

HCA8-4AD User' s manual

Manual No.	15100007A
Version No.	V1.0
Date	October, 2015

1. Outline

This section outlines HCA8-4AD/HCA8C-4AD. For common descriptions of the HCA8-4AD/HCA8C-4AD, these model names are referred to as the 4AD.

1.1 Outline of function

HCA8-4AD is an analog special function block which is connectable with HCA8 / HCA8C series PLC used to capture 4-ch voltage / current data. HCA8C-4AD cannot be connected to HCA8 series PLC.

- Up to 8 units can be connected to the HCA8/HCA8C series PLC. (including the other special function blocks).
- Either "voltage input" or "current input" can be specified for each channel.
- The A/D conversion values will be stored in the 4AD buffer memory (BFM).
- Set the digital filter to read out stable A/D conversion values.

2. Specifications

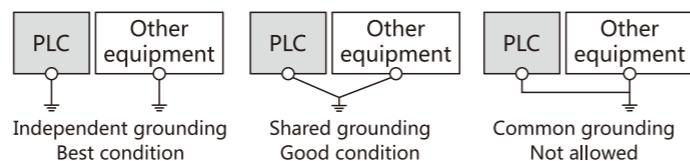
This chapter describes the general, power supply, and performance specifications for the 4AD.

2.1 Generic specifications

Items	Specification				
Ambient temperature	0 to 55°C (32 to 131°F) when operating -25 to 75°C(-13 to 167°F) when stored				
Relative humidity	5 to 95%RH (no condensation) when operating				
Vibration resistance*4		Frequency (Hz)	Acceleration (m/s ²)	Half amplitude (mm)	Sweep Count for X, Y, Z: 10 times (80 min in each direction)
	DIN Rail Mounting	10 to 57 57 to 150	— 4.9	0.035 —	
	Direct Mounting*1	10 to 57 57 to 150	— 9.8	0.075 —	
Shock resistance*4	147 m/s ² Acceleration, Action time: 11 ms, 3 times by half-sine pulse in each direction X, Y, and Z				
Noise resistance	Using noise simulator of: Noise voltage: 1,000 Vp-p / Noise width: 1 μs / Rise: 1 ns / Cycle: 30 to 100 Hz				
Dielectric withstand voltage	500V AC, for 1 min	Between all terminals and ground terminal			
Insulation resistance	5MΩ or more using 500V DC insulation resistance meter				
Grounding	Class D grounding (grounding resistance: 100Ω or less) <Common grounding with a heavy electrical system is not allowed.>*2				
Working atmosphere	Free from corrosive or flammable gas and excessive conductive dust.				
Working altitude	<2000m*3				

*1 The direct mounting method cannot be used with HCA8-4AD.

*2



*3 If the pressure is higher than the atmospheric pressure, do not use the 4AD; 4AD may malfunction.
*4 The criterion is shown in IEC61131-2.

2.2 Power specifications

Item	Specifications
A/D conversion circuit drive power	24V DC ±10%, 100mA (It is necessary to supply 24V DC from the terminal block.)
CPU drive power	5V DC, 100mA (Since the internal power is supplied from the main unit, it is not necessary to supply power externally.)

