output points for the D/A Converter Unit is 4. However, the allocated I/O are 2 words and it is required to control the output CH switch flag when data is written in the D/A Converter Unit.



Reference: “6 I/O Allocations and Program”

- When programming, be sure to set up the program to check the upper and lower limits of the digital value. In the D/A Converter Unit, output data and output CH switch flag are allocated to the same I/O number. Data error can be detected successfully with the flags when the digital input value is within the range of K-4096 to K4095. Even when the digital input value is out of the range, however, data conversion may be mistakenly conducted. (i.e. The analog conversion is conducted.)

1 Unit Outline

1.1 Functions

1. D/A Converter Unit for FP0/FP Σ

Internal data of the FP0/FP Σ is converted to the analog value and output.

2. Output range

- (1) Voltage output type (AFP04121): -10V to +10V (K-2000 to K2000)
- (2) Current output type (AFP04123): 4 mA to 20 mA (K0 to K4000)

3. High-accuracy output

Overall accuracy: ± 1 % F. S. or less (at 0 to 55°C)
 ± 0.6 % F. S. or less (at 25°C)

1.2 Product Number

- D/A Converter Unit

Part name	Analog output points	Model number	Product number
FP0 D/A Converter Unit (Voltage output type)	4 points	FP0-A04V	AFP04121
FP0 D/A Converter Unit (Current output type)	4 points	FP0-A04I	AFP04123

1.3 Expansion Limit

- Number limit

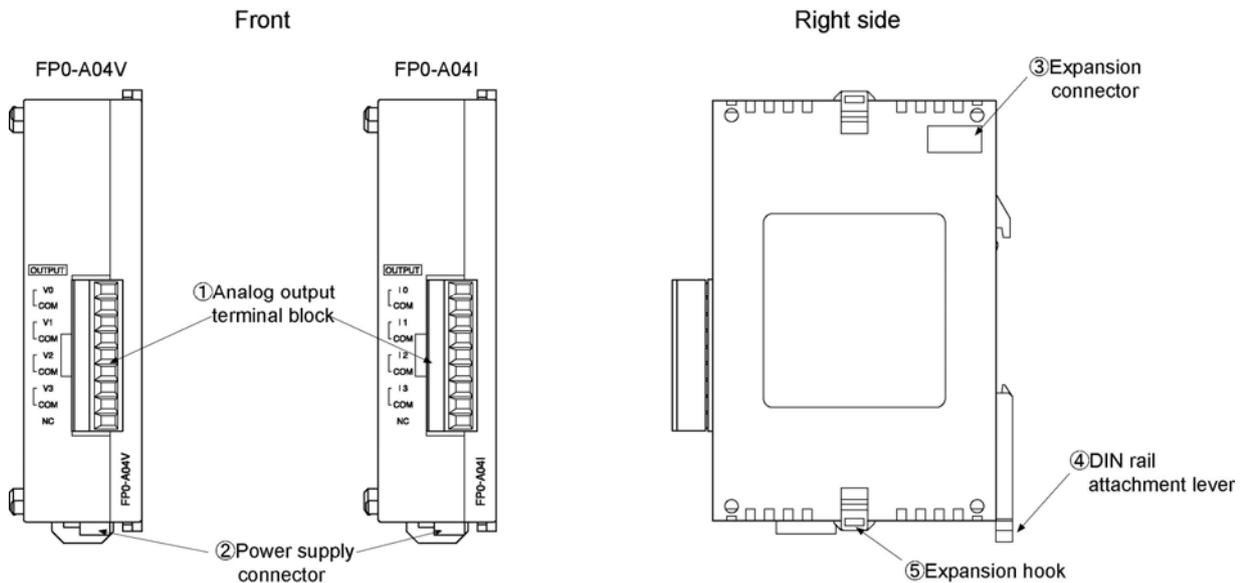
Up to 3 expansion units can be connected with the Control Unit.



Reference: "6.1 I/O No."

2 Part Names and Functions

- D/A Converter Unit



① Analog output terminal block (9-pin)

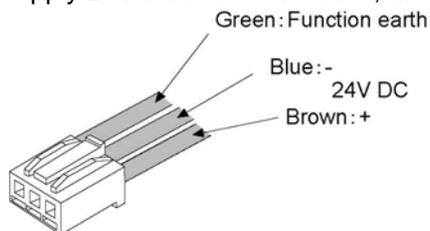
Manufactured by Phoenix Contact Co. Model number: MC1.5/9-ST-3.5 (Product No.: 1840434).

Suitable wires

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

② Power supply connector

Supply 24V DC. For connection, use the power supply cable (AFP0581) that comes with the Unit.



③ Expansion connector

Connects the expansion unit with the internal circuit of the Control Unit.

