FC9Y-B902

IDEC

FC4A SERIES
Analog I/O Module

User's Manual

MicroSmart

IDEC CORPORATION

SAFETY PRECAUTIONS

- Read this user's manual to make sure of correct operation before starting installation, wiring, operation, maintenance, and inspection of the FC4A series MicroSmart analog I/O modules.

- All MicroSmart modules are manufactured under IDEC's rigorous quality control system, but users must add a backup or failsafe provision to the control system using the MicroSmart in applications where heavy damage or personal injury may be caused in case the MicroSmart should fail.

- In this user's manual, safety precautions are categorized in order of importance to Warning and Caution:

⚠ **Warning** — **Warning notices are used to emphasize that improper operation may cause severe personal injury or death.**

- Turn off the power to the MicroSmart before starting installation, removal, wiring, maintenance, and inspection of the MicroSmart. Failure to turn power off may cause electrical shocks or fire hazard.

- Special expertise is required to install, wire, program, and operate the MicroSmart. People without such expertise must not use the MicroSmart.

- Emergency stop and interlocking circuits must be configured outside the MicroSmart. If such a circuit is configured inside the MicroSmart, failure of the MicroSmart may cause disorder of the control system, damage, or accidents.

- Install the MicroSmart according to the instructions described in this user's manual. Improper installation will result in falling, failure, or malfunction of the MicroSmart.

⚠ **Caution** — **Caution notices are used where inattention might cause personal injury or damage to equipment.**

- The MicroSmart is designed for installation in a cabinet. Do not install the MicroSmart outside a cabinet.

- Install the MicroSmart in environments described in this user's manual. If the MicroSmart is used in places where the MicroSmart is subjected to high-temperature, high-humidity, condensation, corrosive gases, excessive vibrations, and excessive shocks, then electrical shocks, fire hazard, or malfunction will result.

- The environment for using the MicroSmart is "Pollution degree 2." Use the MicroSmart in environments of pollution degree 2 (according to IEC 60664-1).

- Prevent the MicroSmart from falling while moving or transporting the MicroSmart, otherwise damage or malfunction of the MicroSmart will result.

- Prevent metal fragments and pieces of wire from dropping inside the MicroSmart housing. Put a cover on the MicroSmart modules during installation and wiring. Ingress of such fragments and chips may cause fire hazard, damage, or malfunction.

- Use a power supply of the rated value. Use of a wrong power supply may cause fire hazard.

- Use an IEC 60127-approved fuse on the power line outside the MicroSmart. This is required when equipment containing the MicroSmart is destined for Europe.

- Use an IEC 60127-approved fuse on the output circuit. This is required when equipment containing the MicroSmart is destined for Europe.

- Use an EU-approved circuit breaker. This is required when equipment containing the MicroSmart is destined for Europe.

- Make sure of safety before starting and stopping the MicroSmart or when operating the MicroSmart to force outputs on or off. Incorrect operation on the MicroSmart may cause machine damage or accidents.

- If relays or transistors in the MicroSmart output modules should fail, outputs may remain on or off. For output signals which may cause heavy accidents, provide a monitor circuit outside the MicroSmart.

- Do not connect the ground wire directly to the MicroSmart. Connect a protective ground to the cabinet containing the MicroSmart using an M4 or larger screw. This is required when equipment containing the MicroSmart is destined for Europe.

- Do not disassemble, repair, or modify the MicroSmart modules.

- When disposing of the MicroSmart, do so as an industrial waste.

About This Manual

This user's manual primarily describes entire functions, installation, programming, and troubleshooting procedures of the FC4A series MicroSmart analog I/O modules.

CHAPTER 1:   GENERAL INFORMATION

General information about the analog I/O modules, applicable CPU module system program version, and WindLDR version.

CHAPTER 2:   MODULE SPECIFICATIONS

Specifications of the analog I/O modules.

CHAPTER 3:   INSTALLATION AND WIRING

Methods and precautions for installing and wiring the analog I/O modules.

CHAPTER 4:   ANALOG I/O CONTROL

General information about programming and setting up various communication systems for the analog I/O modules.

CHAPTER 5:   TROUBLESHOOTING

Procedures to determine the cause of trouble and actions to be taken when any trouble occurs while operating the analog I/O modules.

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Alphabetical listing of key words.

MicroSmart Modules

Category		Modules
CPU modules	All-in-one type	FC4A-C10R2, FC4A-C16R2, FC4A-C24R2 FC4A-C10R2C, FC4A-C16R2C, FC4A-C24R2C
	Slim type	FC4A-D20K3, FC4A-D20S3 FC4A-D20RK1, FC4A-D20RS1 FC4A-D40K3, FC4A-D40S3
Expansion modules	Expansion I/O modules	Input modules, output modules, mixed I/O modules
	Function modules	Analog I/O modules, AS-Interface master module
Option modules		HMI module, RS232C communication adapter, RS485 communication adapter, memory cartridge, clock cartridge
Communication modules		HMI base module, RS232C communication module, RS485 communication module

IMPORTANT INFORMATION

Under no circumstances shall IDEC Corporation be held liable or responsible for indirect or consequential damages resulting from the use of or the application of IDEC PLC components, individually or in combination with other equipment.

All persons using these components must be willing to accept responsibility for choosing the correct component to suit their application and for choosing an application appropriate for the component, individually or in combination with other equipment.

All diagrams and examples in this manual are for illustrative purposes only. In no way does including these diagrams and examples in this manual constitute a guarantee as to their suitability for any specific application. To test and approve all programs, prior to installation, is the responsibility of the end user.

TABLE OF CONTENTS

1: GENERAL INFORMATION

Introduction

This chapter describes general information and specifications of the FC4A series MicroSmart analog I/O modules.

About the Analog I/O Modules

Analog I/O modules are available in 3-I/O types, 2-, 4-, and 8-input types, and 1- and 2-output types. The input channel can accept voltage and current signals, thermocouple and resistance thermometer signals, or thermistor signals. The output channel generates voltage and current signals.

Analog I/O Module Type Numbers

Name	I/O Signal	I/O Points	Category	Type No.
Analog I/O Module	Voltage (0 to 10V DC) Current (4 to 20mA)	2 inputs	END Refresh Type	FC4A-L03A1
	Voltage (0 to 10V DC) Current (4 to 20mA)	1 output		
	Thermocouple (K, J, T) Resistance thermometer (Pt100)	2 inputs		FC4A-L03AP1
	Voltage (0 to 10V DC) Current (4 to 20mA)	1 output		
Analog Input Module	Voltage (0 to 10V DC) Current (4 to 20mA)	2 inputs	Ladder Refresh Type	FC4A-J2A1
	Voltage (0 to 10V DC) Current (4 to 20mA) Thermocouple (K, J, T) Resistance thermometer (Pt100, Pt1000, Ni100, Ni1000)	4 inputs		FC4A-J4CN1
	Voltage (0 to 10V DC) Current (4 to 20mA)	8 inputs		FC4A-J8C1
	Thermistor (NTC, PTC)	8 inputs		FC4A-J8AT1
Analog Output Module	Voltage (0 to 10V DC) Current (4 to 20mA)	1 output	END Refresh Type	FC4A-K1A1
	Voltage (–10 to +10V DC) Current (4 to 20mA)	2 outputs	Ladder Refresh Type	FC4A-K2C1

END Refresh Type and Ladder Refresh Type

Depending on the internal circuit design for data refreshing, analog I/O modules are categorized into two types.

Analog I/O Module Category		END Refresh Type	Ladder Refresh Type
While CPU is running	Parameter Refreshing	At the end processing in the first scan	When executing ANST macro
	Analog I/O Data Refreshing	At the end processing	In the step after ANST macro (always refreshed whether input to ANST is on or off)
While CPU is stopped	Analog Output Data Refreshing	When M8025 (maintain outputs while CPU stopped) is on, output data is refreshed. When off, output is turned off.	Maintains output status when the CPU is stopped. Output data can be changed using STPA instruction while the CPU is stopped. See page 4-21.
Data Register Allocation		By default	Optionally designated in ANST macro

END Refresh Type

Each END refresh type analog I/O module is allocated 20 data registers to store analog I/O data and parameters for controlling analog I/O operation. These data registers are updated at every end processing while the CPU module is running. WindLDR has ANST macro to program the analog I/O modules.

The CPU module checks the analog I/O configuration only once at the end processing in the first scan. If you have changed the parameter while the CPU is running, stop and restart the CPU to enable the new parameter.

Ladder Refresh Type

Each ladder refresh type analog I/O module can be allocated any data registers to store analog I/O data and parameters for controlling analog I/O operation. The data registers are programmed in the ANST macro. Analog I/O data are updated at the ladder step following the ANST macro. Analog I/O parameters are updated when the ANST macro is executed, so analog I/O parameters can be changed while the CPU is running.

Applicable CPU Modules and WindLDR Version

END refresh type analog I/O modules as many as listed below can be used with any FC4A and FC5A MicroSmart CPU modules and WindLDR versions.

Ladder refresh type analog I/O modules can be used with the FC4A and FC5A MicroSmart CPU module system program versions and WindLDR versions as listed below.

All-in-one 10- and 16-I/O type CPU modules cannot use either END refresh or ladder refresh type analog I/O modules.

FC4A MicroSmart CPU Module	All-in-One Type			Slim Type	
	FC4A-C10R2 FC4A-C10R2C	FC4A-C16R2 FC4A-C16R2C	FC4A-C24R2 FC4A-C24R2C	FC4A-D20K3 FC4A-D20S3	FC4A-D20RK1 FC4A-D20RS1 FC4A-D40K3 FC4A-D40S3
CPU System Program Version	—	—	204 or higher	204 or higher	203 or higher
WindLDR Version	—	—	5.0 or higher		
Quantity of Analog I/O Modules	—	—	4	7	7

FC5A MicroSmart CPU Module	All-in-One Type			Slim Type	
	FC5A-C10R2 FC5A-C10R2C	FC5A-C16R2 FC5A-C16R2C	FC5A-C24R2 FC5A-C24R2C (Note)	FC5A-D16RK1 FC5A-D16RS1	FC5A-D32K3 FC5A-D32S3
CPU System Program Version	—	—	100 or higher	100 or higher	100 or higher
WindLDR Version	—	—	5.0 or higher		
Quantity of Analog I/O Modules	—	—	4	7	7

Note: FC5A all-in-one 24-I/O type CPU modules cannot use analog I/O modules in combination with the AS-Interface master module (FC4A-AS62M) and/or expansion RS232C communication module (FC5A-SIF2). When using these modules in combination with analog I/O modules, use the slim type CPU module.

Confirming System Program Version

The system program version can be confirmed using WindLDR.

1. Connect a PC to communication port 1 or 2 on the MicroSmart CPU module using the computer link cable 4C (FC2A-KC4C).

2. From the WindLDR menu bar, select **Online** > **Monitor**. The monitor mode is enabled.

3. From the WindLDR menu bar, select **Online** > **PLC Status**. The PLC Status dialog box appears and shows the system program version.