2.3 Performance specifications

Item	Specifications	
	Voltage input	Current input
Analog input range	-10V to +10V DC (Input resistance: 250 kΩ)	-20mA to +20mA DC, 4mA to 20mA DC (Input resistance: 250 Ω)
Absolute maximum input	±15V	±30mA
Digital output	With sign, 16bits, binary	With sign, 15bits, binary
Resolution	0.32mV (20V × 1/ 64,000) 2.5mV (20V × 1/8000)	1.25μA (40mA × 1/32,000) 5.00μA (40mA × 1/8000)
Overall accuracy	<ul style="list-style-type: none"> Ambient temperature: 25°C ±5°C 0.3% (±60mV) for 20V full scale Ambient temperature: 0°C ~ 55°C 0.5% (±100mV) for 20V full scale 	<ul style="list-style-type: none"> Ambient temperature: 25°C ±5°C ±0.5% (±200μA) for 40mA full scale Same accuracy (±200μA) for 4mA to 20mA input Ambient temperature: 0°C ~ 55°C ±1% (±400μA) for 40mA full scale Same accuracy (±400μA) for 4mA to 20mA input
A/D conversion time	500μs × number of selected channels	
Insulation method	<ul style="list-style-type: none"> The photocoupler is used to insulate the analog input area from the PLC. The DC/DC converter is used to insulate the analog input area from the power supply unit. Channels are not insulated from each other. 	
Number of I/O points occupied	8 points (Taken from either the input or output points of the PLC.)	

2.4 Input mode (characteristics) BFM #0

For the 4AD, there are two types of input characteristics: voltage (-10 to +10V) and current (4 to 20mA, -20 to +20mA) input characteristics. The input characteristics depend on the set input mode as described below. For each input range, there are 3 input modes.

1. Voltage input characteristics [-10 to +10V] (Input mode: 0 to 2)

Set input mode: 0	Set input mode: 1	Set input mode: 2
Input type: Voltage input Analog input range: -10 to +10V Digital output range: -32000 to +32000	Input type: Voltage input Analog input range: -10 to +10V Digital output range: -4000 to +4000	Input type: Voltage input (analog value direct indication) Analog input range: -10 to +10V Digital output range: -10000 to +10000

2. Current input characteristics [4 to 20mA] (Input mode: 3 to 5)

Set input mode: 3	Set input mode: 4	Set input mode: 5
Input type: Current input Analog input range: 4 to 20 mA Digital output range: 0 to 16000	Input type: Current input Analog input range: 4 to 20 mA Digital output range: 0 to 4000	Input type: Current input (analog value direct indication) Analog input range: 4 to 20 mA Digital output range: 4000 to 20000

3. Current input characteristics [-20 to +20mA] (Input mode: 6 to 8)

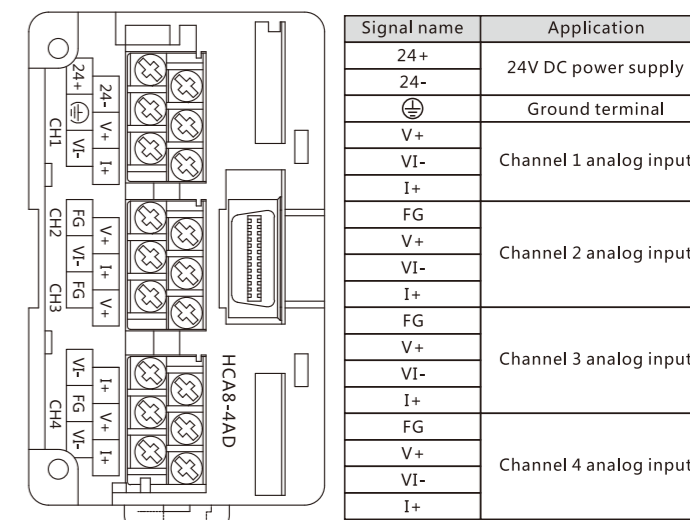
Set input mode: 6	Set input mode: 7	Set input mode: 8
Input type: Current input Analog input range: -20 to +20 mA Digital output range: -16000 to +16000	Input type: Current input Analog input range: -20 to +20 mA Digital output range: -4000 to +4000	Input type: Current input (analog value direct indication) Analog input range: -20 to +20 mA Digital output range: -20000 to +20000