④ DIN rail attachment lever (One-touch hook)

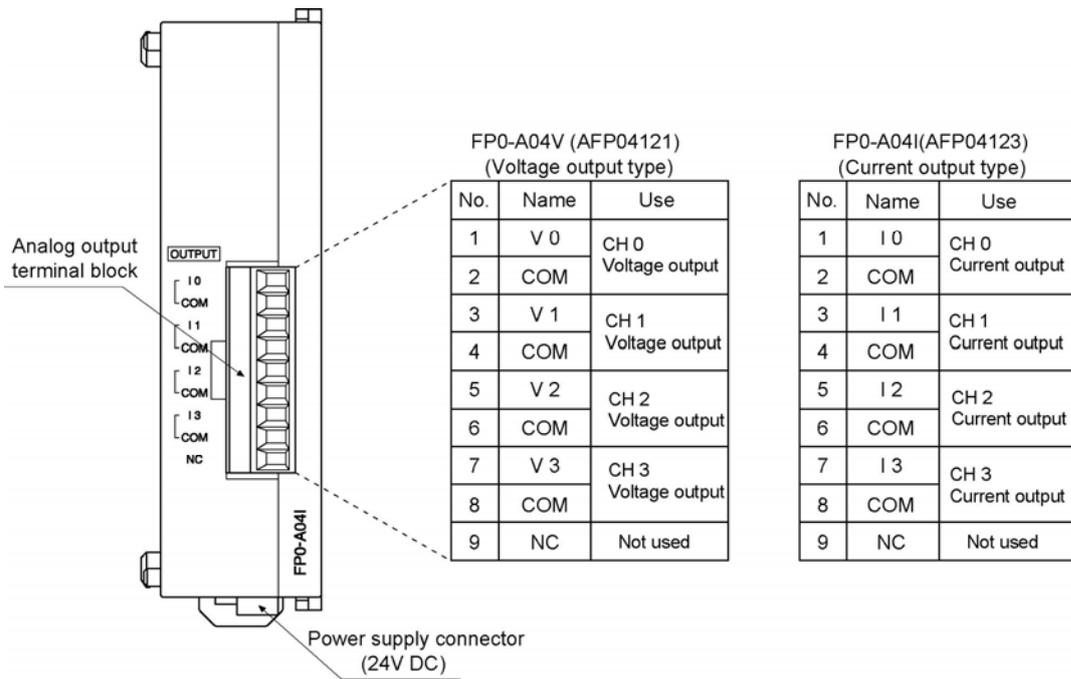
The Unit can be installed to the DIN rail through one-touch operation.

This lever is also used for installing the Unit to the FP0 Slim Type Mounting Plate (AFP0803).

⑤ Expansion hook

Used to secure expansion units.

3 Analog Output Terminal Block

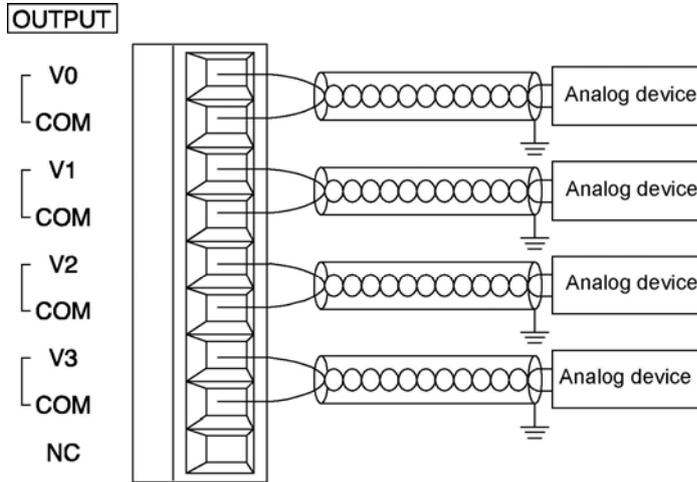


Note: 4 COM terminals are connected in the Unit.

