

SECTION 10

Analog Input/Output Option Board

This section describes how to use Analog Input/Output Option Board.

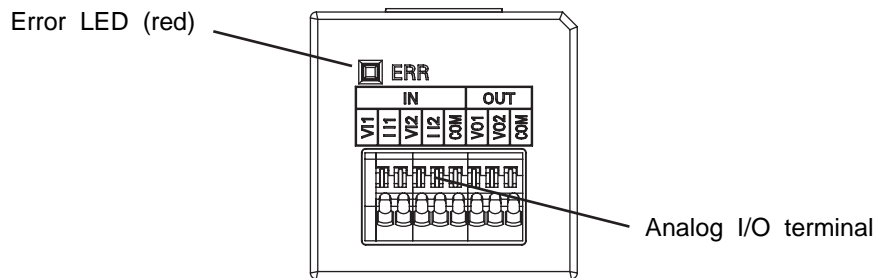
10-1	General Specifications	506
10-2	Part Names	506
10-3	Installation and Setting	507
10-3-1	Installation	507
10-3-2	Setting	507
10-3-3	Removing	507
10-4	Memory Allocation	508
10-4-1	CIO Area Allocation	508
10-4-2	Auxiliary Area Allocation	508
10-5	Analog Input Option Board	509
10-6	Analog Output Option Board	512
10-7	Analog I/O Option Board	516
10-8	Startup Operation	520
10-9	Trouble Shooting	521
10-10	The Use of Analog Option Board	521
10-10-1	Procedure	521
10-10-2	Program Example	522

10-1 General Specifications

CP1 series analog option board units are non-isolated analog units which allow you to easily realize analog input/output function for CP1L-EL/EM series PLC.

Analog Option Board		Voltage Input 0V~10V (Resolution:1/4000)	Current Input 0mA~20mA (Resolution:1/2000)	Voltage Output 0V~10V (Resolution:1/4000)
Analog I/O Option Board	CP1W-MAB221	2CH		2CH
Analog Input Option Board	CP1W-ADB21	2CH		---
Analog Output Option Board	CP1W-DAB21V	---		2CH

10-2 Part Names



Terminal Arrangement for CP1W-ADB21

VI1	II1	VI2	II2	COM
-----	-----	-----	-----	-----

Terminal Arrangement for CP1W-DAB21V

VO1	VO2	COM
-----	-----	-----

Terminal Arrangement for CP1W-MAB221

VI1	II1	VI2	II2	COM	VO1	VO2	COM
-----	-----	-----	-----	-----	-----	-----	-----

Note Two COM are connected in inner circuit.

LED pattern

LED	Color	Description	Status	Remark
ERR	Red	Fault condition indicator	Flash	A communication error with CPU unit has occurred at the unit.
			Lit	Other errors except the communication error.
			Not lit	Operation is normal.

10-3 Installation and Setting

10-3-1 Installation

The following processing explains how to install and remove an Analog Option Board.

⚠ Caution Always turn OFF the power supply to the CPU unit and wait until all the operation indicators go out before installing or removing the analog option board. Not doing so may result in an unexpected operation.

- 1,2,3...**
1. Press the up/down lock-levers on both sides of the Option Board slot cover at the same time to unlock the cover, and then pull the cover out.
 2. Check the alignment to make the corner cut of the Analog Option Board fit in the Option Board slot, and firmly press the Analog Option Board in until it snaps into place.

10-3-2 Setting

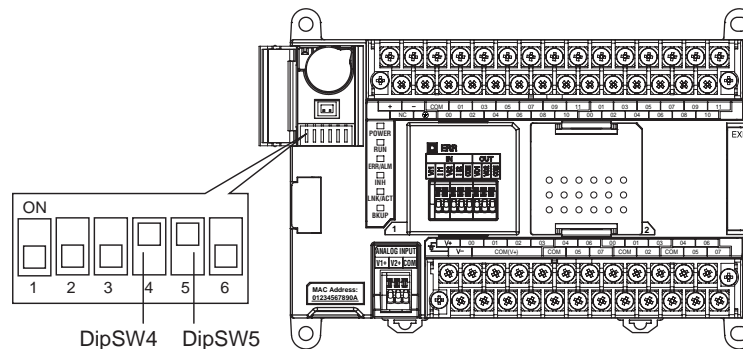
To use the analog option board on CP1L-EL/EM series PLC, firstly, it is necessary to set the serial communication settings of the CPU Unit in one of the following two ways.

Method1: Set by Dipswitch on PLC unit.

For CPU Units with 30 and 40 points, switch DipSW4 of the CPU unit to ON, if the Analog Option Board is mounted on the Option Board slot 1 (left side). Switch DipSW5 of the CPU unit to ON, if the Analog Option Board is mounted on the Option Board slot 2 (right side).

For CPU Units with 20 I/O points, switch DipSW4 of the CPU unit to ON.

Note DipSW4 and DipSW5 are OFF at shipment.



Method2: Set the option port communication parameters by PLC settings.

If DipSW4 or DipSW5 is OFF, the relative option port's communication parameters can also be set by PLC settings in CX-Programmer.

Please set the baud rate of the relative option port at 115200bps in Toolbus mode.

10-3-3 Removing

Always turn OFF the power supply to the CPU unit and wait until all the operation indicators go out.

Press the up/down lock-levers on both sides of the Analog Option Board at the same time to unlock the Option Board, and then pull it out.

10-4 Memory Allocation

10-4-1 CIO Area Allocation

The memory allocation about analog conversion in the CIO area of PLC is shown as the following diagram.