System Program Version (Special data register D8029)
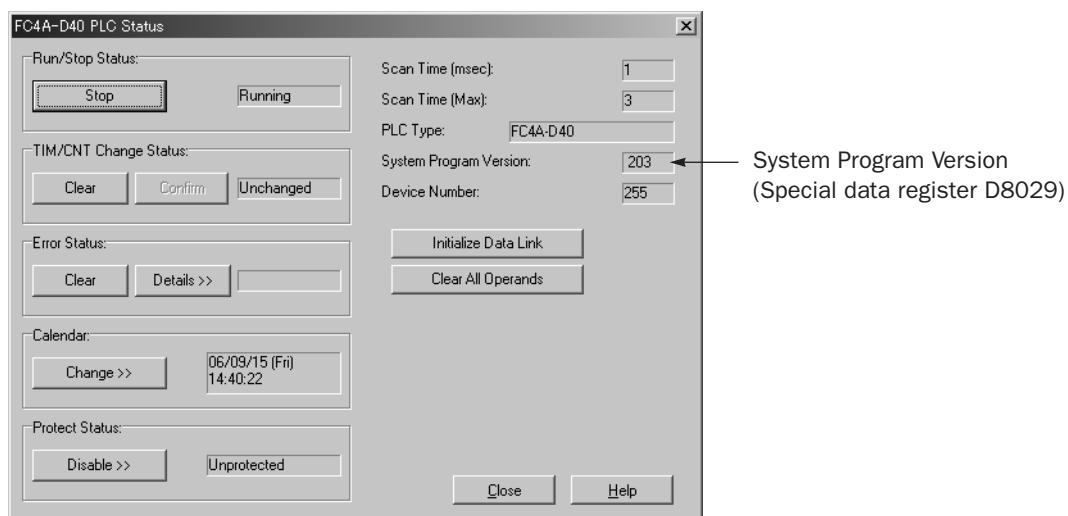
2: MODULE SPECIFICATIONS

Introduction

This chapter describes parts names, functions, specifications, and dimensions of the analog I/O modules.

Parts Description
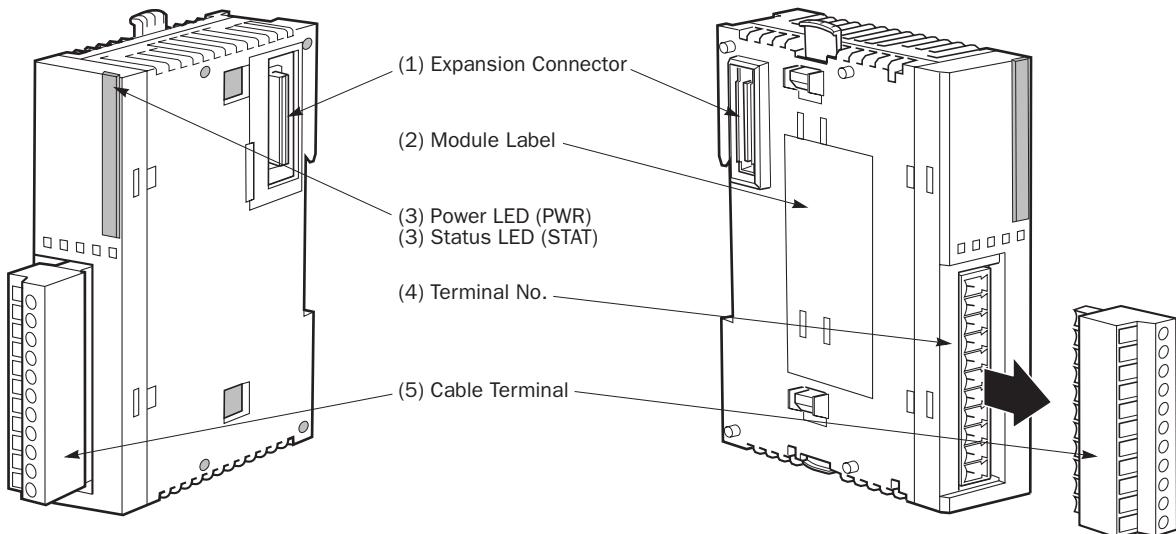
The terminal style depends on the model of analog I/O modules.

(1) Expansion Connector Connects to the CPU and other I/O modules.
(The all-in-one 10- and 16-I/O type CPU modules cannot be connected.)

(2) Module Label Indicates the analog I/O module Type No. and specifications.

(3) Power LED (PWR) END refresh type FC4A-L03A1, FC4A-L03AP1, FC4A-J2A1, FC4A-K1A1:
Turns on when power is supplied to the analog I/O module.

(3) Status LED (STAT) Ladder refresh type FC4A-J4CN1, FC4A-J8C1, FC4A-J8AT1, FC4A-K2C1:
Indicates the operating status of the analog I/O module.

Status LED	Analog Input Operating Status
OFF	Analog I/O module is stopped
ON	Normal operation
Flash	Initializing Changing configuration Hardware initialization error External power supply error

(4) Terminal No. Indicates terminal numbers.

(5) Cable Terminal All analog I/O modules have a removable terminal block.

Analog I/O Module Specifications

General Specifications (END Refresh Type)

Type No.	FC4A-L03A1	FC4A-L03AP1	FC4A-J2A1	FC4A-K1A1
Rated Power Voltage	24V DC			
Allowable Voltage Range	20.4 to 28.8V DC			
Terminal Arrangement	See Analog I/O Module Terminal Arrangement on pages 2-8 to 2-11.			
Connector on Mother Board	MC1.5/11-G-3.81BK (Phoenix Contact)			
Connector Insertion/Removal Durability	100 times minimum			
Internal Current Draw	50 mA (5V DC) 0 mA (24V DC)	50 mA (5V DC) 0 mA (24V DC)	50 mA (5V DC) 0 mA (24V DC)	50 mA (5V DC) 0 mA (24V DC)
External Current Draw (Note)	45 mA (24V DC)	40 mA (24V DC)	35 mA (24V DC)	40 mA (24V DC)
Weight	85g			

Note: The external current draw is the value when all analog inputs are used and the analog output value is at 100%.

General Specifications (Ladder Refresh Type)

Type No.	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1	FC4A-K2C1
Rated Power Voltage	24V DC			
Allowable Voltage Range	20.4 to 28.8V DC			
Terminal Arrangement	See Analog I/O Module Terminal Arrangement on pages 2-8 to 2-11.			
Connector on Mother Board	MC1.5/10-G-3.81BK (Phoenix Contact)			
Connector Insertion/Removal Durability	100 times minimum			
Internal Current Draw	50 mA (5V DC) 0 mA (24V DC)	40 mA (5V DC) 0 mA (24V DC)	45 mA (5V DC) 0 mA (24V DC)	60 mA (5V DC) 0 mA (24V DC)
External Current Draw (Note)	55 mA (24V DC)	50 mA (24V DC)	55 mA (24V DC)	85 mA (24V DC)
Weight	140g	140g	125g	110g

Note: The external current draw is the value when all analog inputs are used and the analog output value is at 100%.

Analog Input Specifications (END Refresh Type)

Type No.	FC4A-L03A1 / FC4A-J2A1		FC4A-L03AP1	
Analog Input Signal Type	**Voltage Input**	**Current Input**	**Thermocouple**	**Resistance Thermometer**
Input Range	0 to 10V DC	4 to 20 mA DC	Type K (0 to 1300°C) Type J (0 to 1200°C) Type T (0 to 400°C)	Pt 100 3-wire type (–100 to 500°C)
Input Impedance	1 MΩ minimum	10Ω	1 MΩ minimum	1 MΩ minimum
Allowable Conductor Resistance (per wire)	—	—	—	200Ω maximum
Input Detection Current	—	—	—	1.0 mA maximum
AD Conversion — Sample Duration Time	20 ms maximum		20 ms maximum	
AD Conversion — Sample Repetition Time	20 ms maximum		20 ms maximum	
AD Conversion — Total Input System Transfer Time (Note 1)	105 ms + 1 scan time		200 ms + 1 scan time	
AD Conversion — Type of Input	Single-ended input	Differential input		
AD Conversion — Operating Mode	Self-scan			
AD Conversion — Conversion Method	∑∆ type ADC			
Input Error — Maximum Error at 25°C	±0.2% of full scale		±0.2% of full scale + reference junction compensation accuracy (±4°C maximum)	±0.2% of full scale
Input Error — Temperature Coefficient	±0.006% of full scale/°C			
Input Error — Repeatability after Stabilization Time	±0.5% of full scale			
Input Error — Non-lineality	±0.2% of full scale			
Input Error — Maximum Error	±1% of full scale			
Data — Digital Resolution	4096 increments (12 bits)			
Data — Input Value of LSB	2.5 mV	4 µA	K: 0.325°C J: 0.300°C T: 0.100°C	0.15°C
Data — Data Type in Application Program	Default: 0 to 4095 Optional: –32768 to 32767 (selectable each channel) (Note 2)			
Data — Monotonicity	Yes			
Data — Input Data Out of Range	Detectable (Note 3)			
Noise Resistance — Maximum Temporary Deviation during Electrical Noise Tests (Note 4)	±3% maximum			Not assured
Noise Resistance — Input Filter	No			
Noise Resistance — Recommended Cable for Noise Immunity	Twisted pair shielded cable		—	
Noise Resistance — Crosstalk	2 LSB maximum			
Isolation	Isolated between input and power circuit			
	Photocoupler-isolated between input and internal circuit			
Effect of Improper Input Connection	No damage			
Maximum Permanent Allowed Overload (No Damage)	13V DC	40 mA DC	—	
Selection of Analog Input Signal Type	Using software programming			
Calibration or Verification to Maintain Rated Accuracy	Impossible			

For Note 1 through Note 4, see page 2-7.

Analog Input Specifications (Ladder Refresh Type)

Type No.		FC4A-J4CN1 / FC4A-J8C1		FC4A-J4CN1	
Analog Input Signal Type		**Voltage Input**	**Current Input**	**Thermocouple**	**Resistance Thermometer**
Input Range		0 to 10V DC	4 to 20 mA DC	Type K: 0 to 1300°C Type J: 0 to 1200°C Type T: 0 to 400°C	Pt100, Pt1000: −100 to 500°C Ni100, Ni1000: −60 to 180°C
Input Impedance		1 MΩ	FC4A-J4CN1: 12Ω FC4A-J8C1: 100Ω	1 MΩ	—
Input Detection Current		—	—	—	0.1 mA
AD Conversion	**Sample Duration Time**	2 ms maximum			
	Sample Repetition Time	FC4A-J4CN1: 10 ms maximum FC4A-J8C1: 2 ms maximum		10 ms maximum	30 ms maximum
	Total Input System Transfer Time (Note 1)	FC4A-J4CN1: 40 ms × channels + 1 scan time FC4A-J8C1: 8 ms × channels + 1 scan time		45 ms × channels + 1 scan time	65 ms × channels + 1 scan time
	Type of Input	Single-ended input			
	Operating Mode	Self-scan			
	Conversion Method	FC4A-J4CN1: ∑Δ type ADC FC4A-J8C1: Successive approximation register method			
Input Error	**Maximum Error at 25°C**	±0.2% of full scale		±0.2% of full scale + reference junction compen-sation accuracy (±3°C maximum)	±0.2% of full scale
	Cold Junction Compensation Error	—	—	±3.0°C maximum	—
	Temperature Coefficient	±0.005% of full scale/°C			
	Repeatability after Stabilization Time	±0.5% of full scale			
	Non-lineality	±0.04% of full scale			
	Maximum Error	±1% of full scale			

Type No.		FC4A-J4CN1 / FC4A-J8C1		FC4A-J4CN1	
Analog Input Signal Type		Voltage Input	Current Input	Thermocouple	Resistance Thermometer
Data	Digital Resolution	50000 increments (16 bits)		K: Approx. 24000 increments (15 bits) J: Approx. 33000 increments (15 bits) T: Approx. 10000 increments (14 bits)	Pt100: Approx. 6400 increments (13 bits) Pt1000: Approx. 64000 increments (16 bits) Ni100: Approx. 4700 increments (13 bits) Ni1000: Approx. 47000 increments (16 bits)
	Input Value of LSB	0.2 mV	0.32 µA	K: 0.058°C J: 0.038°C T: 0.042°C	Pt100: 0.086°C Pt1000: 0.0086°C Ni100: 0.037°C Ni1000: 0.0037°C
	Data Type in Application Program	Default: 0 to 50000		Default: 0 to 50000	Pt100, Ni100: 0 to 6000 Pt1000, Ni1000: 0 to 60000
	Monotonicity	Optional: −32768 to 32767 (selectable for each channel) (Note 2)			
	Input Data Out of Range	—		Temperature: Celsius, Fahrenheit	
Data	Digital Resolution	Yes			
	Input Value of LSB	Detectable (Note 3)			
Noise Resistance	Maximum Temporary Deviation during Electrical Noise Tests (Note 4)	±3% maximum			Not assured
	Input Filter	Software			
	Recommended Cable for Noise Immunity	Twisted pair cable		—	
	Crosstalk	2 LSB maximum			
Isolation		Isolated between input and power circuit			
		Photocoupler-isolated between input and internal circuit			
Effect of Improper Input Connection		No damage			
Maximum Permanent Allowed Overload (No Damage)		11V DC	22 mA DC	—	
Selection of Analog Input Signal Type		Using software programming			
Calibration or Verification to Maintain Rated Accuracy		Impossible			

For Note 1 through Note 4, see page 2-7.