4 Wiring

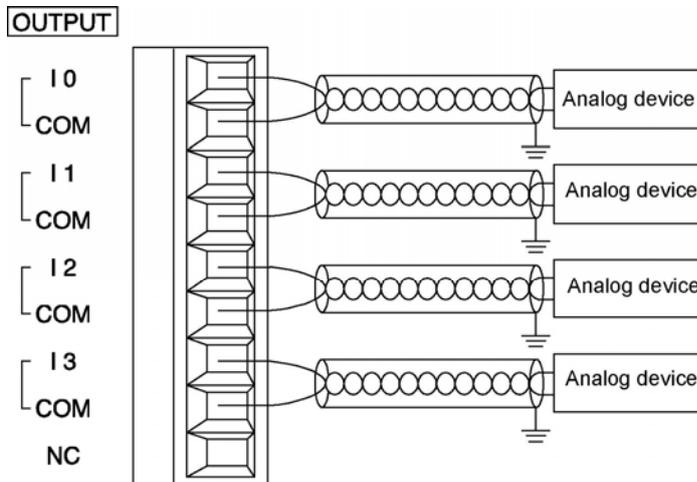
- Wiring method

FP0-A04V (AFP04121) Voltage output type



4 COM terminals are connected in the Unit.

FP0-A04I (AFP04123) Current output type



4 COM terminals are connected in the Unit.



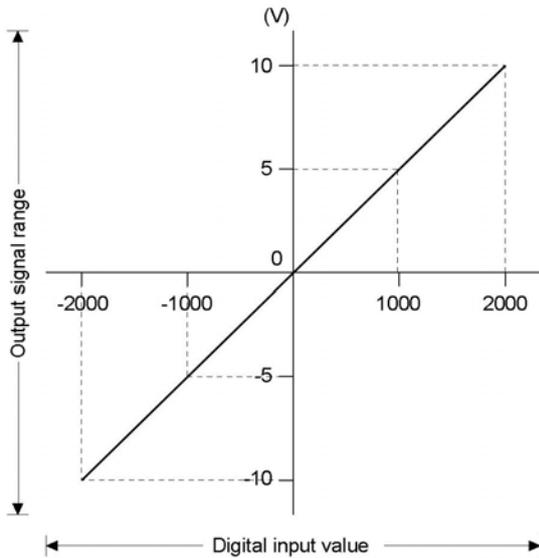
Notes: 1. Keep the space more than 100 mm between the output line and the power line/high voltage line.

2. For the analog output wiring, dual-core twisted pair shielded wires are recommended to be grounded on the analog device side.

5 Conversion Characteristics

- FP0-A04V (AFP04121) Voltage output type

Voltage range: -10V to +10V output
Conversion characteristic

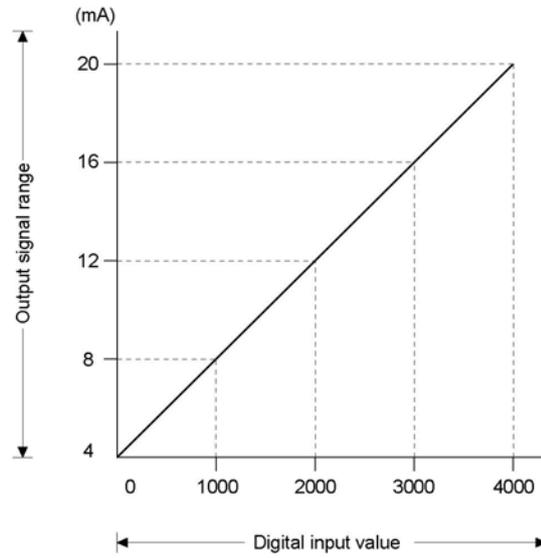


Correspondence table of D/A Conversion values

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

- FP0-A04I (AFP04123) Current output type

Current range: 4mA to 20mA output
Conversion characteristic



Correspondence table of D/A Conversion values

Digital input value	Output current (mA)
0	4.0
500	6.0
1000	8.0
1500	10.0
2000	12.0
2500	14.0
3000	16.0
3500	18.0
4000	20.0

If the input value is out of the range

Digital input value	Converted value
- 2001 or less	Unchanged (Previous value just before the digital value [-2001 or less] is input remains.)
+ 2001 or more	Unchanged (Previous value just before the digital value [+2001 or more] is input remains.)

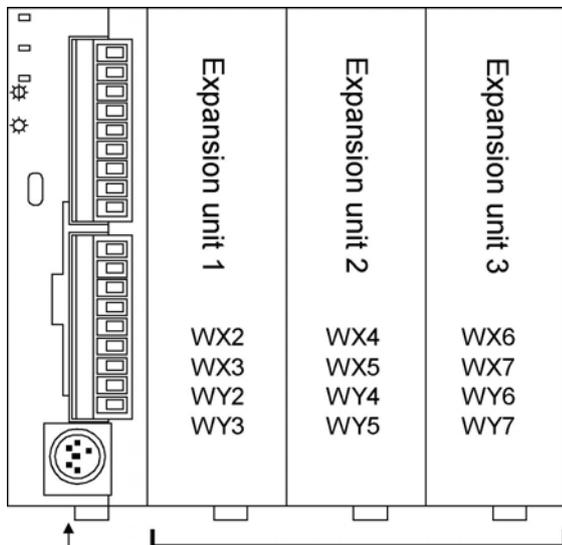
If the input value is out of the range

Digital input value	Converted value
-1 or less	Unchanged (Previous value just before the digital value [-1 or less] is input remains.)
4001 or more	Unchanged (Previous value just before the digital value [4001 or more] is input remains.)

6 I/O Allocations and Program

6.1 I/O No.

- I/O No.



FP0/FP Σ
control unit

Up to 3 expansion units, including D/A Converter Unit, can be connected with the Control Unit.
2 words (2 x 16 bits) are allocated to WX and WY each.