The beginning CIO channel is shown in the following table.

CP1L-EL/EM series PLC

I/O Capacity	Option Port	Beginning Channel (m)	Channel Range
20	Port 1	CIO2990	CIO2990 ~ CIO2999
30/40	Port 1 (Left)	CIO2980	CIO2980 ~ CIO2989
	Port 2 (Right)	CIO2990	CIO2990 ~ CIO2999

The details of allocated CIO channels are described in the following table.

Channel	Contents		
	CP1W-ADB21	CP1W-DAB21V	CP1W-MAB221
m	Analog Input 1	---	Analog Input 1
m+1	Analog input 2	---	Analog input 2
m+2 to m+4	---	---	---
m+5	---	Analog Output 1	Analog Output 1
m+6	---	Analog Output 2	Analog Output 2
m+7 to m+9	---	---	---

10-4-2 Auxiliary Area Allocation

Analog Option Unit Status Area

Option board status area: A435 (initial value "0000H")

I/O Capacity	AR Bits	Option Port	Content	Error Process
20	A435.15	Port 1	I/O option board run state	0: Initial state or unit abnormality state 1: work normally
30/40	A435.14	Port 1 (Left)		
	A435.15	Port 2 (Right)		

Note A435.14 or A435.15 sets on if analog option board already worked normally. Then user can read A/D input data and write D/A output data.

Output off bit: AR500.15

AR Bits	Content	Error Process
A500.15	Output Off Bit	0: output effective 1: analog option board DA output clear

Note This bit will also affect other PLC output channels. Please refer to *Appendix D Auxiliary Area Allocations by Address* for more information.

10-5 Analog Input Option Board

Each CP1W-ADB21 Analog Input Option Board provides two analog inputs.

- The analog input signal ranges are 0 to 10 V (with a resolution 1/4,000) and 0 to 20 mA (with a resolution 1/2,000).

Main Analog Input Option Board Specifications

Item	Specifications	
	Voltage Input	Current Input
Input signal range	0 V to 10 V	0 mA to 20 mA
Max. rated input	0 V to 15 V	0 mA to 30 mA
External input impedance	200 kΩ min.	Approx. 250 Ω
Resolution	1/4000 (full scale)	1/2000 (full scale)
Overall accuracy	25°C: ±0.5% (full scale) 0 to 55°C: ±1.0% (full scale)	25°C: ±0.6% (full scale) 0 to 55°C: ±1.2% (full scale)
A/D conversion data	0000 to 0FA0 hex	0000 to 07D0 hex
Averaging function	Not supported	
Conversion time	Inner sample time 2ms/point Refresh time > 6ms basing on baud rate and PLC cycle time	
Isolation method	None	
Current consumption	5 VDC: 20 mA max.	

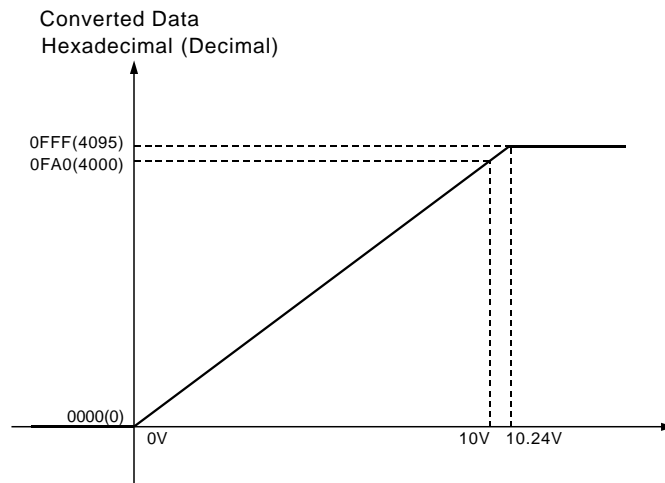
Analog Input Signal Ranges

Analog input data is digitally converted according to the input signal range as shown below.

Note When the input exceeds the specified range, the A/D conversion data will be fixed at either the lower limit or upper limit.

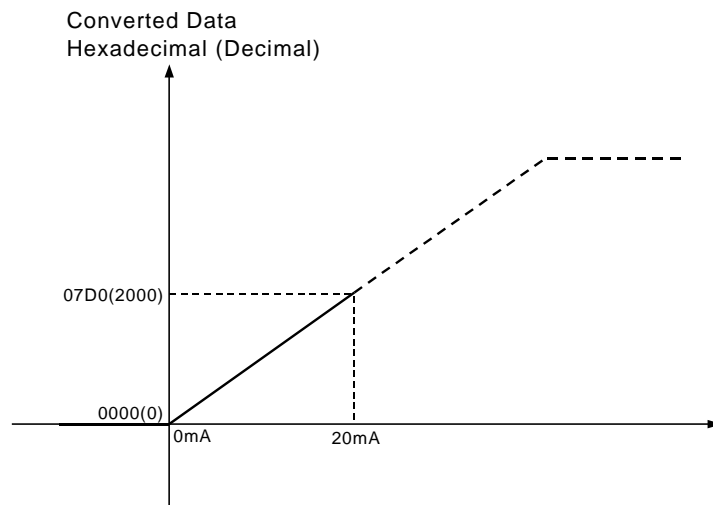
■ 0 to 10 V

The 0 to 10 V range corresponds to the hexadecimal values 0000 to 0FA0 (0 to 4000). The entire data range is 0000 to 0FFF (0 to 4095).

