

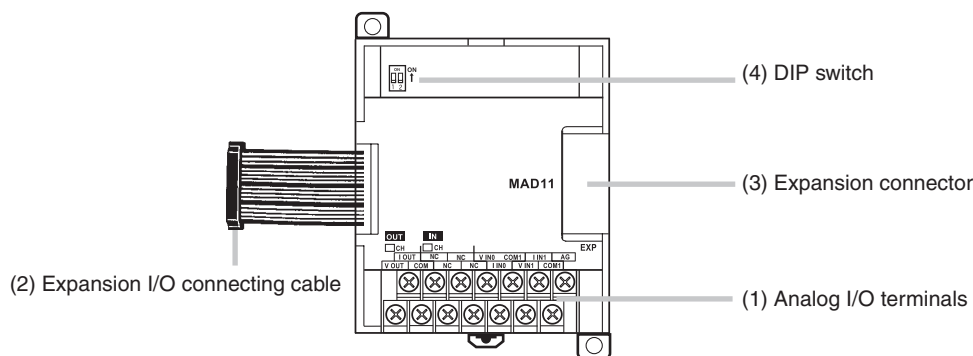
7-4-2 CP1W-MAD11/CPM1A-MAD11 Analog I/O Units

Each CP1W-MAD11/CPM1A-MAD11 Analog I/O Unit provides 2 analog inputs and 1 analog output.

- The analog input range can be set to 0 to 5 VDC, 1 to 5 VDC, 0 to 10 VDC, -10 to 10 VDC, 0 to 20 mA, or 4 to 20 mA. The inputs have a resolution of 1/6000.
An open-circuit detection function can be used with the 1 to 5 VDC and 4 to 20 mA settings.
- The analog output range can be set to 1 to 5 VDC, 0 to 10 VDC, -10 to 10 VDC, 0 to 20 mA, or 4 to 20 mA. The outputs have a resolution of 1/6000.

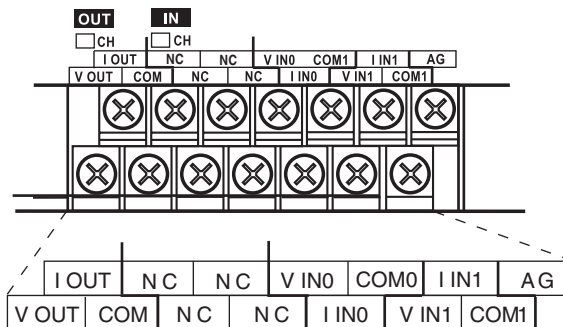
Part Names

CP1W-MAD11/CPM1A-MAD11



- (1) Analog I/O Terminals
Connected to analog I/O devices.

CPM1A-MAD11 Terminal Arrangements



Note For current inputs, short V IN0 to I IN0 and V IN1 to I IN1.

V OUT	Voltage output
I OUT	Current output
COM	Output common
V IN0	Voltage input 0
I IN0	Current input 0
COM0	Input common 0
V IN1	Voltage input 1
I IN1	Current input 1
COM1	Input common 1

- (2) Expansion I/O Connecting Cable
Connected to the expansion connector of a CP1L CPU Unit or a CMP1A Expansion Unit or Expansion I/O Unit. The cable is provided with the Analog I/O Unit and cannot be removed.

Caution Do not touch the cables during operation. Static electricity may cause operating errors.

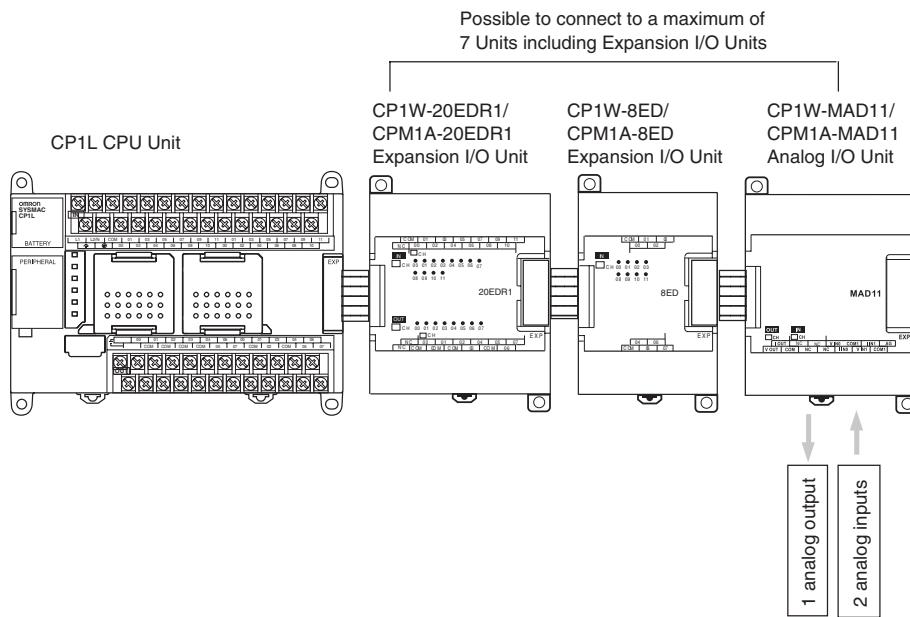
- (3) Expansion Connector
Used for connecting Expansion Units or Expansion I/O Units.
- (4) DIP Switch
Used to enable or disable averaging.