- With the installation location above, the I/O data is allocated in the table below.

		Expansion unit 1	Expansion unit 2	Expansion unit 3
Output	CH0, 2 output data	WY2	WY4	WY6
	CH1, 3 output data	WY3	WY5	WY7
Input	Status data	WX2	WX4	WX6

Status Data

X20	D/A Converter unit power (1: ON, 0: OFF)
X21	Used in the system.
X22	
X23	
X24	CH0 data writing status (1: Error, 0: Normal) ^{Note}
X25	CH1 data writing status (1: Error, 0: Normal) ^{Note}
X26	CH2 data writing status (1: Error, 0: Normal) ^{Note}
X27	CH3 data writing status (1: Error, 0: Normal) ^{Note}
X28 to 2F	Used in the system.



Note: Output data and output CH switch flag are allocated to the same I/O number. Data error can be detected successfully with the flags when the digital input value is within the range of K-4096 to K4095.

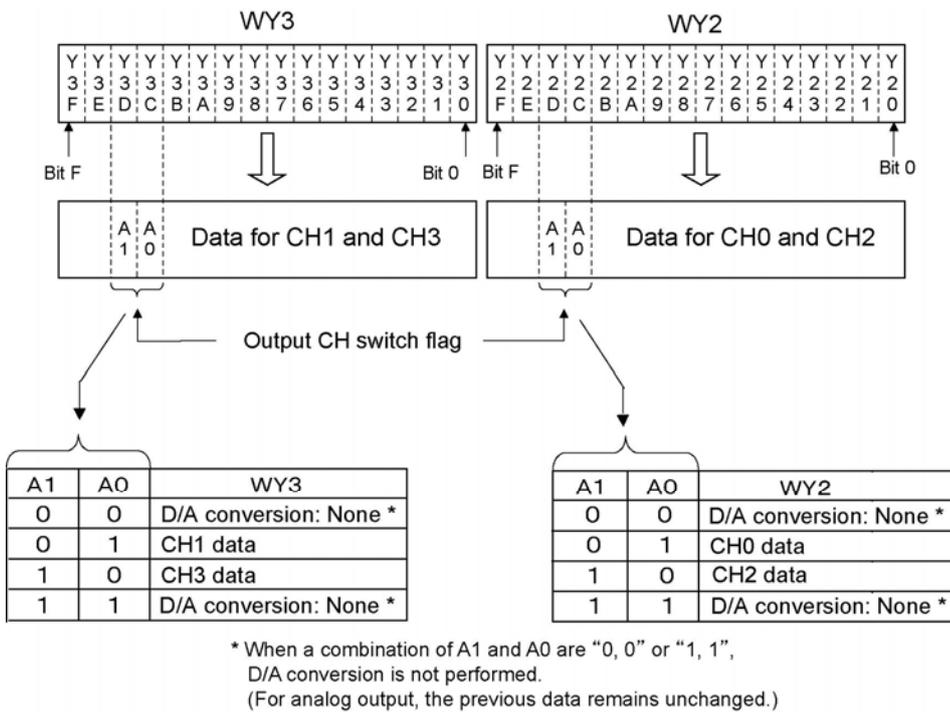
Even when the digital input value is out of the range, however, data conversion may be mistakenly conducted. To prevent this problem, be sure to set up the program to check the upper and lower limits of the digital value.



Reference: “ 6.2 Program “

- Example of I/O allocation

I/O Allocation when D/A Converter Unit is used as Expansion Unit 1.



- Writing conversion data

Writing scan

The Unit performs D/A conversion by specifying the output data and Channel (CH). Both CH0 and CH2 are allocated to WY2, and both CH1 and CH3 are allocated to WY3. The data for channels that are not allocated to the same I/O No. (i.e. data for CH0 and CH1, and data for CH2 and CH3, data for CH0 and CH3, data for CH1 and CH2) can be written in the D/A converter unit in one scanning process. When writing the data allocated to the same I/O No. (CH0 and CH2, CH1 and CH3), however, perform 2 scanning processes with the scan pulse relay R9012.

Example:

When CH0 and CH2 are used

Writing CH0 data in WY2 at the time of "n" scan

Writing CH2 data in WY2 at the time of "n+1" scan

Data writing cannot be performed in the same scanning process.
Data can be written in WY2 once in 2 scanning processes (at the time of "n" and "n+1" scan).

When CH0 and CH1 are used

Writing CH0 data in WY2 at the time of "n" scan

Writing CH1 data in WY3 at the time of "n" scan

Data writing can be performed in the same scanning process.
Data can be written in WY2 and WY3 at the time of "n" scan.