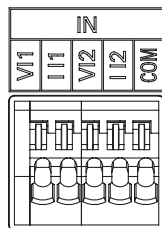


■ 0 to 20 mA

The 0 to 20 mA range corresponds to the hexadecimal values 0000 to 07D0 (0 to 2000). The possible data range is 0000 to 0FFF (0 to 4095). But it is strongly suggested that the input current must not exceed 30 mA.



Analog Input Terminal Arrangement

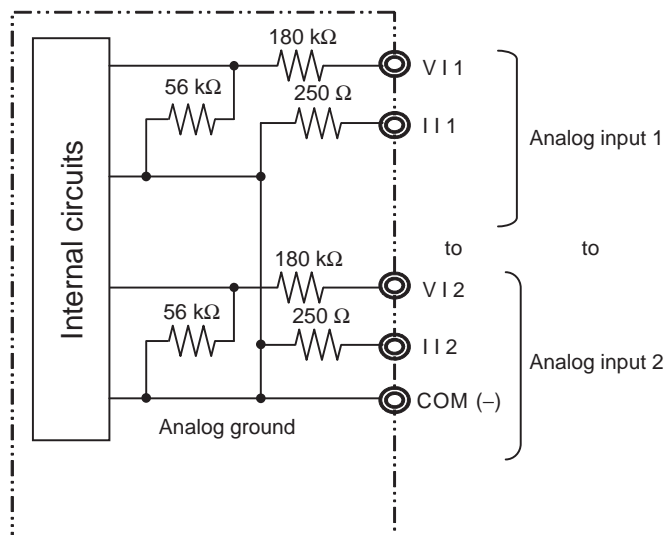


VI1	Voltage Input 1
II1	Current Input 1
VI2	Voltage Input 2
II2	Current Input 2
COM	Input Common

Note When using current inputs, voltage input terminals must be short-circuited with current input terminals.

Wiring

Internal Circuits



Applicable Cables and Terminal Wiring

■ **Applicable Cables**

Solid wire or ferrules can be used.

- Recommended solid wire

Wire type	Wire size
Solid Wire	0.2mm ² to 0.5mm ² (AWG24 to AWG20)

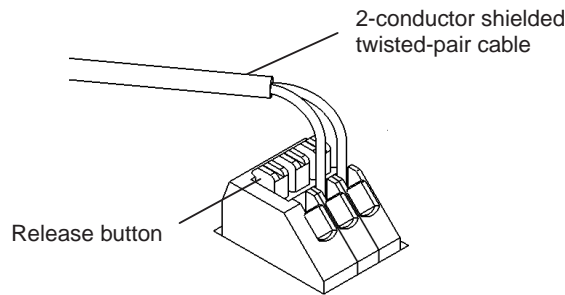
- Recommended ferrules

Manufacturer	Model	Applicable wire
Phoenix Contact	AI-0.5-10	0.5mm ² (AWG20)

Note Do not connect bare stranded wires directly to terminals.

■ **Terminal Wiring**

When wiring the analog I/O terminal block, treat either solid or stranded wires directly.

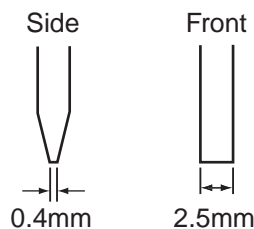


- To make the connection, press the release button in with a small flat blade screwdriver and push the line in while the lock is released. Remove the screwdriver and lock it inside.
- To disconnect the wiring, press the release button in with a small flat blade screwdriver and pull the line out while the lock is released.

- Note**
- (1) Ferrules with/without plastic sleeve cannot be used.
 - (2) When using stranded wire, twist the core so that the barbed wires cannot protrude.
 - (3) Do not solder-plate the end of cable.

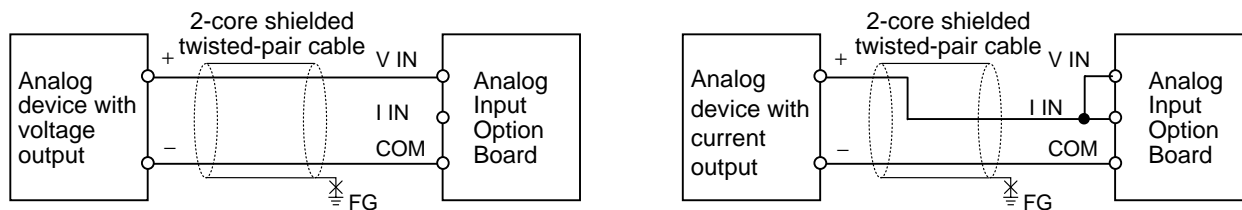
The screwdriver shown below is recommended for wiring.

Model	Manufacturer
SZS 0.4×2.5	Phoenix Contact



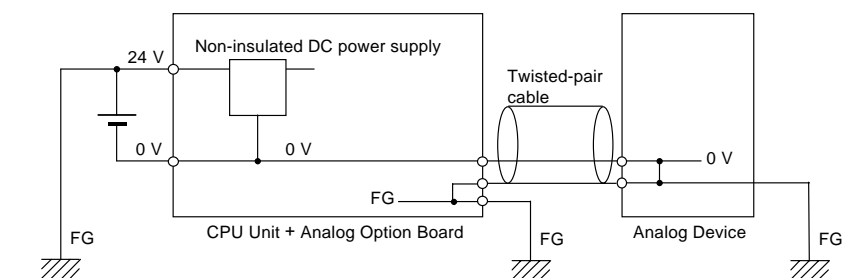
Wiring for Analog Inputs

To prevent noise, 2-core shielded twisted-pair cable should be used. And the shield can be connected to the FG terminal if necessary.