3. Wiring

3.1 Wiring precautions

- Make sure to cut off all phases of the power supply externally before attempting wiring work.
- Failure to do so may cause electric shock or damage to the product.
- Connect the DC power supply wiring to the dedicated terminals described in this manual.
- If an AC power supply is connected to a DC input/output terminal or DC power supply terminal, the PLC will burn out.
- Do not wire vacant terminals externally.
- Doing so may damage the product.
- Perform class D grounding (grounding resistance: 100Ω or less) to the grounding terminal on the main unit.
- Do not use common grounding with heavy electrical systems.
- When drilling screw holes or wiring, make sure cutting or wire debris does not enter the ventilation slits.
- Failure to do so may cause fire, equipment failures or malfunctions.
- Make sure to observe the following precautions in order to prevent malfunctions under the influence of noise:
 - Do not bundle the power line or shield of the analog input/output cable together with or lay it close to the main circuit, high-voltage line, or load line. Otherwise, noise disturbance and/or surge induction are likely to take place. As a guideline, lay the control line at least 100mm (3.94") or more away from the main circuit, high-voltage line, or load line.
 - Ground the shield of the analog input/output cable at one point on the signal receiving side.
- However, do not use common grounding with heavy electrical systems.
- Make sure to properly wire to the terminal block (European type) in accordance with the following precautions.
- Failure to do so may cause electric shock, equipment failures, a short-circuit, wire breakage, malfunctions, or damage to the product.
- The disposal size of the cable end should be 9mm.

- Tightening torque should be within 0.22 ~ 0.25N·m.
 - Twist the end of strand wire and make sure that there are no loose wires.
 - Do not solder-plate the electric wire ends.
 - Do not connect more than the specified number of wires or electric wires of unspecified size.
 - Affix the electric wires so that neither the terminal block nor the connected parts are directly stressed.
 - Make sure to properly wire the terminal block in accordance with the following precautions.
- Failure to do so may cause electric shock, equipment failures, a short-circuit, wire breakage, malfunctions, or damage to the product.
- The disposal size of the cable end should follow the dimensions described in the manual.
 - Tightening torque should be within 0.5 ~ 0.8N·m.

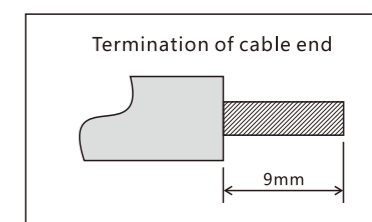


3.2 Cable (HCA8-4AD)

1. Cable Applicable cable and tightening torque

	Wire size (stranded/ single-wire)	Tightening torque	Termination
Single wire	0.3 mm ² to 0.5 mm ² (AWG22 to 20)	0.22 to 0.25 N·m	<ul style="list-style-type: none"> To connect a stranded cable, peel the cover off the cable and then twist the core before connection. To connect a single-wire cable, peel the cover off the cable before connection.
Double wire	0.3 mm ² (AWG22)		
Rod terminal with insulation sleeve	0.3 mm ² to 0.5 mm ² (AWG22 to 20) (Refer to the external view of rod terminal shown in the following figure.)		<ul style="list-style-type: none"> Rod terminal with insulation sleeve (recommended terminal) AI 0.5-8WH : Manufactured by Phoenix Contact Caulking tool CRIMPFOX ZA 3: Manufactured by Phoenix Contact (or CRIMPFOX UD 6: Manufactured by Phoenix Contact)

- #### 2. Termination of cable end
- To terminate the cable, treat the stranded/single-wire directly or use the rod terminal with insulation sleeve.
- To directly terminate end of stranded/single-wire cable:
 - Terminate the end of the stranded cable so that the "barbed wires" cannot protrude.
 - Do not solder-plate the end of the cable.