When data is regarded as an error

Digital data from the control unit is written in the D/A Converter Unit.
When more than the specified amount of data (-2000 to 2000 for voltage type Unit, 0 to 4000 for current type Unit) is written in the Unit, the Unit regards the data as an error and writes the error flag in WX2. As a result, the D/A conversion is not performed. (For analog output, the previous data remains unchanged.)^{Note}
When the correct data is written, the error flag is cleared and D/A conversion is executed.

Note: Output data and output CH switch flag are allocated to the same I/O number. Data error can be detected successfully with the flags when the digital input value is within the range of K-4096 to K4095. Even when the digital input value is out of the range, however, data conversion may be mistakenly conducted as shown below. To prevent this problem, be sure to set up the program to check the upper and lower limits of the digital value.

Example: When writing K4096 in WY2
K4096 = 0001000000000000
D/A Converter Unit regards Y2D and Y2C as output CH switch flags:
Y2D, Y2C = 01 ← CH0
Data = 000000000000 ← 0

Consequently, the analog value that is equivalent to the digital value "0" is output from CH 0.

Negative data

When the negative data (minus data) is written, set the output CH switch flag to two's complement data.
(When specifying the minus data in the decimal data, the data automatically becomes two's complement data.)

Then, set the output CH switch flag to two's complement data in the same way as the plus data)



Reference: Easy outputting both + and - data " 6.2 Program "

Example: When writing -1 in CH0

-1=1111111111111111←Two's complement

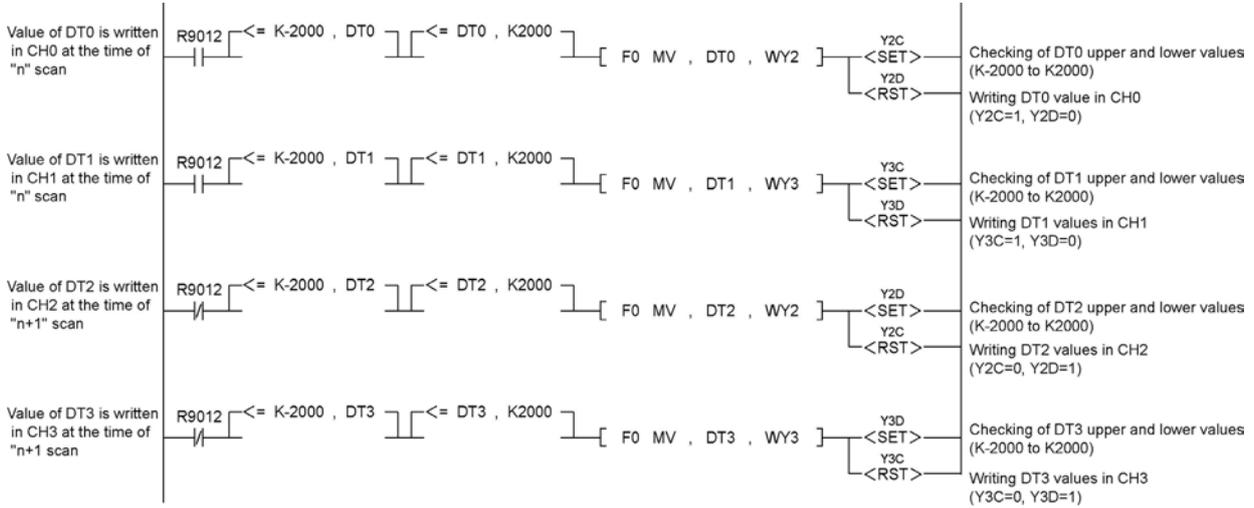
Setting the output CH switch flag: 1101111111111111 (Bit C=1, Bit D=0 for CH0)

6.2 Program

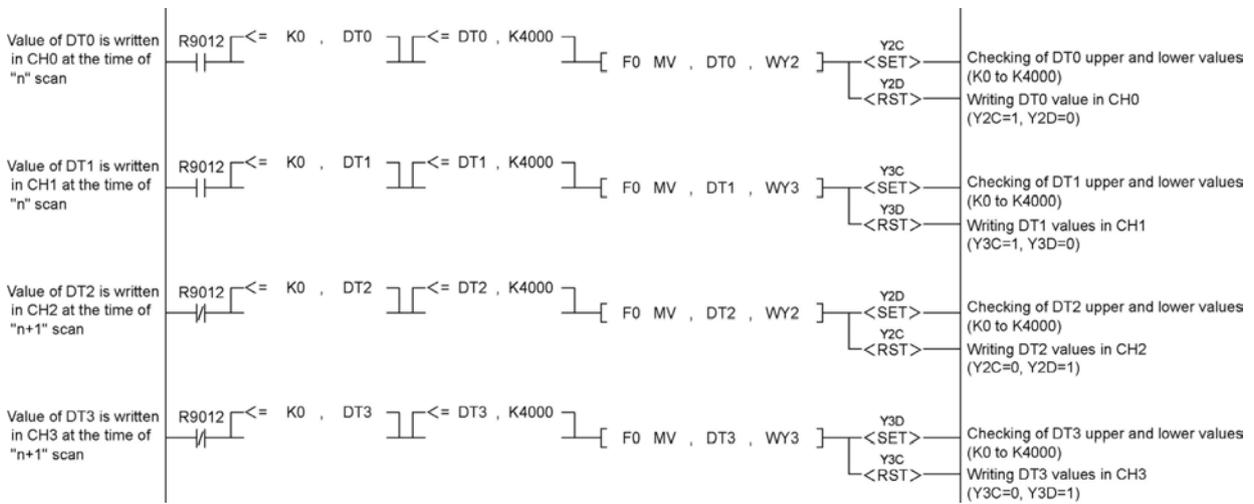
- Ladder program for outputting the data to each channel