- Note**
- (1) If necessary, connect the shield to the FG terminal to prevent noise.
 - (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.

⚠ Caution When connecting the analog option board to an outside analog device, either ground the 0 V side of the PLC's external power supply or do not ground the PLC's external power supply at all. Otherwise the PLC's external power supply may be shorted depending on the connection methods of the outside analog device. **DO NOT** ground the 24 V side of the PLC's external power supply, as shown in the following diagram.



10-6 Analog Output Option Board

Each CP1W-DAB21V Analog Output Option Board provides two analog outputs.

- The analog output signal range is 0 to 10 V (with a resolution 1/4,000).

Main Analog Output Option Board Specifications

Item	Specifications	
	Voltage Output	Current Output
Output signal range	0 V to 10 V	---
External output allowable load resistance	2 kΩ min.	---
External output impedance	0.5 Ω max.	---
Resolution	1/4,000 (full scale)	---
Overall accuracy	25°C: ±0.5% 0 to 55°C: ±1.0%	---
D/A conversion data	0000 to 0FA0 hex	---
Conversion time	Inner conversion time 2ms/point Refresh time > 6ms basing on baud rate and PLC cycle time	
Isolation method	None	
Current consumption	5 VDC: 60 mA max.	

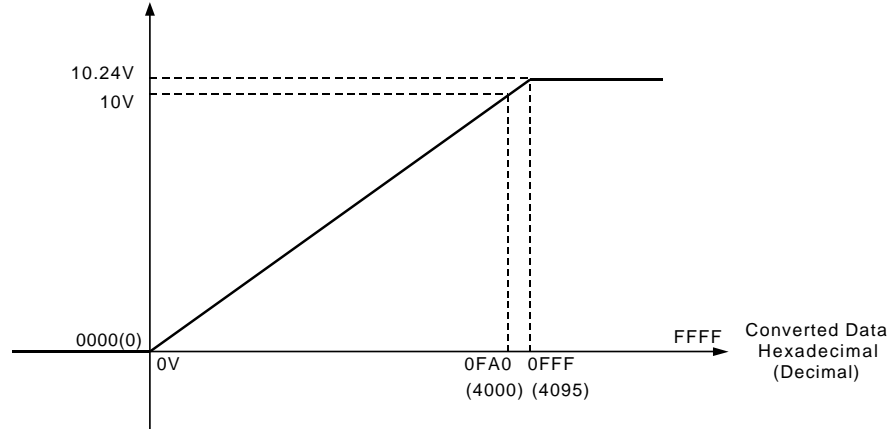
Analog Output Signal Ranges

The analog values depend on the output signal range, as shown in the following diagram.

Note When the output exceeds the specified range, the output signal will be fixed at either the lower limit or upper limit.

■ **0 to 10 V**

The hexadecimal values 0000 to 0FA0 (0 to 4000) correspond to an analog voltage range of 0 to 10 V. The entire output range is 10 to 10.24 V.



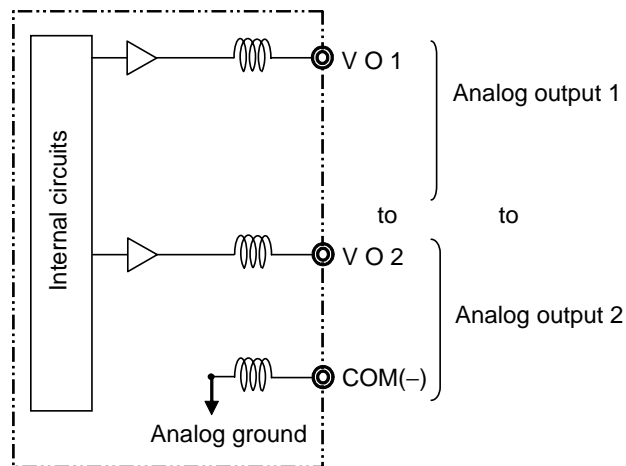
Analog Output Terminal Arrangement



VO1	Voltage Output 1
VO2	Voltage Output 2
COM	Output Common

Wiring

Internal Circuits



Applicable Cables and Terminal Wiring

■ **Applicable Cables**

Solid wire or ferrules can be used.

- Recommended solid wire

Wire type	Wire size
Solid Wire	0.2mm ² to 0.5mm ² (AWG24 to AWG20)

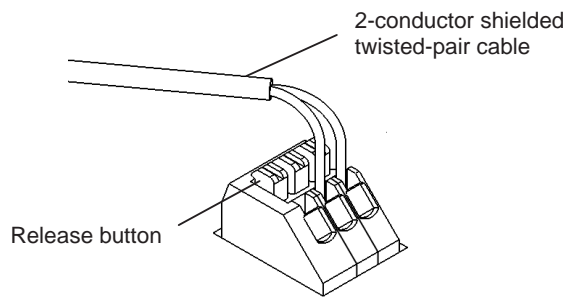
- Recommended ferrules

Manufacturer	Model	Applicable wire
Phoenix Contact	AI-0.5-10	0.5mm ² (AWG20)

Note Do not connect bare stranded wires directly to terminals.

■ **Terminal Wiring**

When wiring the analog I/O terminal block, treat either solid or stranded wires directly.