Analog Input Specifications (Ladder Refresh Type)

Type No.	FC4A-J8AT1	
Analog Input Signal Type	NTC	PTC
Input Range	–50 to 150°C	
Applicable Thermistor	100 kΩ maximum	
Input Detection Current	0.1 mA	
AD Conversion — Sample Duration Time	2 ms maximum	
Sample Repetition Time	2 ms × channels	
Total Input System Transfer Time (Note 1)	10 ms × channels + 1 scan time (Note 1)	
Type of Input	Single-ended input	
Operating Mode	Self-scan	
Conversion Method	Successive approximation register method	
Input Error — Maximum Error at 25°C	±0.2% of full scale	
Temperature Coefficient	±0.005% of full scale/°C	
Repeatability after Stabilization Time	±0.5% of full scale	
Non-lineality	No	
Maximum Error	±1% of full scale	
Data — Digital Resolution	Approx. 4000 increments (12 bits)	
Input Value of LSB	0.05°C	
Data Type in Application Program	Default: 0 to 4000 Optional: –32768 to 32767 (selectable for each channel) (Note 2) Temperature: Celsius, Fahrenheit (NTC only) Resistance: 0 to 10000	
Monotonicity	Yes	
Input Data Out of Range	Detectable (Note 3)	
Noise Resistance — Maximum Temporary Deviation during Electrical Noise Tests (Note 4)	±3% maximum	
Input Filter	Software	
Recommended Cable for Noise Immunity	—	
Crosstalk	2 LSB maximum	
Isolation	Isolated between input and power circuit	
	Photocoupler-isolated between input and internal circuit	
Effect of Improper Input Connection	No damage	
Selection of Analog Input Signal Type	Using software programming	
Calibration or Verification to Maintain Rated Accuracy	Impossible	

Analog Output Specifications

Category			END Refresh Type			Ladder Refresh
Type No.			FC4A-L03A1	FC4A-L03AP1	FC4A-K1A1	FC4A-K2C1
Output Range		Voltage	0 to 10V DC			−10 to +10V DC
		Current	4 to 20 mA DC			
Load	Load Impedance		2 kΩ minimum (voltage), 300Ω maximum (current)			
	Applicable Load Type		Resistive load			
DA Conversion	Settling Time		50 ms	130 ms	50 ms	1 ms/ch
	Total Output System Transfer Time		Settling time + 1 scan time			1 ms × channels + 1 scan time
Output Error	Maximum Error at 25°C		±0.2% of full scale			
	Temperature Coefficient		±0.015% of full scale/°C			±0.005% of full scale/°C
	Repeatability after Stabilization Time		±0.5% of full scale			
	Output Voltage Drop		±1% of full scale			
	Non-lineality		±0.2% of full scale			
	Output Ripple		1 LSB maximum			±0.1% of full scale
	Overshoot		0%			
	Total Error		±1% of full scale			
Data	Digital Resolution		4096 increments (12 bits)			50000 increments (16 bits)
	Output Value of LSB	Voltage	2.5 mV			0.4 mV
		Current	4 µA			0.32 µA
	Data Type in Application Program		Default: 0 to 4095 (voltage, current)			−25000 to 25000 (voltage)
						0 to 50000 (current)
			Optional: −32768 to 32767 (selectable for each channel) (Note 2)			
	Monotonicity		Yes			
Current Loop Open			Not detectable			
Noise Resistance	Maximum Temporary Deviation during Electrical Noise Tests (Note 4)		±3% maximum			
	Recommended Cable for Noise Immunity		Twisted pair shielded cable			Twisted pair cable
	Crosstalk		No crosstalk because of 1 channel output			2 LSB maximum
Isolation			Isolated between output and power circuit			
			Photocoupler-isolated between output and internal circuit			
Effect of Improper Output Connection			No damage			
Selection of Analog Output Signal Type			Using software programming			
Calibration or Verification to Maintain Rated Accuracy			Impossible			

Note 1: Total input system transfer time = Sample repetition time + Internal processing time
When using the FC4A-J4CN1, FC4A-J8C1, or FC4A-J8AT1, the total input system transfer time increases in proportion to the number of channels used.

Note 2: The data processed in the analog I/O module can be linear-converted to a value between −32768 and 32767. The optional range designation, and analog I/O data minimum and maximum values can be selected using data registers allocated to analog I/O modules. See page 4-12.

Note 3: When an error is detected, a corresponding error code is stored to a data register allocated to analog I/O operating status. See page 4-6.

Note 4: The value is measured when a 500V clamp voltage is applied to the power supply and I/O lines.

Analog I/O Module Terminal Arrangement and Wiring Diagrams

## FC4A-L03A1 (Analog I/O Module) — Screw Terminal Type

Applicable Terminal Block: **FC4A-PMT11P (supplied with the analog I/O module)**

Terminal No.	Channel
+	24V DC
−	
⏚	
+	OUT
−	
NC	IN0
+	
−	
NC	IN1
+	
−	
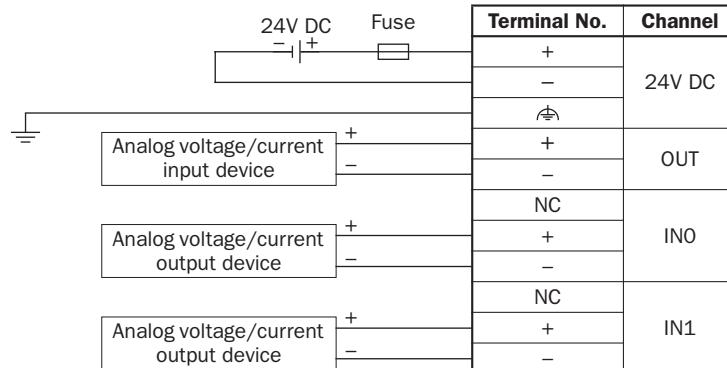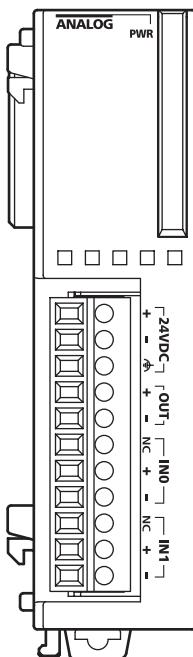
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.
- Before turn on the power, make sure that wiring to the analog I/O module is correct. If wiring is incorrect, the analog I/O module may be damaged.

## FC4A-L03AP1 (Analog I/O Module) — Screw Terminal Type

Applicable Terminal Block: **FC4A-PMT11P (supplied with the analog I/O module)**

Terminal No.		Channel
+		24V DC
−		
⏚		
+		OUT
−		
NC	A	IN0
+	B'	
−	B	
NC	A	IN1
+	B'	
−	B	
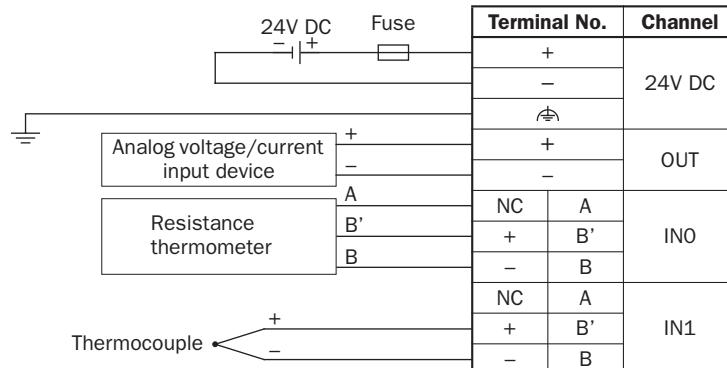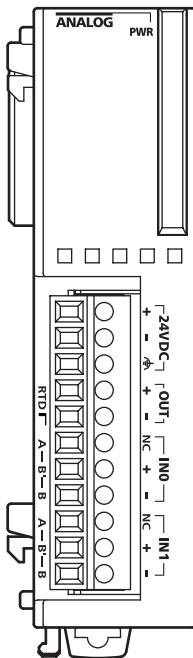
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- When connecting a resistance thermometer, connect the three wires to RTD (resistance temperature detector) terminals A, B', and B of input channel IN0 or IN1.
- When connecting a thermocouple, connect the two wires to terminals + and − of input channels IN0 or IN1.
- Do not connect any wiring to unused terminals.
- Do not connect the thermocouple to a hazardous voltage (60V DC or 42.4V peak or higher).

### FC4A-J2A1 (Analog Input Module) — Screw Terminal Type

Applicable Terminal Block: **FC4A-PMT11P (supplied with the analog input module)**

Terminal No.	Channel
+	24V DC
−	
⏚	
NC	—
NC	
NC	IN0
+	
−	
NC	IN1
+	
−	
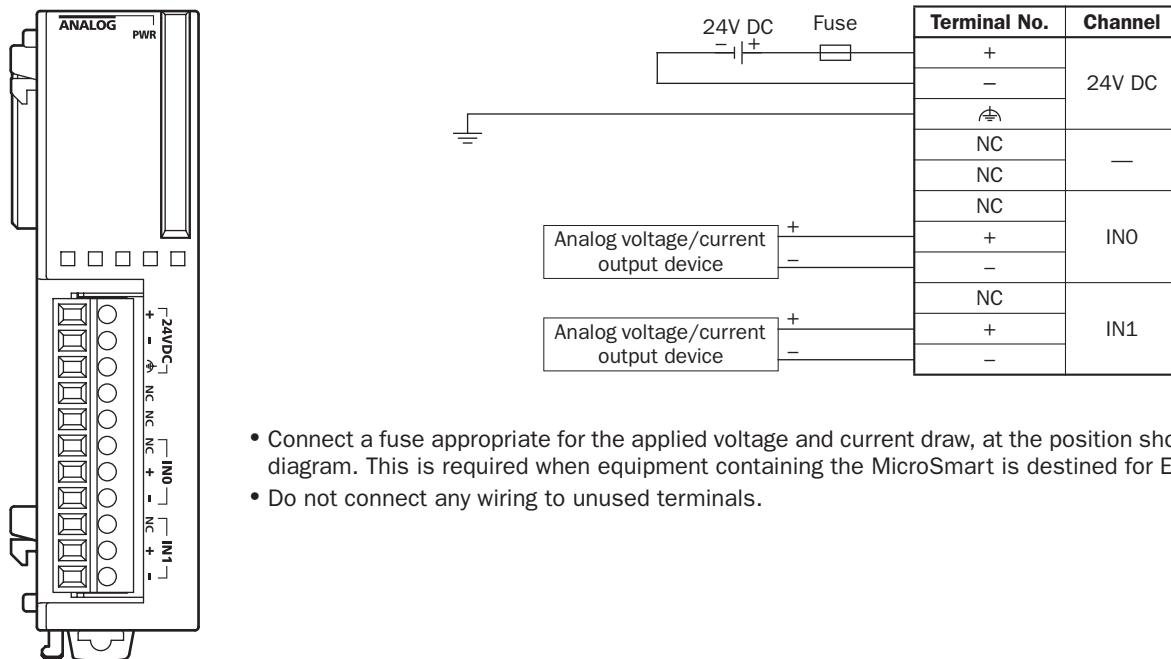
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.