Indicates the program that outputs the DT0 to DT3 data to CH0 to CH3 of the D/A Converter Unit which is used as Expansion Unit 1.

FP0-A04V (AFP04121) Voltage output type



FP0-A04I (AFP04123) Current output type



Note: Y2C, Y2D, Y3C, Y3D, WY2, and WY3 are changed depending on where the D/A Converter Unit is installed.



Reference: "6.1 I/O No."

7 When Error Occurred

7.1 What to Do

- When analog output is not conducted

Confirm the followings:

1. The D/A Converter Unit is correctly installed in the Control Unit.
2. Power is supplied to the D/A Converter Unit.
3. Digital input values are correct.
(Voltage output type: K-2000 to K2000, Current output type: K0 to K4000)
4. The output CH switch flag is correctly set.
5. Output programs of CH0 and CH2 (or, CH1 and CH3) are not executed in the same scanning process.

7.2 Digital Input Value when Out of Range

When the digital value that is out of the specified range is input in the FP0 D/A Converter Unit, the following analog value is output.

- Voltage output type (AFP04121)

Digital input value	Converted value
- 2001 or less	Unchanged (Previous value just before the digital value [-2001 or less] is input remains.)
+ 2001 or more	Unchanged (Previous value just before the digital value [+2001 or more] is input remains.)

- Current output type (AFP04123)

Digital input value	Converted value
-1 or less	Unchanged (Previous value just before the digital value [-1 or less] is input remains.)
4001 or more	Unchanged (Previous value just before the digital value [4001 or more] is input remains.)



Note: In the FP0 D/A Converter Unit, output data and output CH switch flag are allocated to the same I/O number. Data error can be detected successfully with the flags when the digital input value is within the range of K-4096 to K4095. Even when the digital input value is out of the range, however, data conversion may be mistakenly conducted. (i.e. The analog conversion is conducted.) To prevent this problem, be sure to set up the program to check the upper and lower limits.



Reference: “ 6.2 Program”

8 Specifications

8.1 Specifications

- General specifications

Item	FP0-A04V (AFP04121) Voltage output type	FP0-A04I (AFP04123) Current output type
Rated operation voltage	24V DC	
Operating voltage range	21.6 to 26.4V DC	
Rated current consumption	100 mA or less (24V DC)	130 mA or less (24V DC)
Current consumption increase of control unit	20 mA or less (24V DC)	
Allowable instantaneous power-off time	10 ms	
Ambient temperature	0 to 55 °C	
Storage temperature	-20 to +70 °C	
Ambient humidity	30 to 85 %RH (at25°C non condensing)	
Storage humidity	30 to 85 %RH (at25°C non condensing)	
Breakdown voltage	500V AC for 1 min. between analog output terminal and power supply/ground terminal	
Insulation resistance	Min. 100 M Ω between analog output terminal and power supply/ground terminal (Testing voltage: 500V DC)	
Vibration resistance	10 to 55 Hz, 1 cycle/min: double amplitude of 0.75 mm for 10 min. on 3 axes (toward X, Y and Z directions)	
Shock resistance	98 m/s ² , 4 times on 3 axes (toward X, Y and Z directions)	
Noise immunity	1000V [P-P] with pulse widths 50 ns, 1 μ s (using noise simulator)	
Operating condition	Must be free from corrosive gases and excessive dust.	
Weight	Approx. 75 g	

- Analog output specifications

Item	FP0-A04V (AFP04121) Voltage output type	FP0-A04I (AFP04123) Current output type
Number of output points	4CH	4CH
Output range	-10 to 10 V	4 to 20 mA
Digital input	K - 2000 to K 2000 ^{Note 1}	K 0 to K 4000 ^{Note 1}
Resolution	1/4000	
Conversion speed	500 μ s/CH ^{Note 2}	
Overall accuracy	± 1 % F. S. or less (at 0 to 55 °C), ± 0.6 % F. S. or less (at 25 °C)	
Output impedance	0.5 Ω or less	-
Allowable output load resistance	1000 Ω or more	500 Ω or less
Maximum output current	± 10 mA	-
Insulation method ^{Note 3}	<ul style="list-style-type: none"> Between analog output terminals and FP0 internal circuits: Photo-coupler insulation (Non insulated between channels) Between analog output terminals and D/A Converter Unit external power supply: Insulation-type DC/DC converter 	
FP0 I/O contact points	Input: 16 points Output: 32 points ^{Note 4}	