Pin1: Average processing for analog input 0
(OFF: Average processing not performed; ON: Average processing performed)
Pin2: Average processing for analog input 1
(OFF: Average processing not performed; ON: Average processing performed)

Main Analog I/O Unit Specifications

Analog I/O Units are connected to the CP1L CPU Unit. Up to seven Units can be connected, including any other Expansion Units and Expansion I/O Units that are also connected.



Item		Voltage I/O	Current I/O	
Analog Input Section	Number of inputs	2 inputs (2 words allocated)		
	Input signal range	0 to 5 VDC, 1 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC	0 to 20 mA or 4 to 20 mA	
	Max. rated input	±15 V	±30 mA	
	External input impedance	1 MΩ min.	Approx. 250 Ω	
	Resolution	1/6000 (full scale)		
	Overall accuracy	25°C	0.3% full scale	0.4% full scale
		0 to 55°C	0.6% full scale	0.8% full scale
	A/D conversion data	16-bit binary (4-digit hexadecimal) Full scale for -10 to 10 V: F448 to 0BB8 hex Full scale for other ranges: 0000 to 1770 hex		
	Averaging function	Supported (Settable for individual inputs via DIP switch)		
Open-circuit detection function	Supported			
Analog Output Section	Number of outputs	1 output (1 word allocated)		
	Output signal range	1 to 5 VDC, 0 to 10 VDC, or -10 to 10 VDC,	0 to 20 mA or 4 to 20 mA	
	Allowable external output load resistance	1 kΩ min.	600 Ω max.	
	External output impedance	0.5 Ω max.		
	Resolution	1/6000 (full scale)		
	Overall accuracy	25°C	0.4% full scale	
0 to 55°C		0.8% full scale		
Set data (D/A conversion)	16-bit binary (4-digit hexadecimal) Full scale for -10 to 10 V: F448 to 0BB8 hex Full scale for other ranges: 0000 to 1770 hex			
Conversion time	2 ms/point (6 ms/all points)			
Isolation method	Photocoupler isolation between analog I/O terminals and internal circuits. No isolation between analog I/O signals.			
Current consumption	5 VDC: 83 mA max., 24 VDC: 110 mA max.			

Analog I/O Signal Ranges

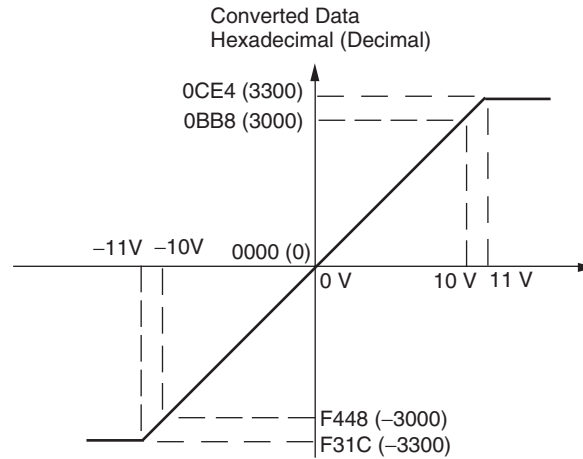
Analog I/O data is digitally converted according to the analog I/O signal range as shown below.

Note When the input exceeds the specified range, the AD converted data will be fixed at either the lower limit or upper limit.

Analog Input Signal Ranges

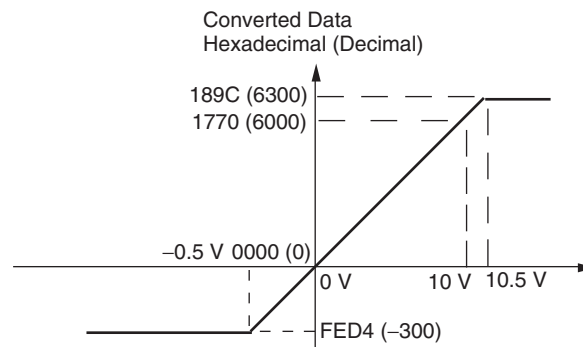
-10 to 10 V

The -10- to 10-V range corresponds to the hexadecimal values F448 to 0BB8 (-3000 to 3000). The entire data range is F31C to 0CE4 (-3300 to 3300). A negative voltage is expressed as a two's complement.



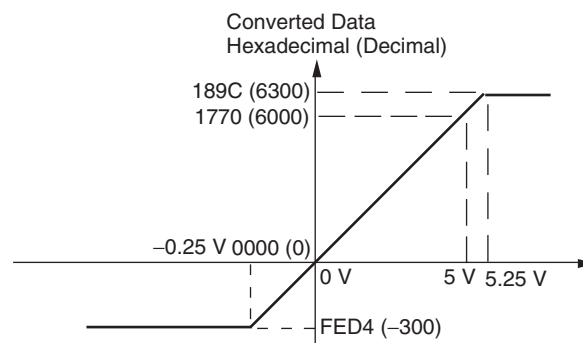
0 to 10 V

The 0- to 10-V range corresponds to the hexadecimal values 0000 to 1770 (0 to 6000). The entire data range is FED4 to 189C (-300 to 6300). A negative voltage is expressed as a two's complement.