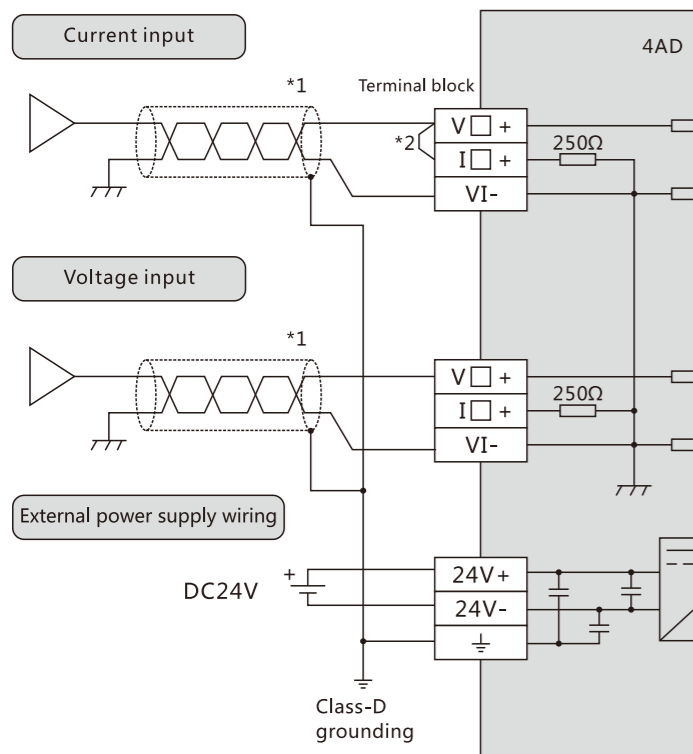


3.3 Power supply wiring

The power (24V DC) of 4AD is supplied from the terminal block [24+]、[24-].
• Ground the "⊕" terminal and "⊖" terminal to the Class - D grounding line (100 or less) together with the ground terminal of the main unit.

3.4 Analog input line

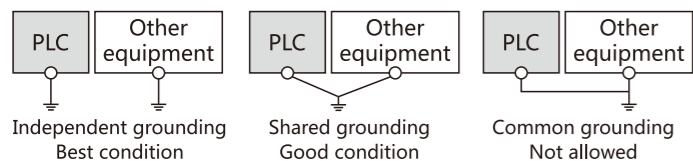
The analog input type, "voltage input "or "current input", can be selected for each channel.



□ in V□+, I□+, ch□ represents channel number.
*1 Use a 2-core twisted shield wire for analog input line, and separate it from other power lines or inductive lines.
*2 For the current input, short-circuit the [V□+] terminal and the [I□+] terminal.

3.5 Grounding

Grounding should be performed as stated below.
• Please perform class-D grounding. (Grounding resistance: 100 Ω or less)
• Independent grounding should be performed for best results.
When independent grounding is not performed, perform "shared grounding" as shown in the following figure.



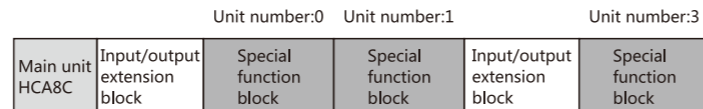
• Please use the grounding wire of AWG22~20(0.3~0.5mm²)
• The PLC grounding point should be close, and all grounding wires should be as short as possible.

4. Reading out analog data

This chapter describes the minimum programming necessary to readout the 4AD analog data.
Follow the procedure below to confirm that the analog data can be properly read out.

4.1 Procedures of reading out analog data

1 Unit number check
Unit numbers from 0 to 7 will be assigned to the special function units/blocks starting from the left. Check the unit number assigned to the 4AD.



2 Input mode (BFM#0) setting
Depending on the analog signal generator to be connected, set the input mode (BFM#0) for each channel.
Use hexadecimal numbers for input mode setting. Set the corresponding channel digit to the input mode setting value specified in the following table:

H O O O O
CH4 CH3 CH1 CH2

Setting value	Input mode	Analog input range	Digital output range
0	Voltage input mode	-10V ~ +10V	-32000 ~ +32000
1	Voltage input mode	-10V ~ +10V	-4000 ~ +4000
2	Voltage input Analog value direct indication mode	-10V ~ +10V	-10000 ~ +10000
3	Current input mode	4mA ~ 20mA	0 ~ 16000
4	Current input mode	4mA ~ 20mA	0 ~ 4000
5	Current input mode Analog value direct indication mode	4mA ~ 20mA	4000 ~ 20000
6	Current input mode	-20mA ~ +20mA	-16000 ~ +16000
7	Current input mode	-20mA ~ +20mA	-4000 ~ +4000
8	Current input mode Analog value direct indication mode	-20mA ~ +20mA	-20000 ~ +20000
F	Channel not used		

5. Buffer memory (BFM)

This chapter describes the buffer memory incorporated in 4AD.