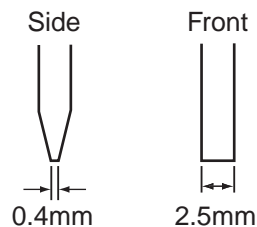


- To make the connection, press the release button in with a small flat blade screwdriver and push the line in while the lock is released. Remove the screwdriver and lock it inside.
- To disconnect the wiring, press the release button in with a small flat blade screwdriver and pull the line out while the lock is released.

- Note**
- (1) Ferrules with/without plastic sleeve cannot be used.
 - (2) When using stranded wire, twist the core so that the barbed wires cannot protrude.
 - (3) Do not solder-plate the end of cable.

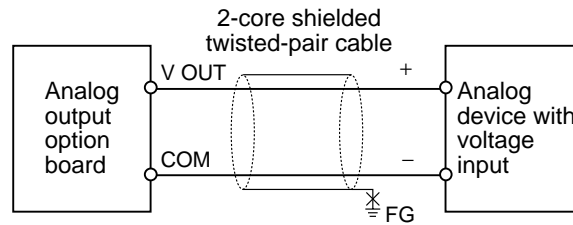
The screwdriver shown below is recommended for wiring.

Model	Manufacturer
SZS 0.4×2.5	Phoenix Contact



Wiring for Analog Outputs

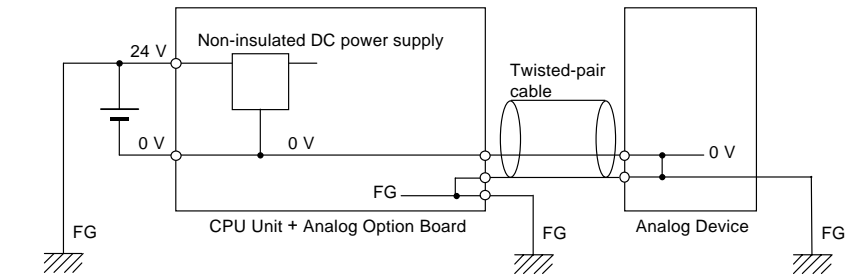
To prevent noise, 2-core shielded twisted-pair cable should be used. And the shield can be connected to the FG terminal if necessary.



Note

- (1) If necessary, connect the shield to the FG terminal to prevent noise.
- (2) Separate wiring from power lines (AC power supply lines, high-voltage lines, etc.)
- (3) When there is noise in the power supply line, install a noise filter on the input section and the power supply.
- (4) When external power is supplied, or when the power is interrupted, there may be a pulse status analog output of up to 1 ms. If this status is a problem, take the following measures.
 - Turn ON the power to the CP1L-EL/EM CPU Unit, check the operation status, and then turn ON the power at the load.
 - Turn OFF the power to the load and then turn OFF the power to the CP1L-EL/EM CPU Unit.

Caution When connecting the analog option board to an outside analog device, either ground the 0 V side of the PLC's external power supply or do not ground the PLC's external power supply at all. Otherwise the PLC's external power supply may be shorted depending on the connection methods of the outside analog device. DO NOT ground the 24 V side of the PLC's external power supply, as shown in the following diagram.



10-7 Analog I/O Option Board

Each CP1W-MAB221 Analog I/O Option Board provides two analog inputs and two analog outputs.

- The analog input signal ranges are 0 to 10 V (with a resolution 1/4,000) and 0 to 20 mA (with a resolution 1/2,000).
- The analog output signal ranges are 0 to 10 V (with a resolution 1/4,000).

Main Analog I/O Option Board Specifications

Item	Specifications		
	Voltage I/O	Current I/O	
Analog Input Section	Input signal range	0 V to 10 V	0 mA to 20 mA
	Max. rated input	0 V to 15 V	0 mA to 30 mA
	External input impedance	200 k Ω min.	Approx. 250 Ω
	Resolution	1/4,000 (full scale)	1/2,000 (full scale)
	Overall accuracy	25°C: $\pm 0.5\%$ (full scale) 0 to 55°C: $\pm 1.0\%$ (full scale)	25°C: $\pm 0.6\%$ (full scale) 0 to 55°C: $\pm 1.2\%$ (full scale)
	A/D conversion data	0000 to 0FA0 hex	0000 to 07D0 hex
	Averaging function	Not supported	
Analog Output Section	Output signal range	0 V to 10 V	---
	External output allowable load resistance	2 k Ω min.	---
	External output impedance	0.5 Ω max.	---
	Resolution	1/4,000 (full scale)	---
	Overall accuracy	25°C: $\pm 0.5\%$ 0 to 55°C: $\pm 1.0\%$	---
	D/A conversion data	0000 to 0FA0 hex	---
Conversion time	Inner conversion time 6ms (4CH total) Refresh time > 6ms basing on baud rate and PLC cycle time		
Isolation method	None		
Current consumption	5 VDC: 80 mA max.		

Analog I/O Signal Ranges

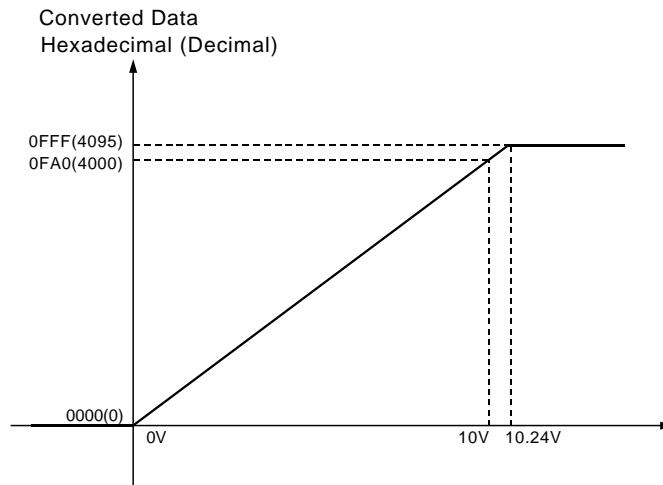
The analog values depend on the I/O signal ranges, as shown in the following diagrams.