FC4A-J4CN1 (Analog Input Module) — Screw Terminal Type

Applicable Terminal Block: **FC4A-PMT10P (supplied with the analog input module)**

| Terminal No.	Channel
24V	24V DC
0V	
⏚	
NC	—
CS	IN0
+	
−	
I−	
CS	IN1
+	
−	IN1
I−	
CS	IN2
+	
−	
I−	
CS	IN3
+	
−	
I−	
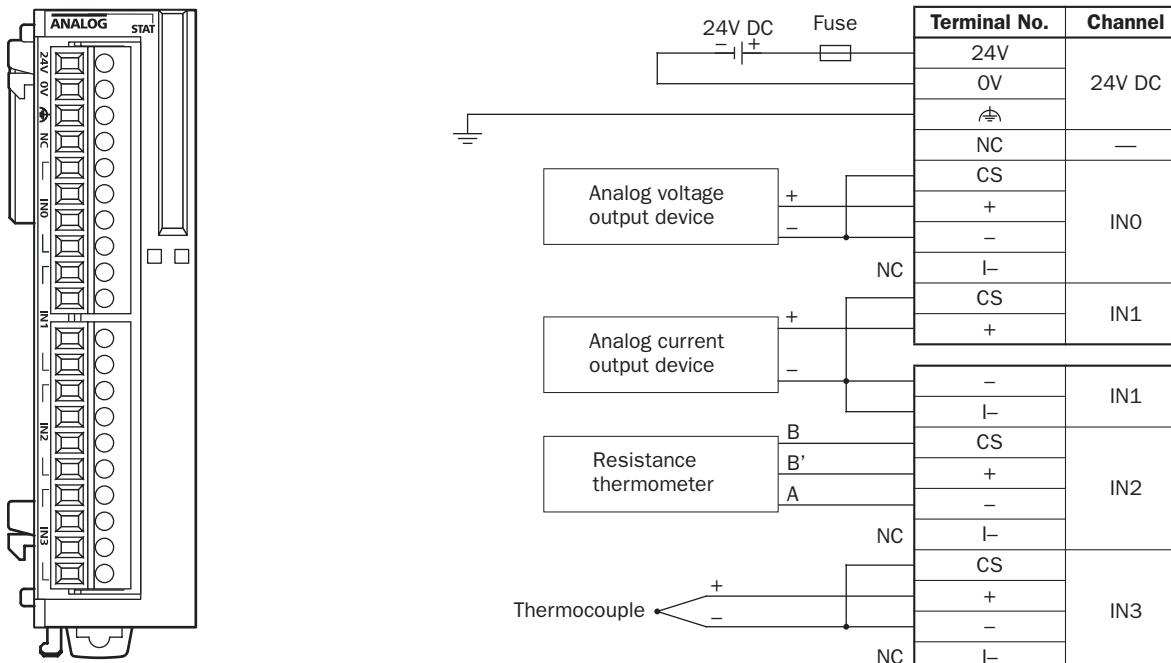
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- When connecting a resistance thermometer, connect three wires B, B', and A to the CS (current sense), +, and − terminals of input channels IN0 through IN3, respectively.
- When connecting a thermocouple, connect the + wire to the + terminal and the − wire to the CS and − terminals.
- Do not connect the thermocouple to a hazardous voltage (60V DC or 42.4V peak or higher).
- Do not connect any wiring to unused terminals.
- − terminals of input channels IN0 through IN3 are interconnected.

FC4A-J8C1 (Analog Input Module) — Screw Terminal Type

Applicable Terminal Block: **FC4A-PMT10P (supplied with the analog input module)**

Terminal No.	Channel
24V	24V DC
0V	
⏚	
NC	—
+	IN0
−	
+	IN1
−	
+	IN2
−	
+	IN3
−	
+	IN4
−	
+	IN5
−	
+	IN6
−	
+	IN7
−	
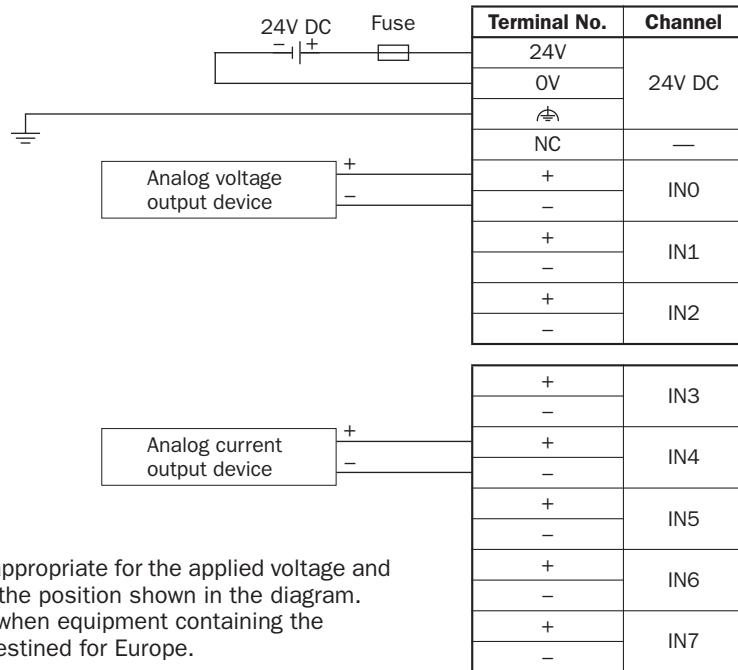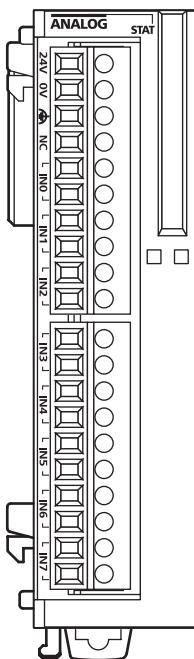
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.
- − terminals of input channels IN0 through IN7 are interconnected.

FC4A-J8AT1 (Analog Input Module) — Screw Terminal Type

**Applicable Terminal Block:** **FC4A-PMT10P (supplied with the analog input module)**

Terminal No.	Channel
24V	24V DC
0V	
⏚	
NC	—
A	IN0
B	
A	IN1
B	
A	IN2
B	
A	IN3
B	
A	IN4
B	
A	IN5
B	
A	IN6
B	
A	IN7
B	
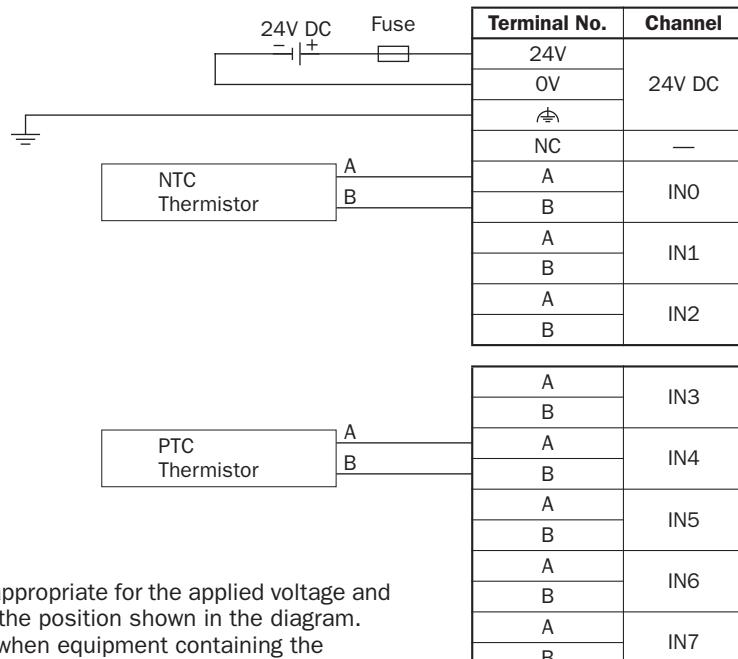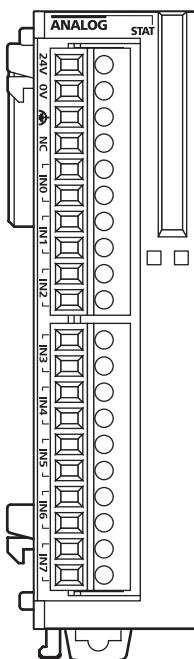
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.

FC4A-K1A1 (Analog Output Module) — Screw Terminal Type

Applicable Terminal Block: FC4A-PMT11P (supplied with the analog output module)

Terminal No.	Channel
+	
−	24V DC
⏚	
+	
−	OUT
NC	
NC	—
NC	
NC	
NC	—
NC	

24V DC   Fuse

Analog voltage/current input device
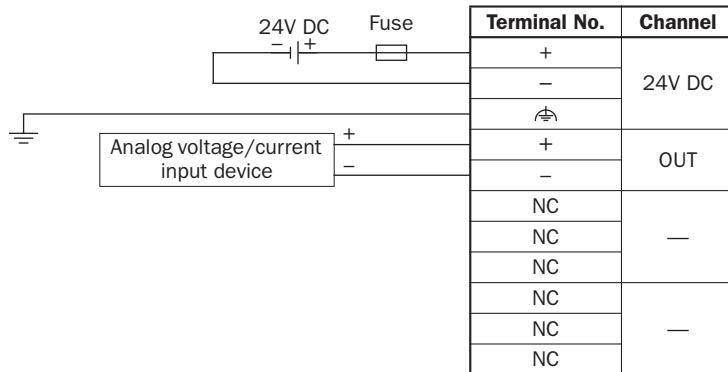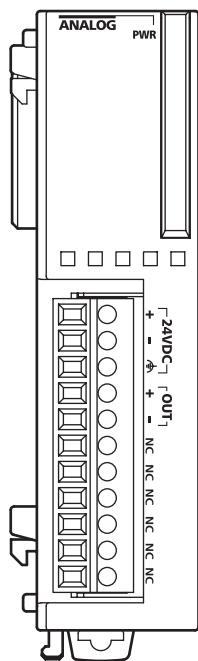
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.