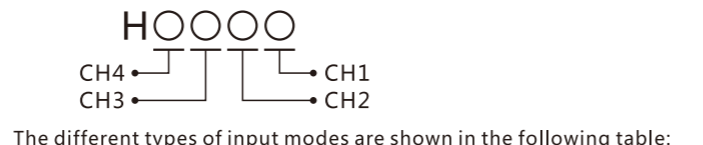
5.1 Buffer memory list (BFM)

4AD incorporates the following buffer memories.

BFM number	Description	Setting range	Initial value	Data type
#0	Input mode setting for channels 1 to 4	*1	H0000	Hexadecimal
#1	Not used	—	—	—
#2	Averaging time units for channel 1	1 ~ 4095	K1	Decimal
#3	Averaging time units for channel 2	1 ~ 4095	K1	Decimal
#4	Averaging time units for channel 3	1 ~ 4095	K1	Decimal
#5	Averaging time units for channel 4	1 ~ 4095	K1	Decimal
#6~#9	Not used	—	—	—
#10	Channel-1 data (current data or average data)	-	—	Decimal
#11	Channel-2 data (current data or average data)	-	—	Decimal
#12	Channel-3 data (current data or average data)	-	—	Decimal
#13	Channel-4 data (current data or average data)	-	—	Decimal
#14~#28	Not used	—	—	—
#29	Error status	—	H0000	Hexadecimal
#30	Model code K2011	—	K2011	Decimal
Others	Not used	—	—	Decimal

5.2 Buffer memory details

5.2.1 BFM#0: Input mode specification
Specify the input modes of channel 1 to 4.
4 hexadecimal digits are assigned to specify the input modes of the 4 channels. Change the value of each digit to change the input mode of each channel. 0 to 8 or F can be set for each digit.



Set value	Input mode	Analog input range	Digital output range
0	Voltage input mode	-10V ~ +10V	-32000 ~ +32000
1	Voltage input mode	-10V ~ +10V	-4000 ~ +4000
2	Voltage input Analog value direct indication mode	-10V ~ +10V	-10000 ~ +10000
3	Current input mode	4mA ~ 20mA	0 ~ 16000
4	Current input mode	4mA ~ 20mA	0 ~ 4000
5	Current input Analog value direct indication mode	4mA ~ 20mA	4000 ~ 20000
6	Current input mode	-20mA ~ +20mA	-16000 ~ +16000
7	Current input mode	-20mA ~ +20mA	-4000 ~ +4000
8	Current input Analog value direct indication mode	-20mA ~ +20mA	-20000 ~ +20000
F	Channel not used		

5.2.2 BFM#2 to #5: Averaging time

To change the channel data type from the immediate data (channels 1 to 4: BFM#10 to #13) to the average data, set the desired averaging time (channels 1 to 4: BFM#2 to 5).
The relation between the set averaging time and the corresponding operation is shown in the following table.

Averaging time (BFM#2 to #5)	Channel data (BFM#10 to #13) type	Error descriptions
0 or less	Immediate data (Each time the A/D conversion is performed, the channel data will be updated.)	K0 will be set, and the averaging time setting error (BFM #29 b1) will occur.
1 (initial value)	Immediate data (Each time the A/D conversion is performed, the channel data will be updated.)	—
2 ~ 400	Average data (Each time the A/D conversion is performed, the average value will be calculated and the channel data will be updated.)	—
401 ~ 4095	Average data (Each time the A/D conversion data reaches the averaging time, the average data will be calculated and the channel data will be updated.)	—
4096 or more	Average data (Each time the A/D conversion data reaches the averaging time, the average data will be calculated and the channel data will be updated.)	4096 will be set, and the averaging time setting error (BFM #29 b1) will occur.