- Note** When the input exceeds the specified range, the A/D conversion data will be fixed at either the lower limit or upper limit.
When the output exceeds the specified range, the output signal will be fixed at either the lower limit or upper limit.

Analog Input Signal Ranges

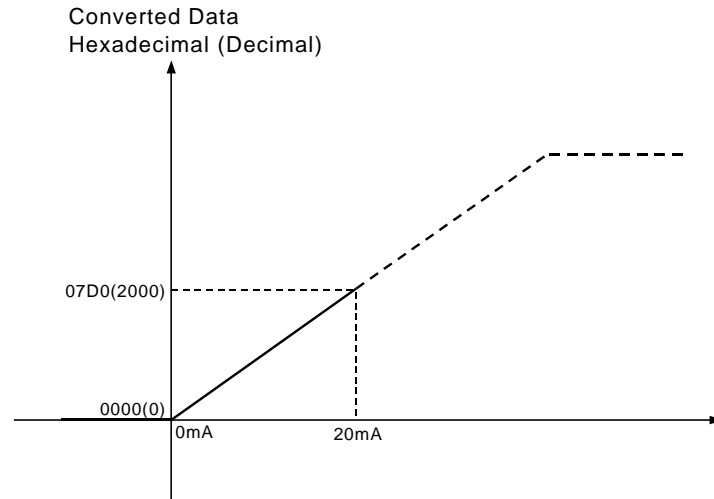
■ 0 to 10 V

The 0 to 10 V range corresponds to the hexadecimal values 0000 to 0FA0 (0 to 4000). The entire data range is 0000 to 0FFF (0 to 4095).



■ **0 to 20 mA**

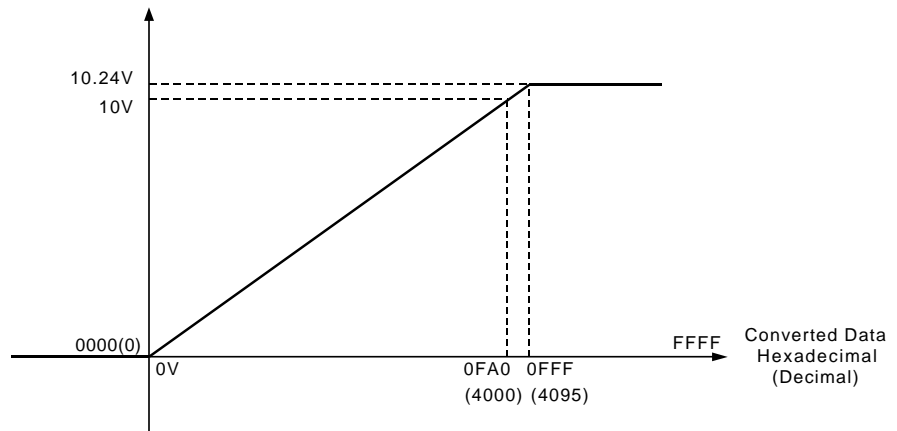
The 0 to 20 mA range corresponds to the hexadecimal values 0000 to 07D0 (0 to 2000). The possible data range is 0000 to 0FFF (0 to 4095). But it is strongly suggested that the input current mustn't exceed 30 mA.



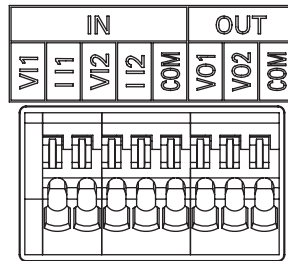
Analog Input Signal Ranges

■ **0 to 10 V**

The hexadecimal values 0000 to 0FA0 (0 to 4000) correspond to an analog voltage range of 0 to 10 V. The entire output range is 10 to 10.24 V.



Analog I/O Terminal Arrangement



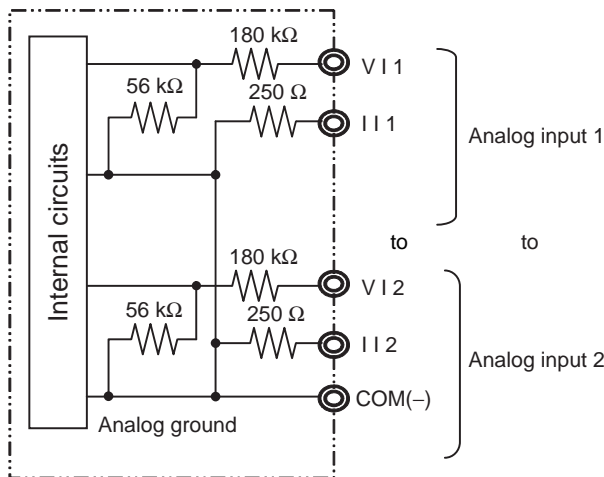
VI1	Voltage Input 1
II1	Current Input 1
VI2	Voltage Input 2
II2	Current Input 2
COM	Analog I/O Common
VO1	Voltage Output 1
VO2	Voltage Output 2
COM	Analog I/O Common

Note When using current inputs, voltage input terminals must be short-circuited with current input terminals.