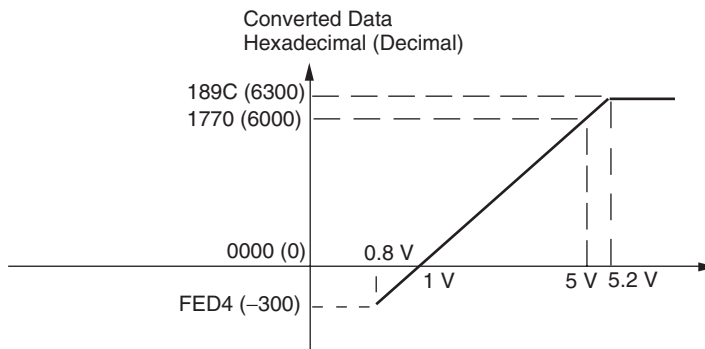
0 to 5 V

The 0- to 5-V range corresponds to the hexadecimal values 0000 to 1770 (0 to 6000). The entire data range is FED4 to 189C (-300 to 6300). A negative voltage is expressed as a two's complement.



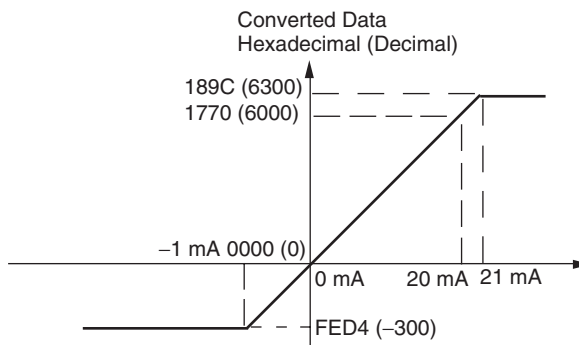
1 to 5 V

The 1- to 5-V range corresponds to the hexadecimal values 0000 to 1770 (0 to 6000). The entire data range is FED4 to 189C (-300 to 6300). Inputs between 0.8 and 1 V are expressed as two's complements. If the input falls below 0.8 V, open-circuit detection will activate and converted data will be 8000.



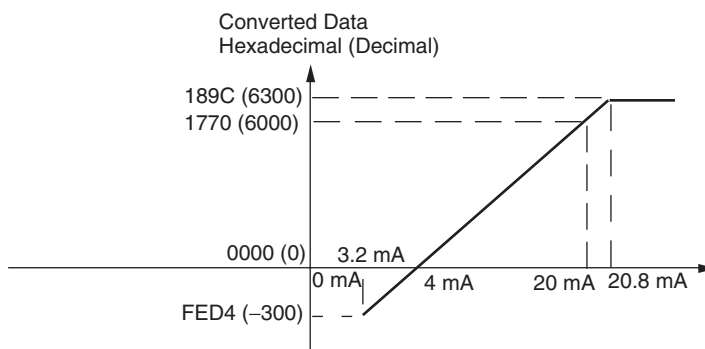
0 to 20 mA

The 0- to 20-mA range corresponds to the hexadecimal values 0000 to 1770 (0 to 6000). The entire data range is FED4 to 189C (-300 to 6300). A negative voltage is expressed as a two's complement.



4 to 20 mA

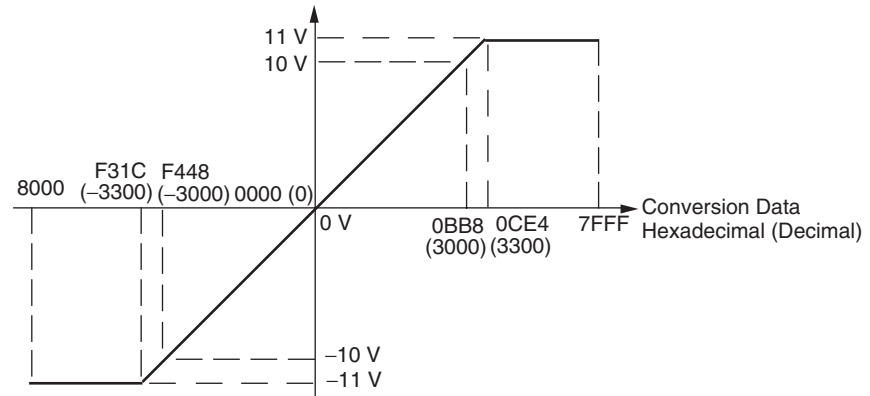
The 4- to 20-mA range corresponds to the hexadecimal values 0000 to 1770 (0 to 6000). The entire data range is FED4 to 189C (-300 to 6300). Inputs between 3.2 and 4 mA are expressed as two's complements. If the input falls below 3.2 mA, open-circuit detection will activate and converted data will be 8000.



Analog Output Signal Ranges

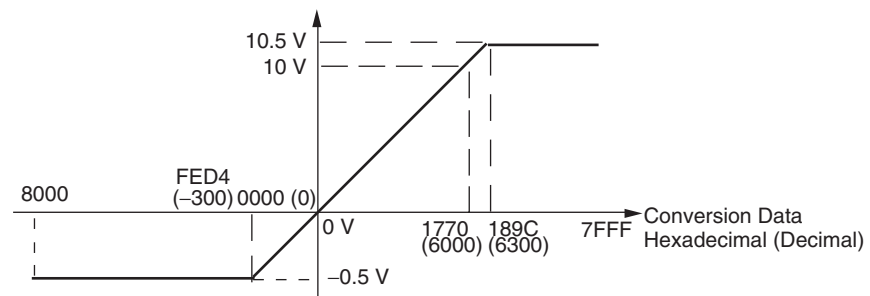
-10 to 10 V

The hexadecimal values F448 to 0BB8 (-3000 to 3000) correspond to an analog voltage range of -10 to 10 V. The entire output range is -11 to 11 V. Specify a negative voltage as a two's complement.