1 Application

If the measurement signal contains comparatively reduced ripple noise, such as supply voltage frequency, averaging will result in obtaining of stable data.
• If the averaging time is out of the setting range, the averaging time setting error (b10 of BFM#29) will occur.

5.2.3 BFM#10 to #13: Channel data

Use these buffer memories to store the A/D converted digital values. The channel data (BFM#10 to #13 for channels 1 to 4) and the data update timing will depend on the set averaging time (BFM#2 to #5 for channels 1 to 4) as shown in the following table.

Averaging time (BFM#2 to #5)	Channel data (BFM#10 to #13) update timing	
	Channel data type	Update timing
0 or less	Immediate data "0" will be set, and the averaging time setting error (b10 of BFM#29) will occur.	Each time the A/D conversion is performed, the data will be updated. The update timing will be as follows: Update time = 500μs*1 ×Number of selected channels
1	Immediate data	Each time the A/D conversion is performed, the data will be updated. The update timing will be as follows: Update time = 500μs*1 ×Number of selected channels
2 ~ 400	Average data	
401 ~ 4095	Average data	
4096 or more	Average data "4096" will be set, and the averaging time setting error (b10 of BFM#29) will occur.	

5.2.4 BFM#29: Error status

Error data is assigned to the bits of BFM#29.

Bit No.	Item	Description
b0	Error detection	If any bits between b2 and b5 are turned on, b0 will turn on.
b1	Averaging time setting error	The averaging time (BFM#2 to #5) is not set correctly. Set the averaging time again in the range from 1 to 4095.
b2	Power supply error	The 24 V power is not supplied properly. Check the wiring condition or the voltage supplied.
b3	Hardware error	HCA8-4AD/HCA8C-4AD may be defective.
b4	A/D conversion error	The A/D conversion value is abnormal.
b5	EEPROM error	EEPROM data error
b6 ~ b15	—	—

If the error cause is eliminated, the error bit will turn off.
Do not directly write "H0000" in BFM#29 using a sequence program.

5.2.5 BFM#30: Model code

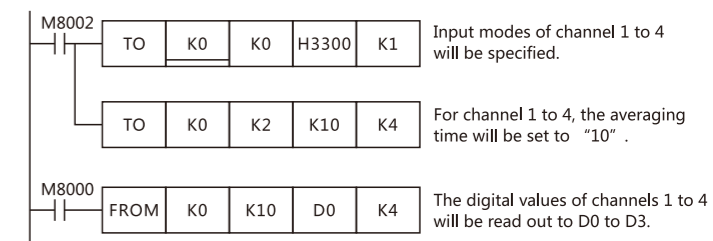
"K2011" (fixed value) is stored as the model code.

6 Examples of Practical Programs

1. Conditions
The sequence program described in this section is created under the following conditions.

- System configuration
The HCA8-4AD (unit No.0) should be connected to the HCA8 Series PLC
- Input mode
Channels 1 and 2 should be set to mode 0 (voltage input, -10V to +10V → -32000 to +32000).
Channels 3 and 4 should be set to mode 3 (current input, 4mA to 20mA → 0 to 16000).
- Averaging time
For channels 1 to 4, the averaging time should be set to "10".
- Device assignment
D0: A/D converted digital value for channel 1
D1: A/D converted digital value for channel 2
D2: A/D converted digital value for channel 3
D3: A/D converted digital value for channel 4

Example of sequence program
For HCA8, HCA8C series PLCs



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- This product has been manufactured under strict quality control. However when installing the product where major accidents or losses could occur if the product fails, install appropriate backup or failsafe functions in the system.