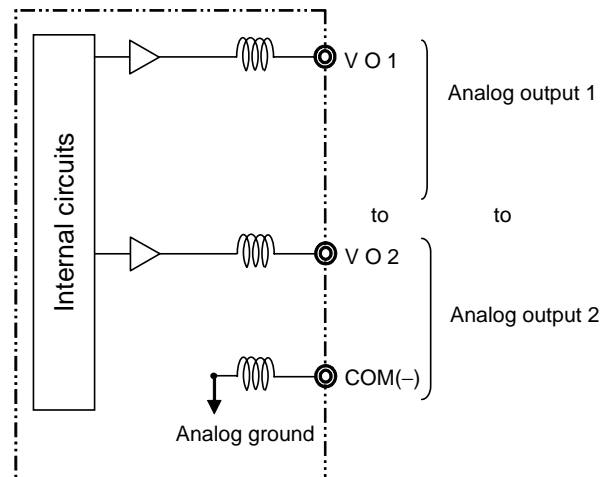
Wiring

Internal Circuits

Analog input



Analog output



Applicable Cables and Terminal Wiring

■ **Applicable Cables**

Solid wire or ferrules can be used.

- Recommended solid wire

Wire type	Wire size
Solid Wire	0.2mm ² to 0.5mm ² (AWG24 to AWG20)

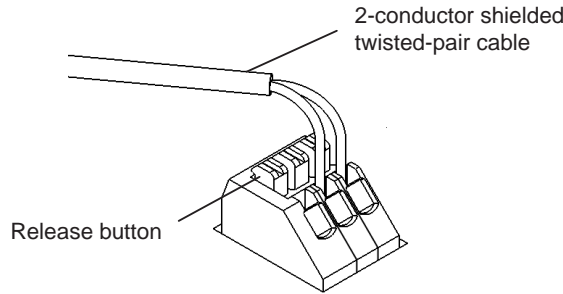
- Recommended ferrules

Manufacturer	Model	Applicable wire
Phoenix Contact	AI-0.5-10	0.5mm ² (AWG20)

Note Do not connect bare stranded wires directly to terminals.

■ **Terminal Wiring**

When wiring the analog I/O terminal block, treat either solid or stranded wires directly.



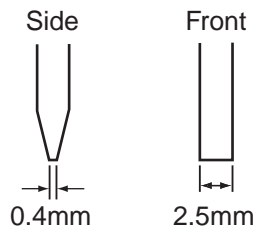
- To make the connection, press the release button in with a small flat blade screwdriver and push the line in while the lock is released. Remove the screwdriver and lock it inside.
- To disconnect the wiring, press the release button in with a small flat blade screwdriver and pull the line out while the lock is released.

Note

- (1) Ferrules with/without plastic sleeve cannot be used.
- (2) When using stranded wire, twist the core so that the barbed wires cannot protrude.
- (3) Do not solder-plate the end of cable.

The screwdriver shown below is recommended for wiring.

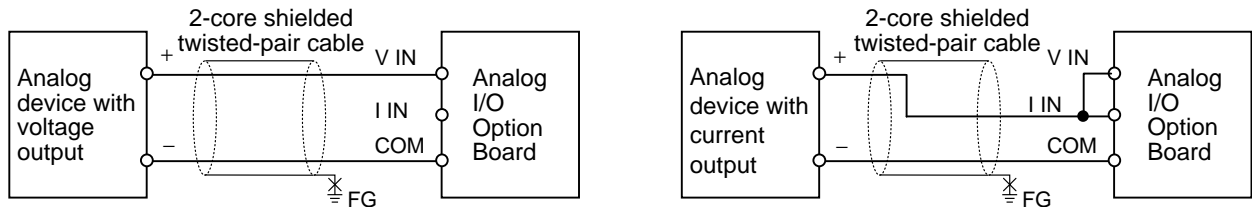
Model	Manufacturer
SZS 0.4×2.5	Phoenix Contact



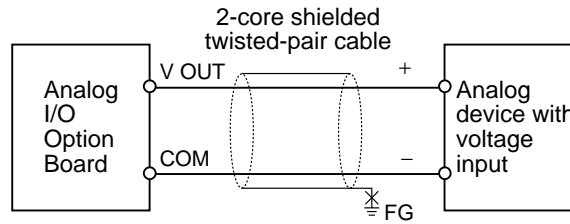
Wiring for Analog I/O

To prevent noise, 2-core shielded twisted-pair cable should be used. And the shield can be connected to the FG terminal if necessary.

Wiring for Analog Inputs

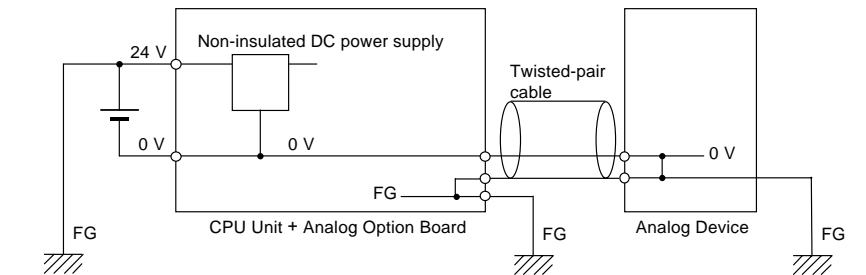


Wiring for Analog Outputs

**Note**

- (1) If necessary, connect the shield to the FG terminal to prevent noise.
- (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.
- (5) When external power is supplied, or when the power is interrupted, there may be a pulse status analog output of up to 1 ms. If this status is a problem, take the following measures.
 - Turn ON the power to the CP1L-EL/EM CPU Unit, check the operation status, and then turn ON the power at the load.
 - Turn OFF the power to the load and then turn OFF the power to the CP1L-EL/EM CPU Unit.