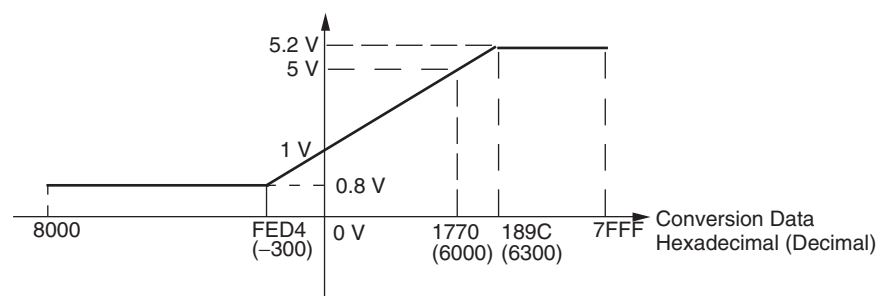
0 to 10 V

The hexadecimal values 0000 to 1770 (0 to 6000) correspond to an analog voltage range of 0 to 10 V. The entire output range is -0.5 to 10.5 V. Specify a negative voltage as a two's complement.



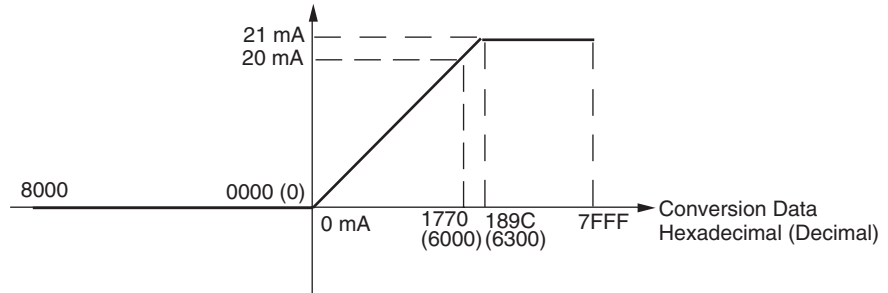
1 to 5 V

The hexadecimal values 0000 to 1770 (0 to 6000) correspond to an analog voltage range of 1 to 5 V. The entire output range is 0.8 to 5.2 V.



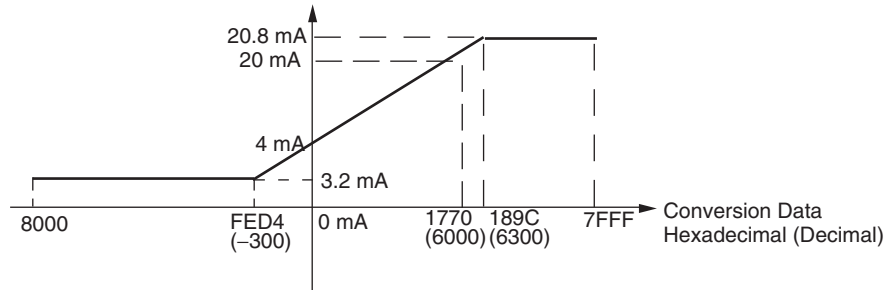
0 to 20 mA

The hexadecimal values 0000 to 1770 (0 to 6000) correspond to an analog current range of 0 to 20 mA. The entire output range is 0 to 21 mA.



4 to 20 mA

The hexadecimal values 0000 to 1770 (0 to 6000) correspond to an analog current range of 4 to 20 mA. The entire output range is 3.2 to 20.8 mA.



Averaging Function for Analog Inputs

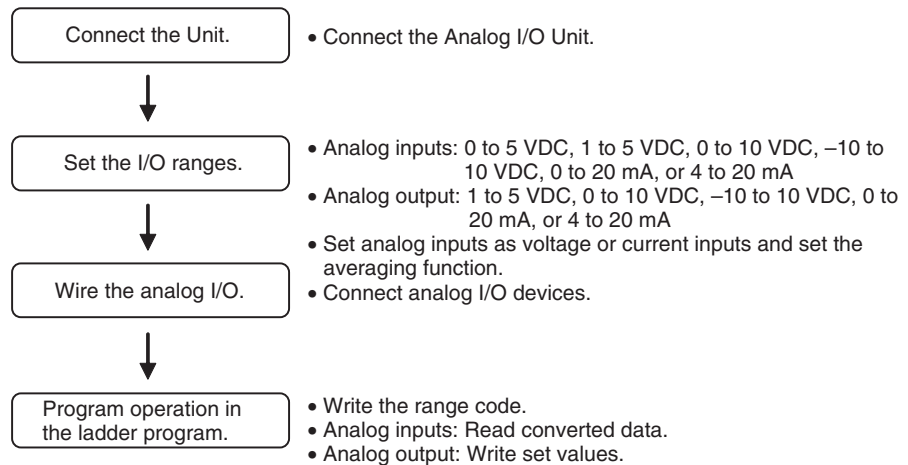
The averaging function can be enabled for inputs using the DIP switch. The averaging function stores the average (a moving average) of the last eight input values as the converted value. Use this function to smooth inputs that vary at a short interval.