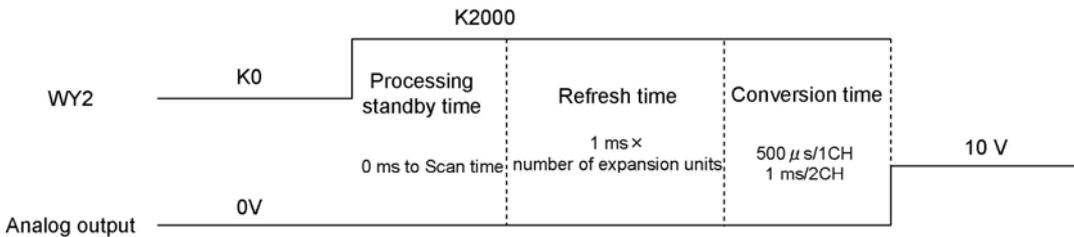
Notes:

1. If the digital input value exceeds the upper/lower limit, an error flag is written in WX2 and D/A conversion is not executed. (For analog output, the previous data remains unchanged.)



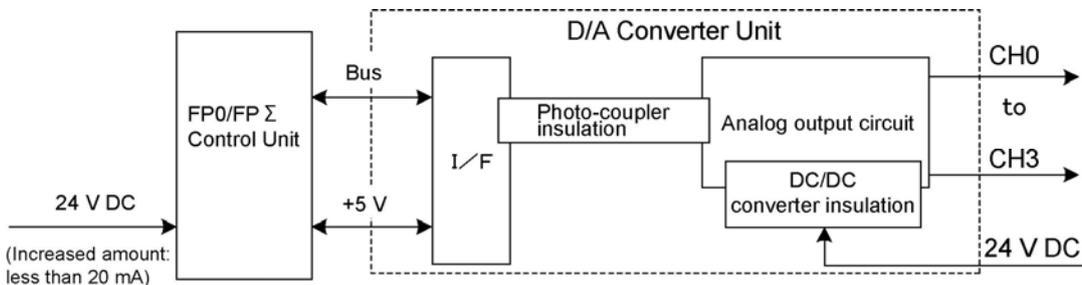
Reference: 6.1 I/O No. "When data is regarded as an error"

2. The time shown below is required when the data output from the control unit is reflected to the analog output data.



When setting the output CH switch flag for the CH (whose data will not be converted) to "00", only one CH's worth of data is converted. For details, refer to "When data is regarded as an error" in Chapter 6-1 "IO No."

3. Schematic diagram of insulation method



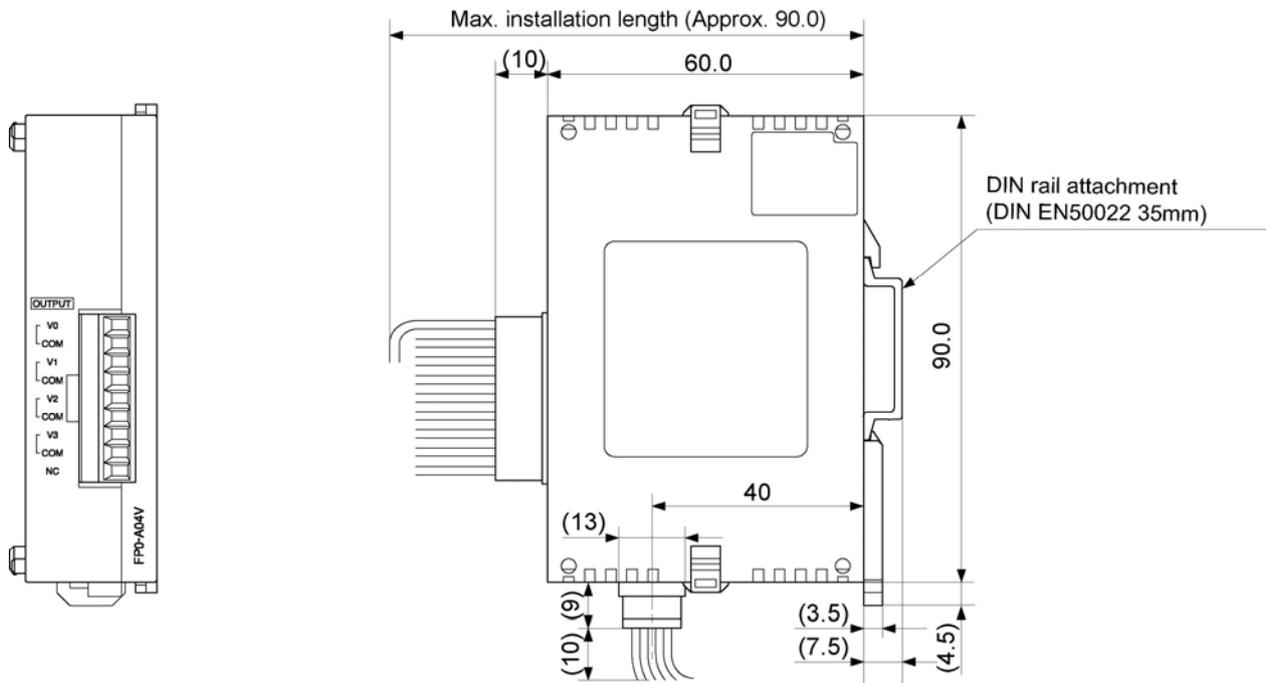
4. The control unit outputs two channels' worth of data to the D/A Converter Unit at each control unit scan.