⚠ Caution When connecting the analog option board to an outside analog device, either ground the 0 V side of the PLC's external power supply or do not ground the PLC's external power supply at all. Otherwise the PLC's external power supply may be shorted depending on the connection methods of the outside analog device. **DO NOT** ground the 24 V side of the PLC's external power supply, as shown in the following diagram.



10-8 Startup Operation

After the power is turned ON, analog option board starts the initialization process. If the initialization finishes normally, the initialization completed flag in related status area (Refer to *10-4-2 Auxiliary Area Allocation: A435*) will be set. Therefore, status monitor content must be added in ladder. Only when the initialization process has finished, user can use the A/D conversion data or write the output data.

The analog input data will be 0000 until the initial processing is completed.

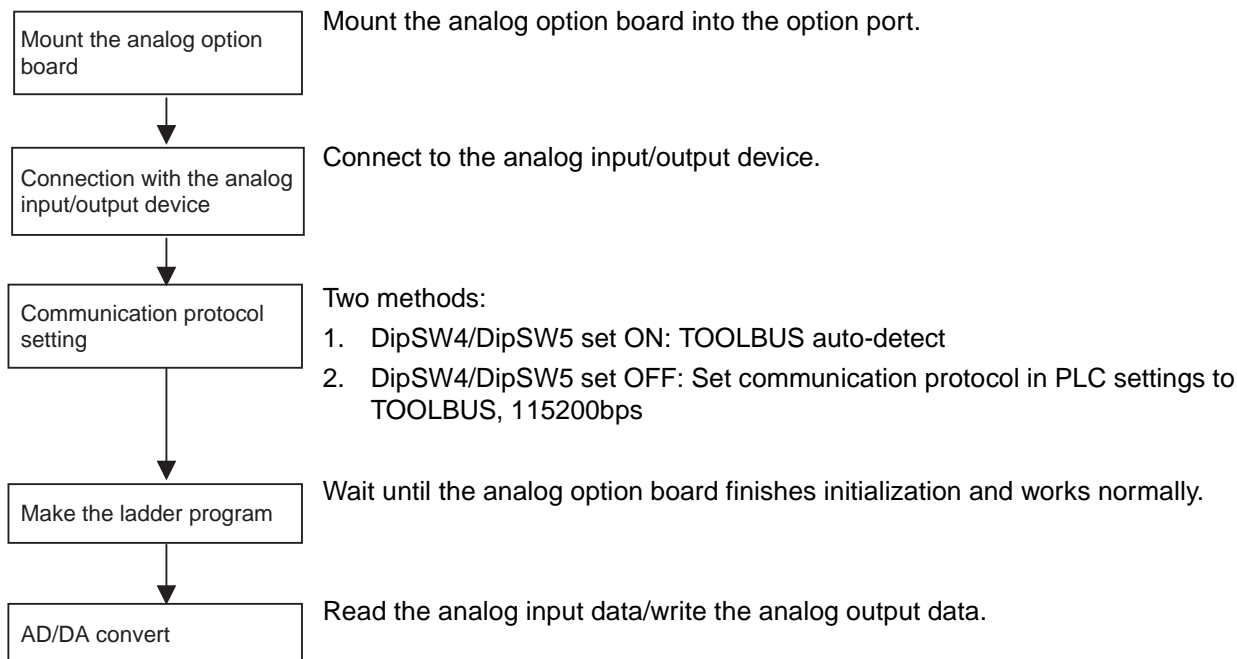
10-9 Trouble Shooting

Trouble-shooting with Indicators

ERR Indicator	Error	Probably Cause	Correction	Auxiliary Area Allocations	AD/DA function
Lit	CPU Unit service monitoring error	Service from the CPU Unit was not completed within the fixed interval.	Check and correct the CPU Unit's operating environment. Check serial communication setting.	A435.14 or A435.15 will be OFF	AD/DA conversion will stop. The analog input conversion data stops refreshing and the analog output conversion output becomes 0V.
	Option board error	An error occurred in the Analog Option Board.	Restart the CPU Unit. Replace the Analog Option Board if the error recurs.		
Flashing	Communication error	The communication between PLC is out of service	Check if PLC is running normally.	A435.14 or A435.15 will be OFF	AD/DA conversion will stop. The analog input conversion data stops refreshing and the analog output conversion output becomes 0V. If the communication recovers from error, the AD/DA conversion will start again.

10-10 The Use of Analog Option Board

10-10-1 Procedure



- Note**
- (1) If PLC communication protocol setting is error, the option board will always try to link the PLC, and the error LED will flash.
 - (2) Only when the initialization process has finished (AR435.14/15 sets on), user can use the A/D conversion data or write the D/A output data.

10-10-2 Program Example

Use the analog option board to carry out 2CH AD inputs and 1CH DA output at the same time.

The ranges of AD/DA are as follows:

- Analog input1: 0~10V
- Analog input2: 0~20mA
- Analog output1: 0~10V

System composing: CP1L-EM (option port 1) + CP1W-MAB221