Open-circuit Detection Function for Analog Inputs

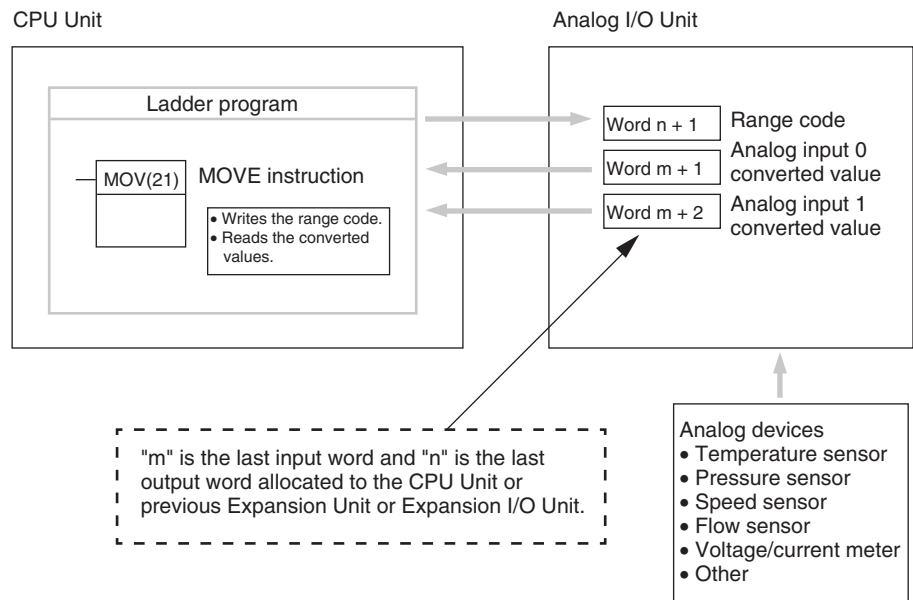
The open-circuit detection function is activated when the input range is set to 1 to 5 V and the voltage drops below 0.8 V, or when the input range is set to 4 to 20 mA and the current drops below 3.2 mA. When the open-circuit detection function is activated, the converted data will be set to 8,000.

The time for enabling or clearing the open-circuit detection function is the same as the time for converting the data. If the input returns to the convertible range, the open-circuit detection is cleared automatically and the output returns to the normal range.

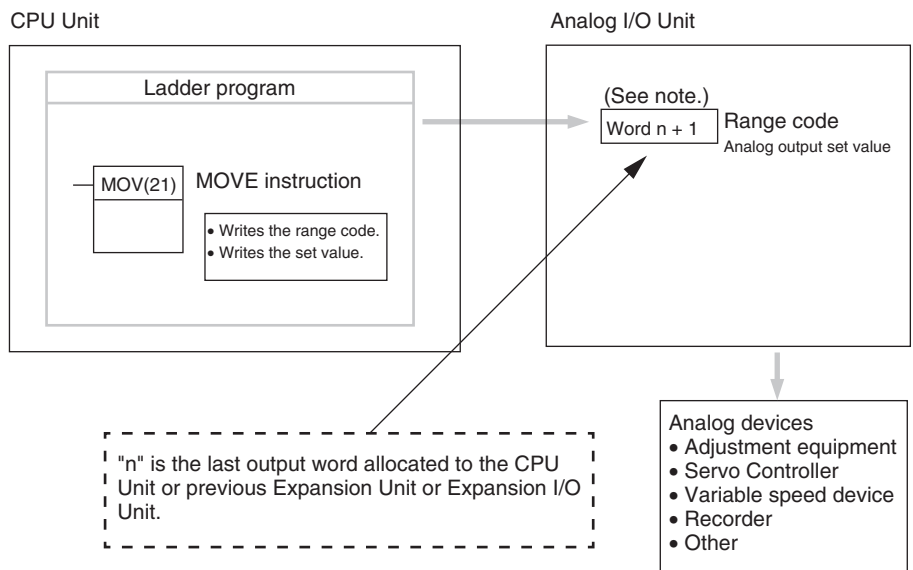
Using Analog I/O



Reading Range Code Settings and A/D Conversion Data



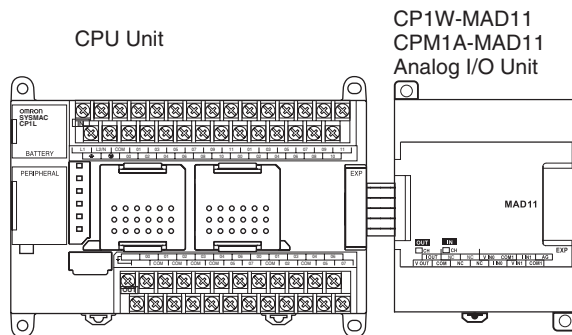
Writing D/A Conversion Data



Note Word (n + 1) can be used for either the range code or the analog output set value.

Connecting the Analog I/O Unit and Setting the DIP Switch

This section describes how to connect an Analog I/O Unit to the CPU Unit.



Setting the Averaging Function

DIP switch pins 1-1 and 1-2 are used to set the averaging function. When averaging is enabled, a moving average of the last eight input values is output as the converted value. The averaging function can be set separately for analog inputs 1 and 2.