FC4A-K2C1 (Analog Output Module) — Screw Terminal Type

**Applicable Terminal Block:** FC4A-PMT10P (supplied with the analog output module)

Terminal No.	Channel
24V	
0V	24V DC
⏚	
NC	—
V+	
I+	OUT0
−	
V+	
I+	OUT1
−	

24V DC   Fuse

Analog voltage input device

Analog current input device
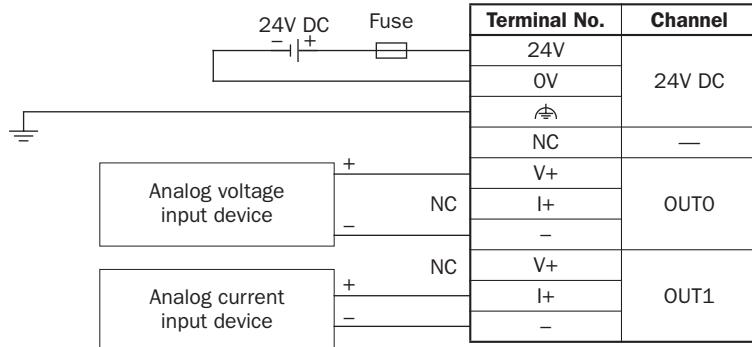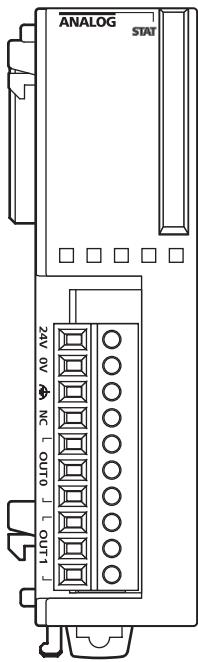
- Connect a fuse appropriate for the applied voltage and current draw, at the position shown in the diagram. This is required when equipment containing the MicroSmart is destined for Europe.
- Do not connect any wiring to unused terminals.
- − terminals of output channels OUT0 and OUT1 are interconnected.

Type of Protection

Input Circuits

FC4A-L03A1, FC4A-L03AP1, FC4A-J2A1
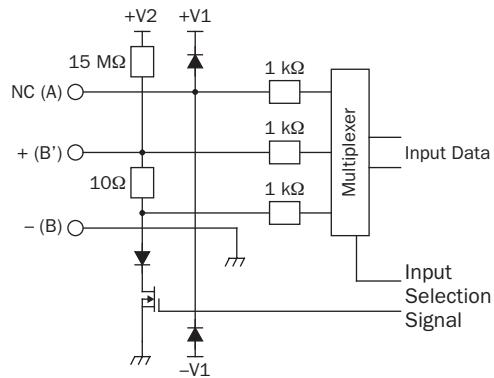
FC4A-J4CN1
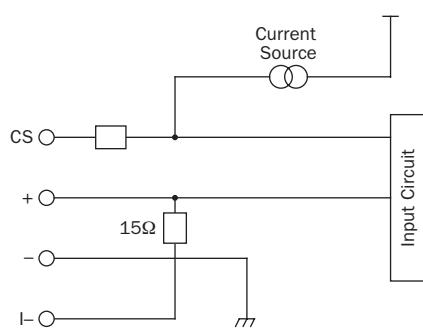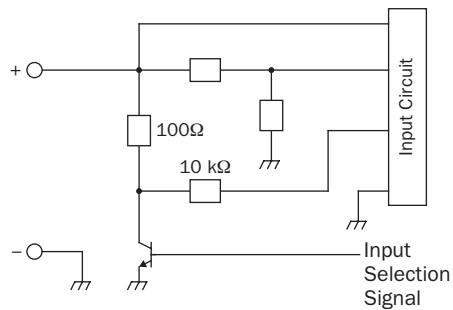
FC4A-J8C1

FC4A-J8AT1
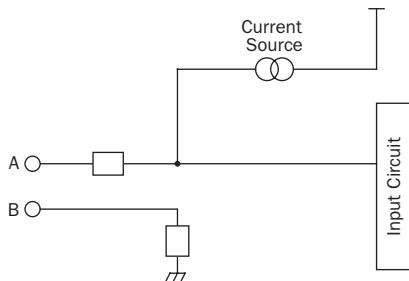
Output Circuits

FC4A-L03A1, FC4A-L03AP1, FC4A-K1A1
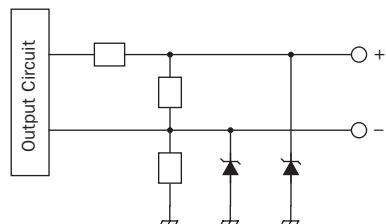
FC4A-K2C1
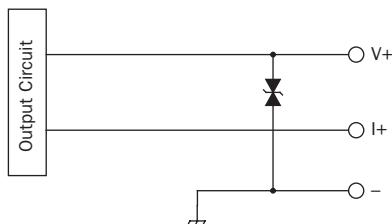
Power Supply for Analog I/O Modules

When supplying power to the analog I/O modules, take the following considerations.

• Power Supply for END Refresh Type Analog I/O Modules

Use separate power supplies for the MicroSmart CPU module and END refresh type analog I/O modules. Power up the analog I/O modules at least 1 second earlier than the CPU module. This is recommended to ensure correct operation of the analog I/O control.

• Power Supply for Ladder Refresh Type Analog I/O Modules

Use the same power supply for the MicroSmart CPU module and ladder refresh type analog I/O modules to suppress the influence of noises.

After the CPU module has started to run, ladder refresh type analog input modules perform initialization for a maximum of 5 seconds. During this period, the analog input data have an indefinite value. Design the user program to make sure that the analog input data are read to the CPU module after the analog input operating status has changed to 0 (normal operation). For the analog input operating status, see page 4-13.

Wiring Analog I/O Lines

Separate the analog I/O lines, particularly resistance thermometer inputs, from motor lines as much as possible to suppress the influence of noises.
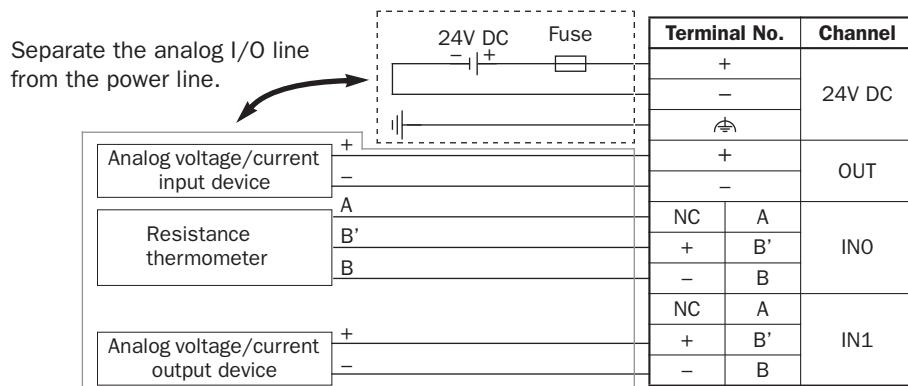
Dimensions

FC4A-L03A1, FC4A-L03AP1, FC4A-J2A1, FC4A-K1A1, FC4A-K2C1

3.8   23.5   14.6   70.0

90.0

4.5*

*8.5 mm when the clamp is pulled out.

FC4A-J4CN1, FC4A-J8C1, FC4A-J8AT1

3.8   23.5   14.6   70.0

90.0

4.5*

*8.5 mm when the clamp is pulled out.
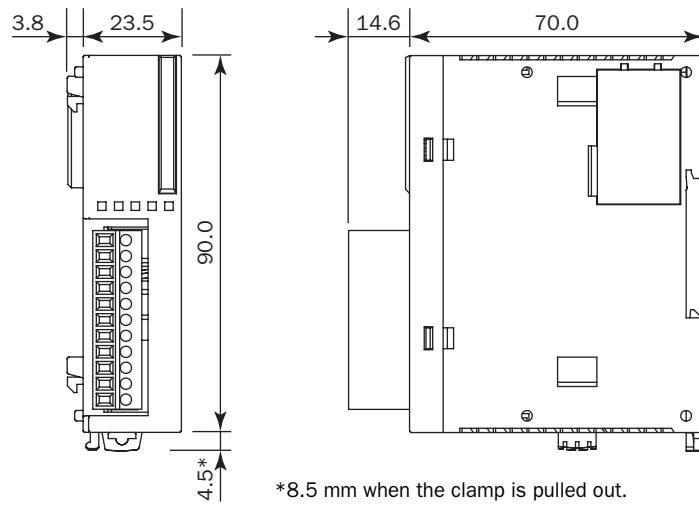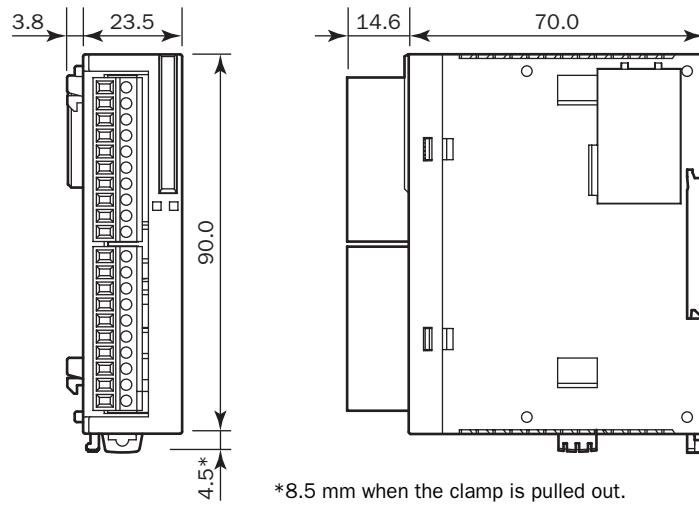
All dimensions in mm.

3: INSTALLATION AND WIRING

Introduction

This chapter describes precautions for installing the analog I/O modules in connection with the internal current draw by other expansion modules.

For general methods and precautions for installation and wiring of the analog I/O modules, see the FC4A MicroSmart user's manual (FC9Y-B812).

⚠ **Warning**
- This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only.
- Explosion hazard — Substitution of components may impair suitability for Class I, Division 2.
- Explosion hazard — Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Mounting Hole Layout for Direct Mounting on Panel Surface

To mount the analog I/O module on a panel surface, use the direct mounting strip and two M4 screws (6 or 8 mm long).

For details about the direct mounting strip, see the FC4A MicroSmart user's manual (FC9Y-B812).
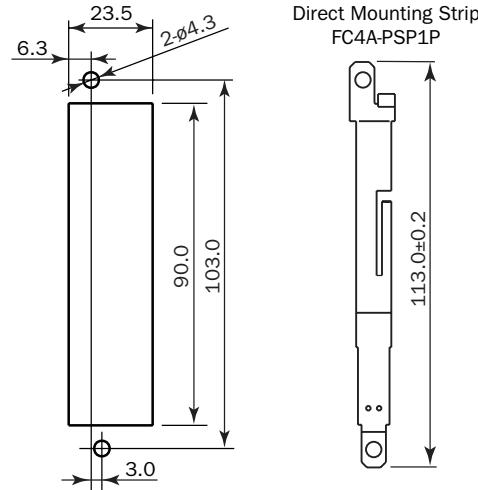
Example: Mounting hole layout for FC4A-C24R2 and three analog I/O modules
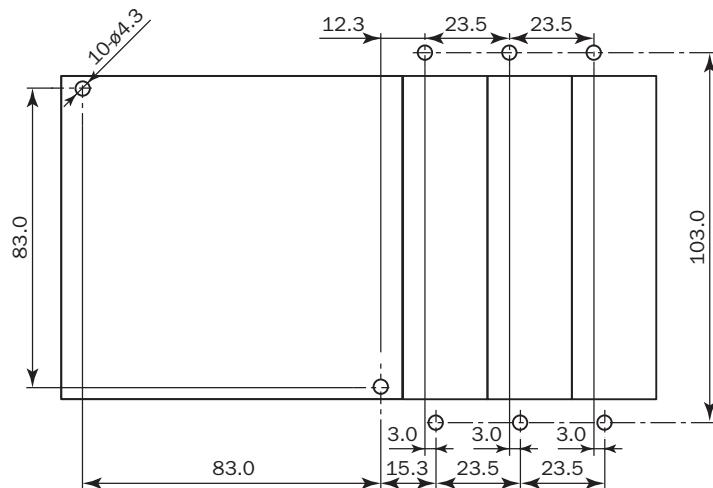
All dimensions in mm.