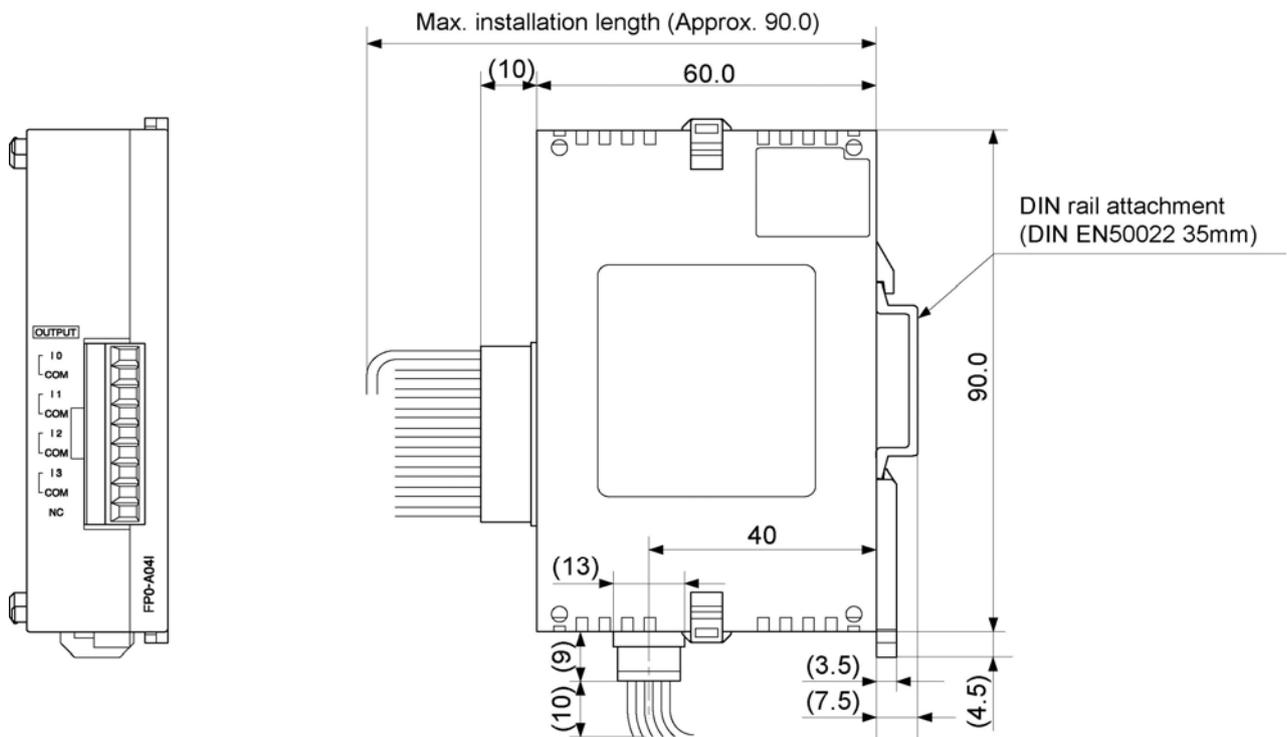
Reference: 6.1 I/O No. "Example of I/O allocation"

8.2 Dimensions

FP0-A04V (AFP04121) Voltage output type



FP0-A04I (AFP04123) Current output type



Record of changes

Manual No.	Date	Description of changes
ARCT1F382E	JUNE.2003	First edition
ARCT1F382E-1	FEB.2006	Second edition
ARCT1F382E-2	NOV.2008	Third edition - Change in Corporate name
ARCT1F382E-3	AUG.2011	Fourth edition - Change in Corporate name - Fixed Errors
ARCT1F382E-4	JUL.2013	Fifth edition - Change in Corporate name

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