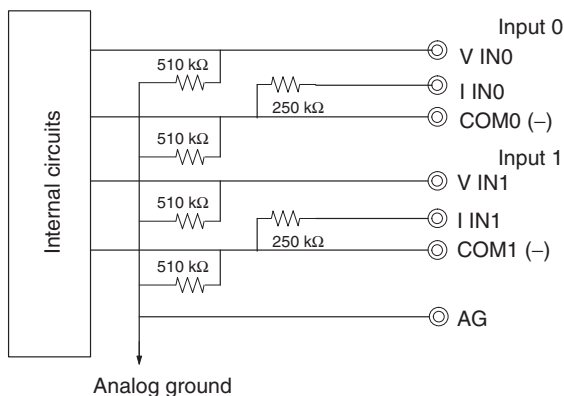


DIP switch pin	Function	Setting	Default
1-1	Averaging	Analog input 0 OFF: Disabled; ON: Enabled	OFF
1-2		Analog input 1 OFF: Disabled; ON: Enabled	OFF

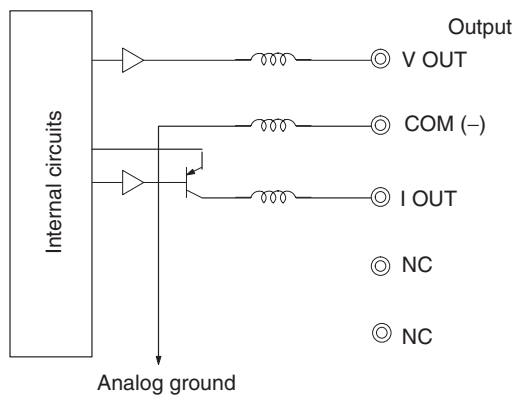
Wiring Analog I/O Devices

Internal Circuits

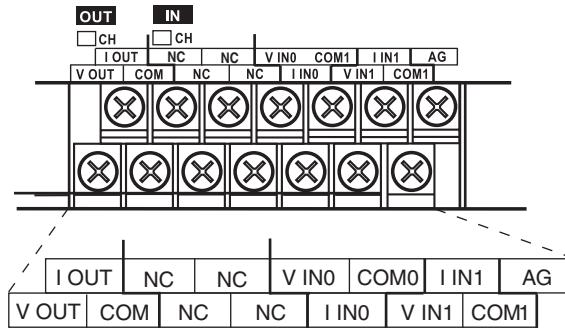
Analog Inputs



Analog Outputs



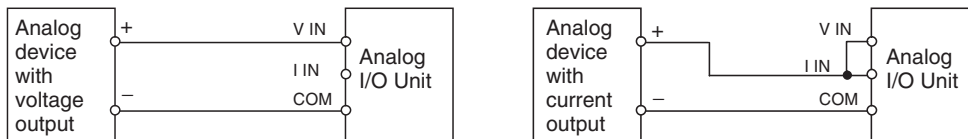
Terminal Arrangements



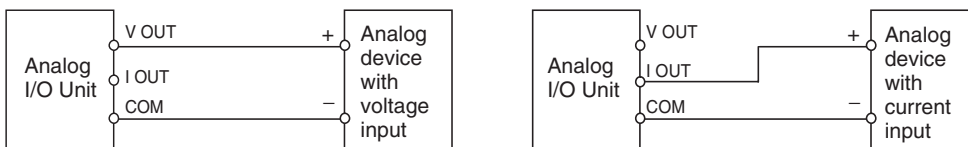
Note For current inputs, short V IN0 to I IN0 and V IN1 to I IN1.

V OUT	Voltage output
I OUT	Current output
COM	Output common
V IN0	Voltage input 0
I IN0	Current input 0
COM0	Input common 0
V IN1	Voltage input 1
I IN1	Current input 1
COM1	Input common 1

Wiring for Analog Inputs

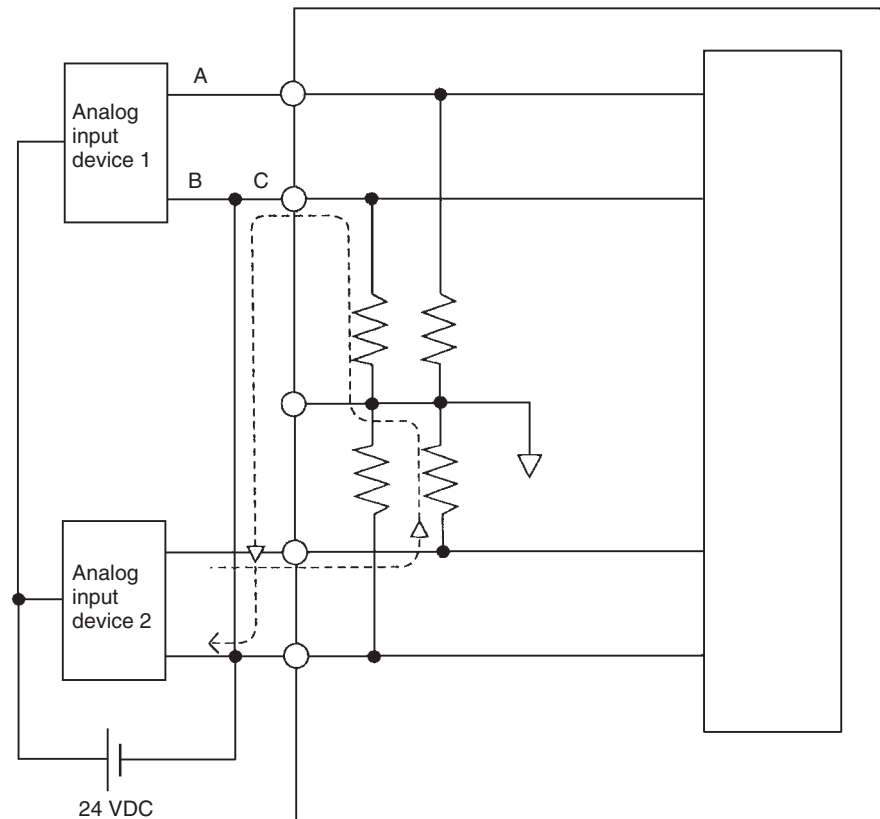


Wiring for Analog Outputs



- Note**
- (1) Use shielded twisted-pair cables, but do not connect the shield.
 - (2) When an input is not being used, short the + and – terminals.
 - (3) Separate wiring from power lines (AC power supply lines, high-voltage lines, etc.)
 - (4) When there is noise in the power supply line, install a noise filter on the input section and the power supply terminals.