Terminal Connection

⚠ **Caution**	• Make sure that the operating conditions and environments are within the specification values.
	• Be sure to connect the grounding wire to a proper ground, otherwise electrical shocks may be caused.
	• Do not touch live terminals, otherwise electrical shocks may be caused.
	• Do not touch terminals immediately after power is turned off, otherwise electrical shocks may be caused.
	• When using ferrules, insert a wire to the bottom of the ferrule and crimp the ferrule.
	• When connecting a stranded wire or multiple solid wires to a screw terminal block, use a ferrule. Otherwise the wire may slip off the screw terminal block.

Ferrules, Crimping Tool, and Screwdriver for Phoenix Terminal Blocks

The screw terminal block can be wired with or without using ferrules on the end of cable. Applicable ferrules for the Phoenix terminal blocks and crimping tool for the ferrules are listed below. The screwdriver is used for tightening the screw terminals on the MicroSmart modules. These ferrules, crimping tool, and screwdriver are made by Phoenix Contact and are available from Phoenix Contact.

Type numbers of the ferrules, crimping tool, and screwdriver listed below are the type numbers of Phoenix Contact. When ordering these products from Phoenix Contact, specify the Order No. and quantity listed below.

Ferrule Order No.

Quantity of Cables	Cable Size	Phoenix Type	Order No.	Pcs./Pkt.
For 1-cable connection	UL1007 AWG16	AI 1,5-8 BK	32 00 04 3	100
	UL1007 AWG18	AI 1-8 RD	32 00 03 0	100
	UL1015 AWG22	AI 0,5-8 WH	32 00 01 4	100
For 2-cable connection	UL1007 AWG18	AI-TWIN 2 x 0,75-8 GY	32 00 80 7	100
	UL1015 AWG22	AI-TWIN 2 x 0,5-8 WH	32 00 93 3	100
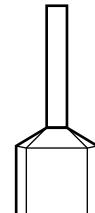
Crimping Tool and Screwdriver Order No.

Tool Name		Phoenix Type	Order No.	Pcs./Pkt.
Crimping Tool		CRIMPFOX ZA 3	12 01 88 2	1
Screwdriver	For CPU modules	SZS 0,6 x 3,5	12 05 05 3	10
	For I/O modules and communication adapter	SZS 0,4 x 2,5	12 05 03 7	10

Screw Terminal Tightening Torque	CPU modules	0.5 N·m
	I/O modules Communication adapter	0.22 to 0.25 N·m

4: ANALOG I/O CONTROL

Introduction

The MicroSmart provides analog I/O control capabilities of 12- through 16-bit resolution using analog I/O modules.

This chapter describes the system setup for using analog I/O modules, WindLDR programming procedures, data register allocation numbers for analog I/O modules, and application examples.

For hardware specifications of analog I/O modules, see page 2-2.

System Setup

The FC4A and FC5A MicroSmart CPU modules can be used with a maximum of seven expansion I/O modules, which include digital I/O modules and analog I/O modules.

Quantity of Applicable Analog I/O Modules

The quantity of the analog I/O modules that can be connected to the MicroSmart CPU module depends on the model of the MicroSmart CPU modules as listed below:

FC4A MicroSmart CPU Module	All-in-One Type			Slim Type	
	FC4A-C10R2 FC4A-C10R2C	FC4A-C16R2 FC4A-C16R2C	FC4A-C24R2 FC4A-C24R2C	FC4A-D20K3 FC4A-D20S3	FC4A-D20RK1 FC4A-D20RS1 FC4A-D40K3 FC4A-D40S3
Quantity of Analog I/O Modules	—	—	4	7	7

FC5A MicroSmart CPU Module	All-in-One Type			Slim Type	
	FC5A-C10R2 FC5A-C10R2C	FC5A-C16R2 FC5A-C16R2C	FC5A-C24R2 FC5A-C24R2C	FC5A-D16RK1 FC5A-D16RS1	FC5A-D32K3 FC5A-D32S3
Quantity of Analog I/O Modules	—	—	4	7	7

System Setup Example

Slot No.:	1	2	3	4	5	6	7
Slim Type CPU Module	Analog I/O Module	Digital I/O Module	Analog I/O Module	Digital I/O Module	Digital I/O Module	Analog I/O Module	Analog I/O Module

Expansion I/O Modules (7 maximum)
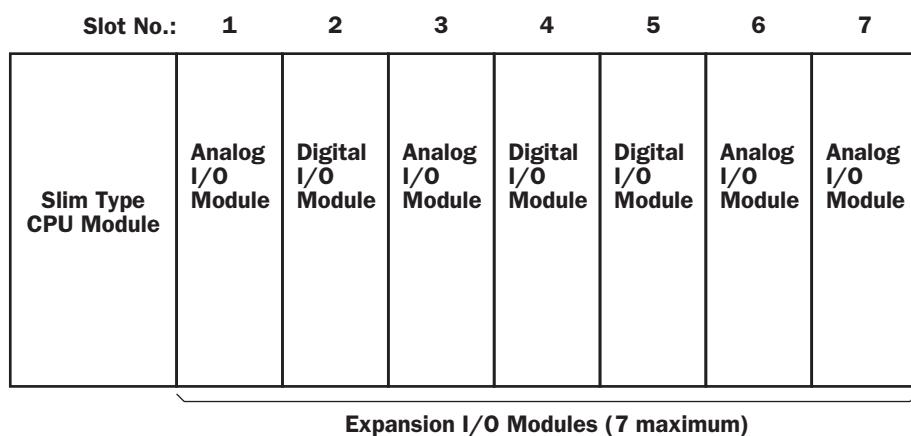
• Slot No.

Indicates the position where the expansion module is mounted. The slot number starts with 1 next to the CPU module up to a maximum of 7.

Note: Analog I/O modules cannot be mounted to the right of the expansion interface module.

Programming WindLDR

Use WindLDR ver. 5.0 or later which has the ANST (Set Analog Module Parameters) macro for easy programming of analog I/O modules. For a start input of the ANST macro, use special internal relay M8120 (initialize pulse) to execute the ANST macro only once after starting the CPU.

1. Click the **ANST** icon ![ANST] from the WindLDR tool bar, then place the cursor where you want to insert the ANST instruction on the ladder editing screen, and click the mouse.

    Or, place the cursor where you want to insert the ANST instruction on the ladder editing screen, and type **ANST**.

The Set Analog Module Parameters dialog box appears.
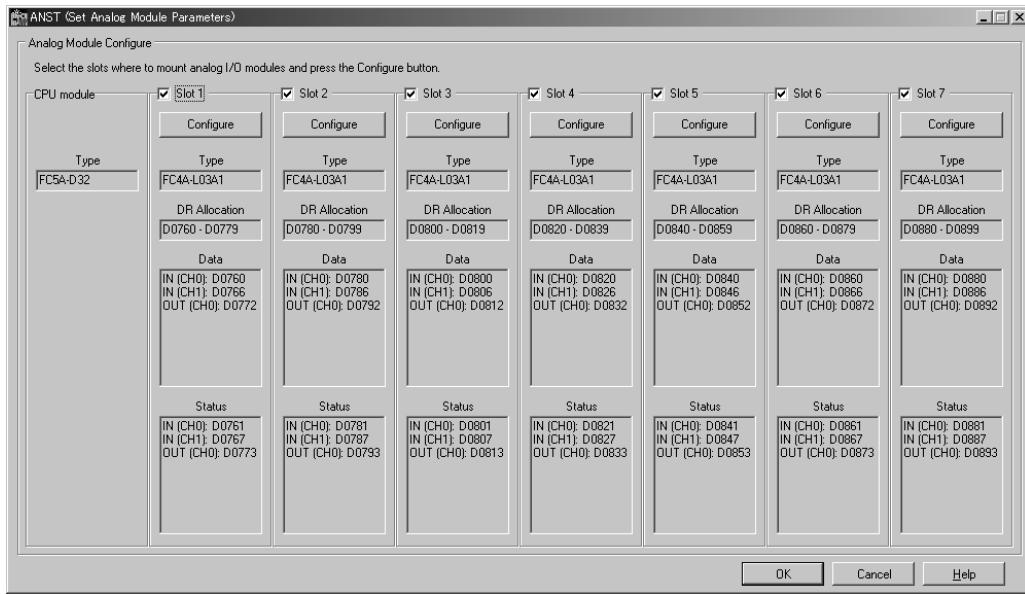
2. Select the slots where analog I/O modules are mounted.

All slots are selected to use seven analog I/O modules as default. Click the check box to deselect slots where analog I/O modules are *not* mounted.

When using analog I/O modules on Slots 1, 3, 6, and 7, deselect Slots 2, 4, and 5 as shown below.
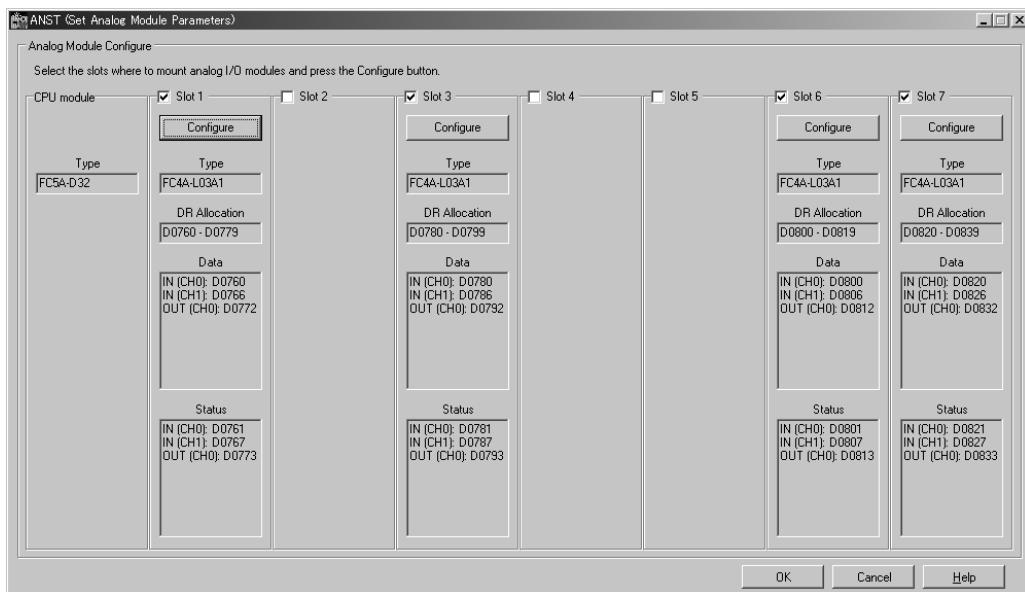
3. Click the **Configure** button under the selected slots.