- (5) Refer to the following diagram regarding wiring disconnections when voltage input is being used.



Example: If analog input device 2 is outputting 5 V and the same power supply is being used for both devices as shown above, approximately 1/3, or 1.6 V, will be applied to the input for input device 1.

If a wiring disconnection occurs when voltage input is being used, the situation described below will result. Either separate the power supplies for the connected devices, or use an isolator for each input.

If the same power supply is being used by the connected devices and a disconnection occurs at points A or B in the above diagram, an unwanted circuit path will occur as shown along the dotted line in the diagram. If that occurs, a voltage of approximately 1/3 to 1/2 of the output voltage of the other connected device will be generated. If that voltage is generated while the setting is for 1 to 5 V, open-circuit detection may not be possible. Also, if a disconnection occurs at point C in the diagram, the negative (-) side will be used in for both devices and open-circuit detection will not be possible.

This problem will not occur for current inputs even if the same power supply is used.

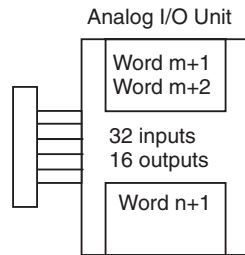
Note When external power is supplied (when setting the range code), or when there is a power interruption, pulse-form analog output of up to 1 ms may be generated. If this causes problems with operation, take countermeasures such as those suggested below.

- Turn ON the power supply for the CP1L CPU Unit first, and then turn ON the power supply for the load after confirming correct operation.
- Turn OFF the power supply for the load before turning OFF the power supply for the CP1L CPU Unit.

Creating a Ladder Program

I/O Allocation

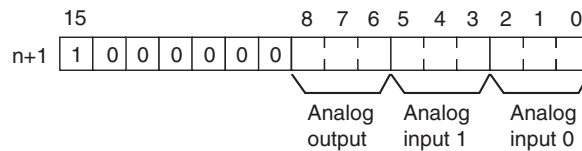
Two input words and one output word are allocated to the Analog I/O Unit starting from the next word following the last allocated word on the CPU Unit or previous Expansion Unit or Expansion I/O Unit.



Writing the Range Code

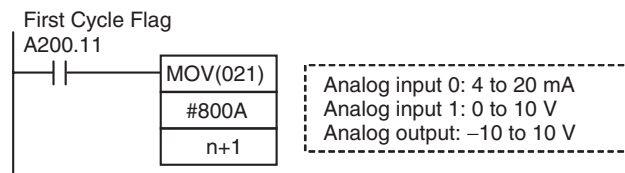
Write the range code to word n+1. A/D or D/A conversion begins when the range code is transferred from the CPU Unit to the Analog I/O Unit. There are five range codes, 000 to 100, that combine the analog input 1 and 2 and analog output signal ranges, as shown below.

Range code	Analog input 0 signal range	Analog input 1 signal range	Analog output signal range
000	-10 to 10 V	-10 to 10 V	-10 to 10 V
001	0 to 10 V	0 to 10 V	0 to 10 V
010	1 to 5 V/4 to 20 mA	1 to 5 V/4 to 20 mA	1 to 5 V
011	0 to 5 V/0 to 20 mA	0 to 5 V/0 to 20 mA	0 to 20 mA
100	---	---	4 to 20 mA



Example

The following instructions set analog input 0 to 4 to 20 mA, analog input 1 to 0 to 10 V, and the analog output to -10 to 10 V.



- The Analog I/O Unit will not start converting analog I/O values until the range code has been written. Until conversion starts, inputs will be 0000, and 0 V or 0 mA will be output.
- After the range code has been set, 0 V or 0 mA will be output for the 0 to 10-V, -10 to 10-V, or 0 to 20-mA ranges, and 1 V or 4 mA will be output for the 1 to 5-V and 4 to 20-mA ranges until a convertible value has been written to the output word.
- Once the range code has been set, it is not possible to change the setting while power is being supplied to the CPU Unit. To change the I/O range, turn the CPU Unit OFF then ON again.

Reading Converted Analog Input Values

The ladder program can be used to read the memory area words where the converted values are stored. Values are output to the next two words ($m + 1$, $m + 2$) following the last input word (m) allocated to the CPU Unit or previous Expansion Unit or Expansion I/O Unit.