The Configure Parameters dialog box appears. All parameters for analog I/O control can be set in this dialog box. Available parameters vary with the type of the analog I/O module.

END Refresh Type Configure Parameters dialog box

FC4A-L03A1
FC4A-L03AP1
FC4A-J2A1
FC4A-K1A1

Analog I/O Data (Note)   Analog I/O Operating Status

Type	Channel	Signal Type	Data Type	Min.	Max.	Data	Status
	IN (CH0)	0 to 10V DC	Binary data	0	4095	D0760	D0761
	IN (CH1)	0 to 10V DC	Binary data	0	4095	D0766	D0767
	OUT (CH0)	0 to 10V DC	Binary data	0	4095	D0772	D0773
FC4A-L03A1							

DR Allocation — Allocation Number D0760 ... Allocation Range D0760 - D0779

OK   Cancel   Help
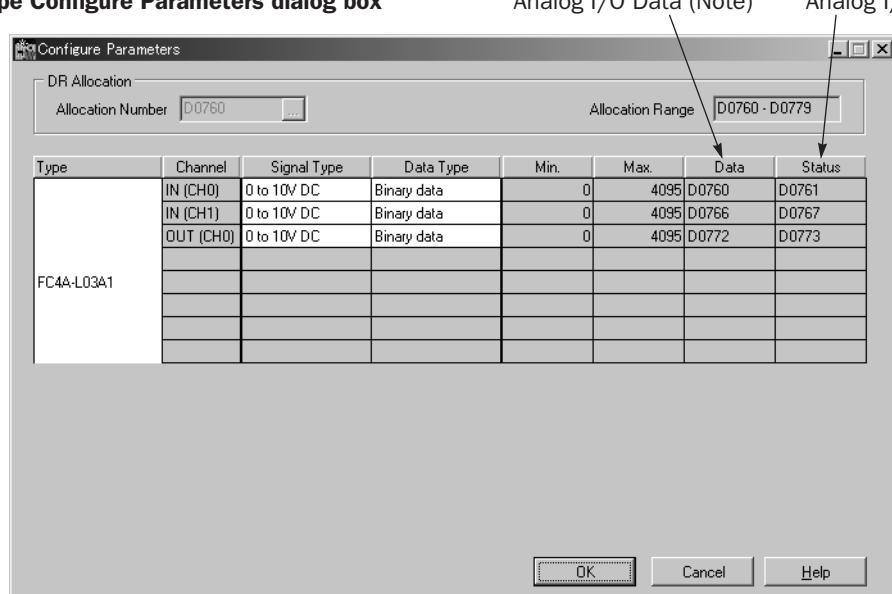
4. Select the type of the analog I/O module.

Click on the right of the analog I/O module Type No., then a pull-down list shows eight available modules.

Depending on the selected analog I/O module, other parameters available for the selected module are shown.

Ladder Refresh Type Configure Parameters dialog box

FC4A-J4CN1
FC4A-J8C1
FC4A-J8AT1
FC4A-K2C1

Analog I/O Data (Note)   Analog I/O Operating Status

DR Allocation — Allocation Number D0760 ... Allocation Range D0760 - D0824

Type	Channel	Filter	Signal Type	Data Type	Scale	Min.	Max.	Data	Status
	IN (CH0)	0	0 to 10V DC	Binary data		0	50000	D0806	D0814
	IN (CH1)	0	0 to 10V DC	Binary data		0	50000	D0807	D0815
	IN (CH2)	0	0 to 10V DC	Binary data		0	50000	D0808	D0816
	IN (CH3)	0	0 to 10V DC	Binary data		0	50000	D0809	D0817
FC4A-J4CN1									

FC4A-L03A1
FC4A-L03AP1
FC4A-J2A1
FC4A-J4CN1
FC4A-J8C1
FC4A-J8AT1
FC4A-K1A1
FC4A-K2C1

OK   Cancel   Help
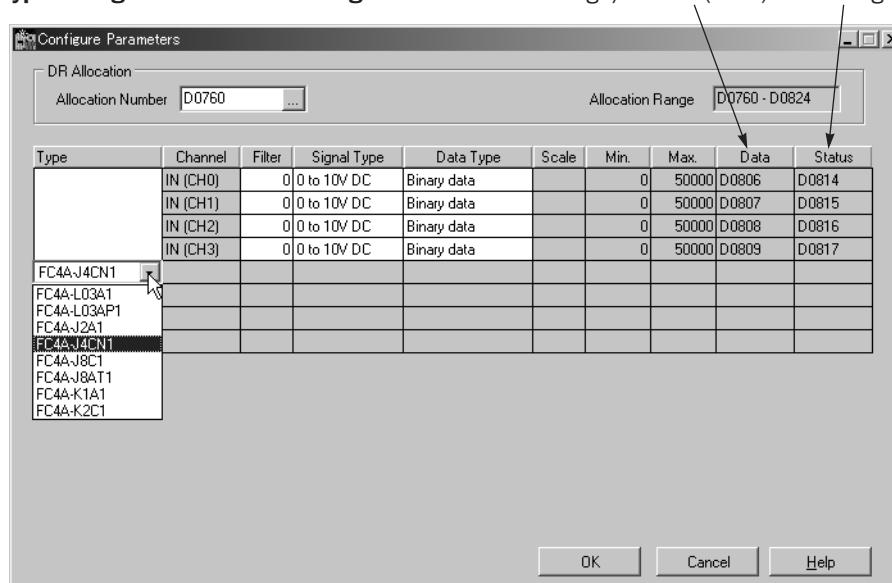
In the Configure Parameters dialog box, parameters in white cells are selectable while gray cells indicate default parameters. In the white cells, optional values can be selected from a pull-down list or entered by typing required values.

Note for PID Instruction Source Operand S4 (process variable)

When using the PID instruction, specify the data register number shown under Data in the Configure Parameters dialog box as source operand S4 (process variable) of the PID instruction. The analog input data in the selected data register is used as the process variable of the PID instruction.

5. Select a DR allocation number (Ladder refresh type only).

CPU Module	DR Allocation
END Refresh Type FC4A-L03A1 FC4A-L03AP1 FC4A-J2A1 FC4A-K1A1	DR allocation starts with D760 as default, and the first DR number cannot be changed. One analog I/O module occupies 20 data registers. When a maximum of seven analog I/O modules are used, data registers D760 through D899 are used for analog I/O control.
Ladder Refresh Type FC4A-J4CN1 FC4A-J8C1 FC4A-J8AT1 FC4A-K2C1	The first data register can be selected as required. Enter the first DR number used for analog I/O control. One analog input module occupies a maximum of 65 data registers. One analog output module occupies 15 data registers.

Ladder Refresh Type Configure Parameters dialog box

First Data Register No.   Allocation range changes automatically.
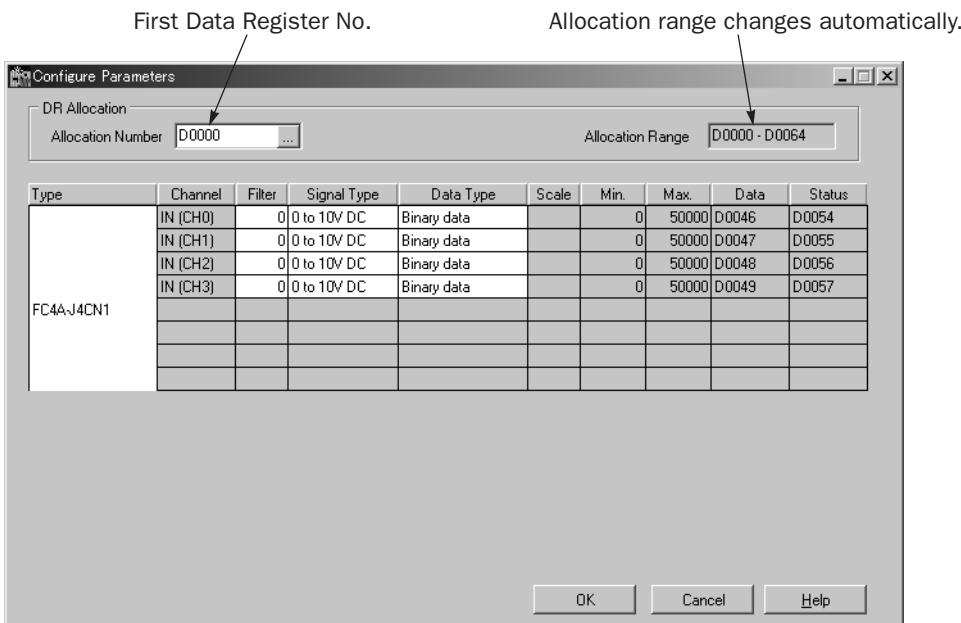
6. Enter a filter value (Ladder refresh type analog input modules only).

The filter function is available for the FC4A-J4CN1, FC4A-J8C1, and FC4A-J8AT1 only. Filtering ensures smooth input of analog data into the CPU module.

Filter Value	Description
0 or 1	Without filter function
2 to 255	The average of N pieces of analog input data is read as analog input data, where N is the designated filter value. $\text{Analog input data} = \dfrac{(\text{Previous analog input data}) \times (\text{Filter value}) + (\text{Current analog input data})}{(\text{Filter value}) + 1}$

7. Select a signal type for each channel.

Click on the right of the Signal Type field, then a pull-down list appears to show all available input or output signal types.

When you do not use any input or output signal, select the default value or **Not used** for the channel.

Analog I/O Module		For unused channel, select
END Refresh Type	FC4A-L03A1, FC4A-J2A1	0 to 10V DC
	FC4A-L03AP1	Type K
Ladder Refresh Type	FC4A-J4CN1, FC4A-J8C1, FC4A-J8AT1, FC4A-K2C1	Not used
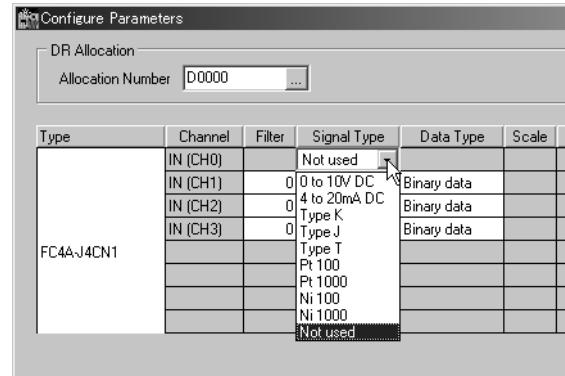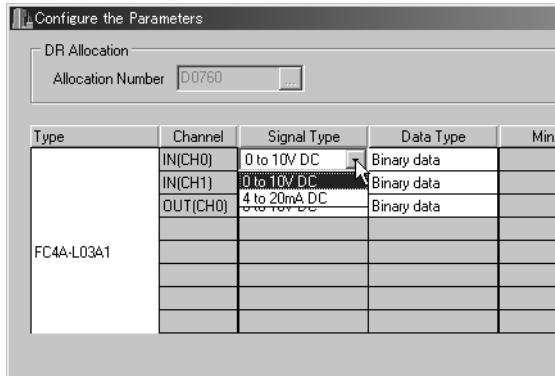
8. Select a data type for each channel.