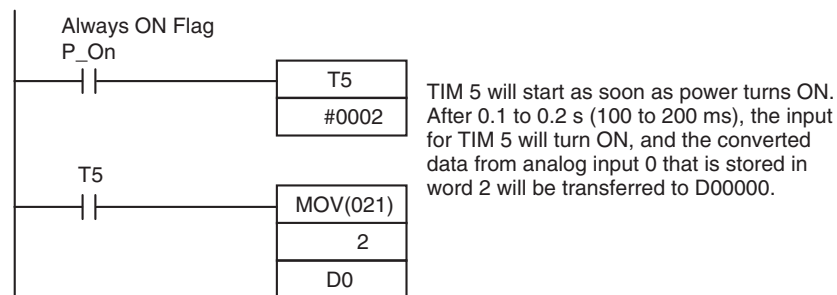
Writing Analog Output Set Values

The ladder program can be used to write data to the memory area where the set value is stored. The output word will be "n+1," where "n" is the last output word allocated to the CPU Unit or previous Expansion Unit or Expansion I/O Unit.

Startup Operation

After power is turned ON, it will require two cycle times plus approx. 50 ms before the first data is converted. The following instructions can be placed at the beginning of the program to delay reading converted data from analog inputs until conversion is actually possible.

Analog input data will be 0000 until initial processing has been completed. Analog output data will be 0 V or 0 mA until the range code has been written. After the range code has been written, the analog output data will be 0 V or 0 mA if the range is 0 to 10 V, -10 to 10 V, or 0 to 20 mA, or it will be 1 V or 4 mA if the range is 1 to 5 V or 4 to 20 mA.

**Handling Unit Errors**

- When an error occurs in the Analog I/O Unit, analog input data will be 0000 and 0 V or 0 mA will be output as the analog output. If a CPU error or an I/O bus error (fatal errors) occurs at the CPU Unit and the analog output is set to 1 to 5 V or 4 to 20 mA, 0 V or 0 mA will be output. For any other fatal errors at the CPU Unit, 1 V or 4 mA will be output.
- Expansion Unit and Expansion I/O Unit errors are output to bits 0 to 6 of word A436. The bits are allocated from A436.00 in order starting from the Unit nearest the CPU Unit. Use these flags in the program when it is necessary to detect errors.

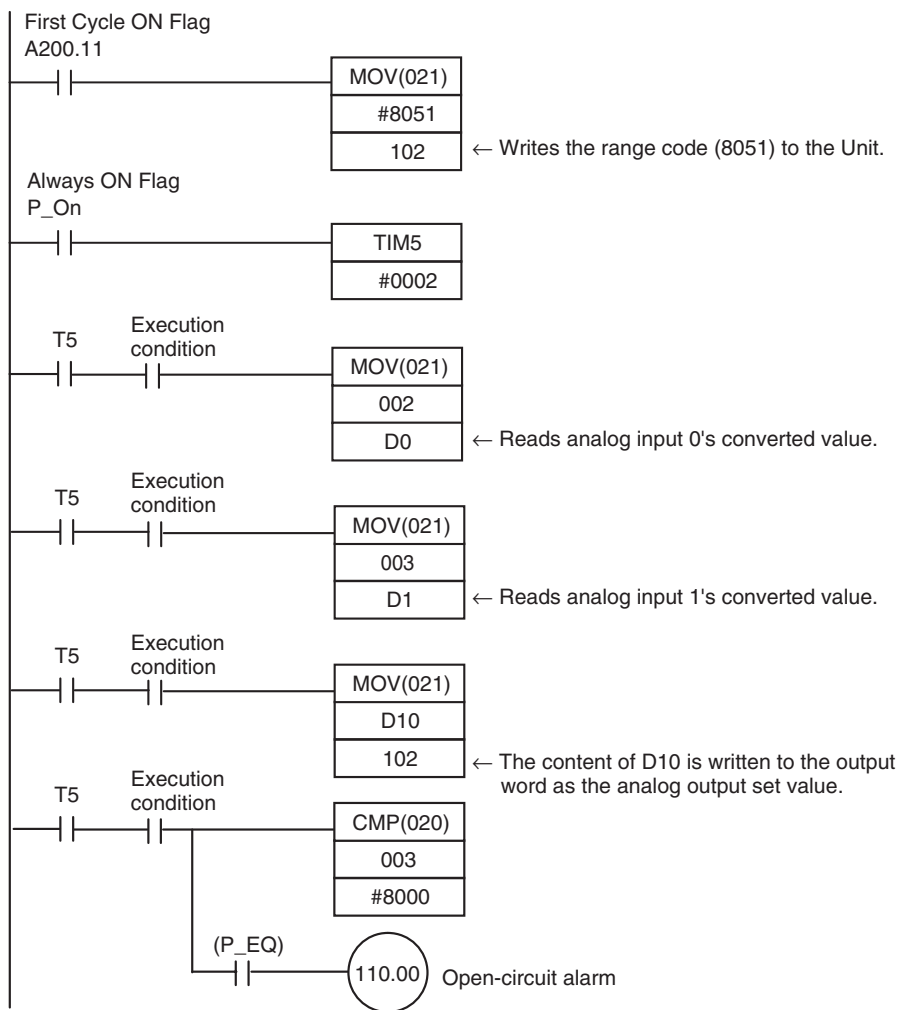
Programming Example

This programming example uses these ranges:

Analog input 0: 0 to 10 V

Analog input 1: 4 to 20 mA

Analog output: 0 to 10 V



7-5 Temperature Sensor Units

CP1W-TS002/TS102 and CPM1A-TS002/TS102 Temperature Sensor Units each provide up to four input points, and CP1W-TS001/TS001 and CPM1A-TS001/TS101 Temperature Sensor Units each provide up to two input points. The inputs can be from thermocouples or platinum resistance thermometers. CP1W-TS002/TS102 and CPM1A-TS002/TS102 Temperature Sensor Units are each allocated four input words.