Click on the right of the Data Type field, then a pull-down list appears to show all available input or output data types.
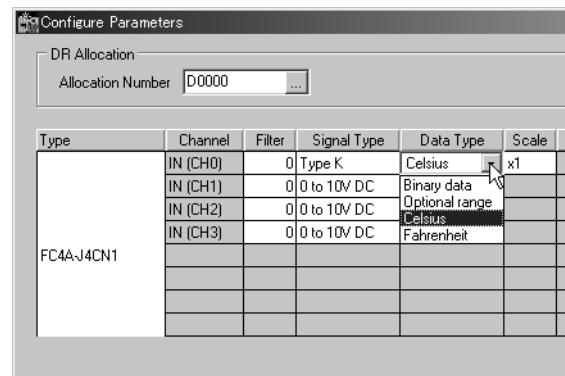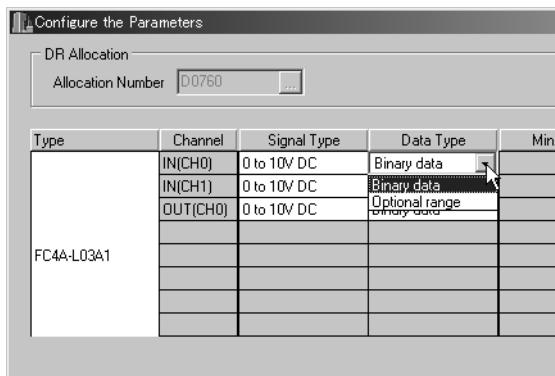
9. Select a scale value (Ladder refresh type analog input modules only).

When Celsius or Fahrenheit is selected for thermocouple, resistance thermometer, or thermistor signal types on ladder refresh type analog input modules, the scale value can be selected from ×1, ×10, or ×100 depending on the selected signal type. Using this function, the analog input data can be multiplied to ensure precise control.
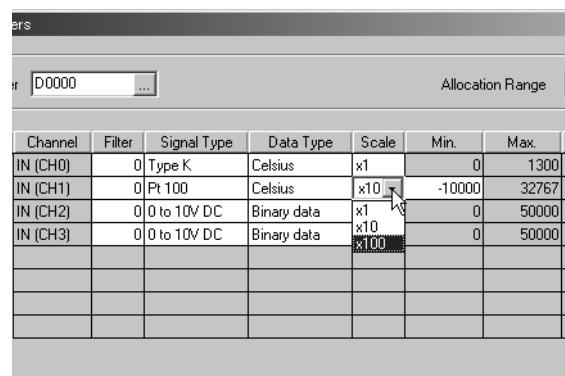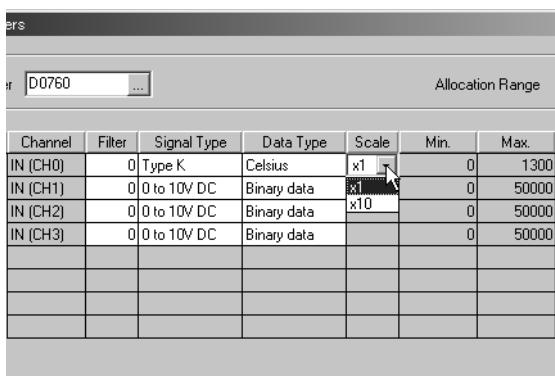
10. Select maximum and minimum values.

For analog input values, when Optional range is selected for the Data Type, designate the analog input data minimum and maximum values which can be –32,768 through 32,767.

In addition, when using resistance thermometers (Pt100, Pt1000, Ni100, or Ni1000) with the Celsius or Fahrenheit Data Type and the ×100 scale, select the analog input data minimum value from 0 or another value in the pull-down list. The maximum value is changed automatically according to the selected minimum value.

For analog output values, when Optional range is selected for the Data Type, designate the analog output data minimum and maximum values which can be –32,768 through 32,767.

	Data Type	Min.	Max.	Data	Status
	Optional range	0	4095	D0760	D0761
	Optional range	-32768	32767	D0766	D0767
	Optional range	-32768	32767	D0772	D0773

Allocation Range D0760 - D0779

Type	Data Type	Scale	Min.	Max.	Data	Status
	Celsius	x100	-10000	32767	D0046	D0054
	Celsius	x100	0	50000	D0047	D0055
DC	Binary data		-10000	50000	D0048	D0056
DC	Binary data		0	50000	D0049	D0057

Allocation Range D0000 - D0064
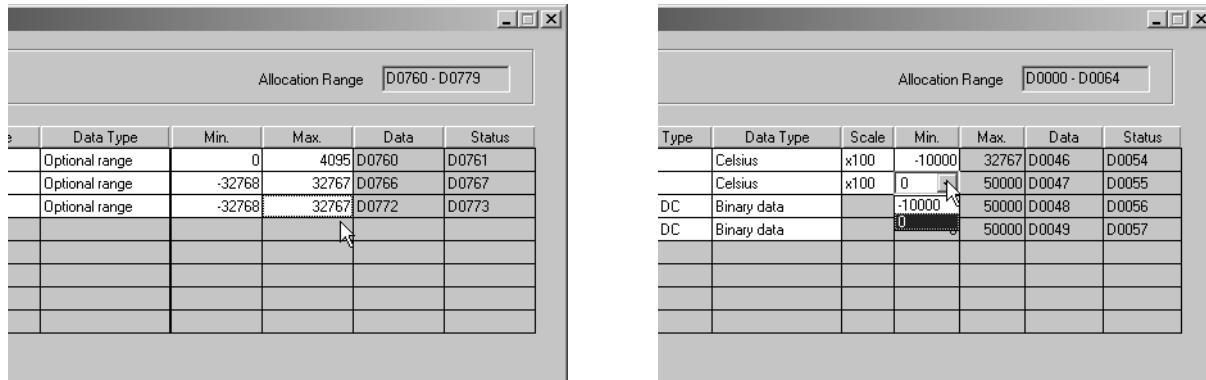
11. View the data register numbers allocated to Data and Status.

Parameter		DR Allocation
Data	**Analog I/O Data** Stores the digital data converted from an analog input signal or converted into an analog output signal. Designated as source operand S4 (process variable) of the PID instruction.	**END Refresh Type** Data registers are automatically allocated depending on the slot where the analog I/O module is mounted. **Ladder Refresh Type** Data registers are automatically allocated depending on the number designated in the DR Allocation Number field.
Status	**Analog I/O Operating Status** Stores an analog I/O operating status code. See pages 4-13 and 4-15.	

12. Click the **OK** button to save changes and exit the Configure Parameter dialog box.

13. Repeat the same steps for other slots.

14. When finished, click the **OK** button to save changes and exit the Set Analog Module Parameters dialog box.
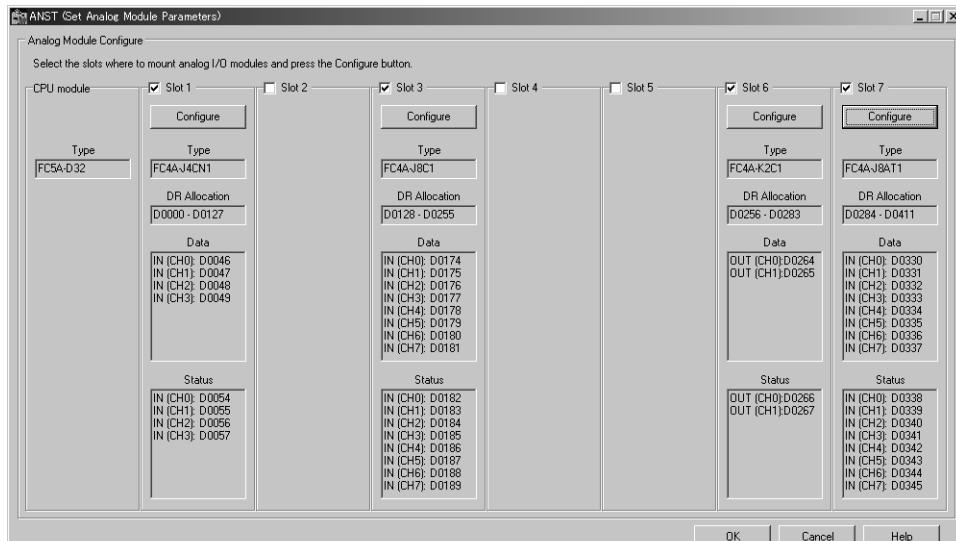
Analog I/O Control Parameters

Available parameters for analog I/O control depend on the type of analog I/O modules as summarized in the following table. Designate the parameters in the Configure Parameters dialog box of the ANST macro as required by your application.

Parameter	Analog I/O Module		Analog Input Module				Analog Output Module	
	END Refresh Type		Ladder Refresh Type				END	Ladder
	FC4A-L03A1	FC4A-L03AP1	FC4A-J2A1	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1	FC4A-K1A1	FC4A-K2C1
Analog Input Signal Type	X	X	X	X	X	X	—	—
	Page 4-11		Page 4-11				—	
Analog Input Data Type	X	X	X	X	X	X	—	—
	Page 4-11		Page 4-11				—	
Analog Input Data Minimum/Maximum Values	X	X	X	X	X	X	—	—
	Page 4-13		Page 4-13				—	
Filter Value	—	—	—	X	X	X	—	—
	—		—	Page 4-13			—	
Thermistor Parameter	—	—	—	—	—	X	—	—
	—			—		4-13	—	
Analog Input Data	X	X	X	X	X	X	—	—
	Page 4-13		Page 4-13				—	
Analog Input Operating Status	X	X	X	X	X	X	—	—
	Page 4-13		Page 4-13				—	
Analog Output Signal Type	X	X	—	—	—	—	X	X
	Page 4-15		—				Page 4-15	
Analog Output Data Type	X	X	—	—	—	—	X	X
	Page 4-15		—				Page 4-15	
Analog Output Data Minimum/Maximum Values	X	X	—	—	—	—	X	X
	Page 4-15		—				Page 4-15	
Analog Output Data	X	X	—	—	—	—	X	X
	Page 4-15		—				Page 4-15	
Analog Output Operating Status	X	X	—	—	—	—	X	X
	Page 4-15		—				Page 4-15	

Data Register Allocation Numbers for Analog I/O Modules

Analog I/O modules are numbered from 1 through 7, in the order of increasing distance from the CPU module. Data registers are allocated to each analog I/O module depending on the analog I/O module number. END refresh type analog I/O modules and ladder refresh type analog I/O modules have different data register allocation.

END Refresh Type Analog I/O Modules

Each END refresh type analog I/O module is automatically allocated 20 data registers to store parameters for controlling analog I/O operation, starting with D760 through D779 for analog I/O module No. 1, up to D880 through D899 for analog I/O module No. 7. When a maximum of seven analog I/O modules are *not* used, data registers allocated to the unused analog I/O module numbers can be used as ordinary data registers.

When a maximum of seven END refresh type analog I/O modules are mounted, data registers D760 through D899 are allocated to analog modules 1 through 7 as shown below. The ANST macro is used to program data registers for the analog I/O module configuration. The CPU module checks the analog I/O configuration only once when the CPU starts to run. If you have changed the parameter while the CPU is running, stop and restart the CPU to enable the new parameter.

The END refresh type analog I/O module number starts with 1 next to the CPU module up to a maximum of 7.

The run-time program download and test program download cannot be used to change analog I/O parameters.

| Channel | Function | END Refresh Type Analog I/O Module No. | | | | | | | R/W |
		1	2	3	4	5	6	7	
Analog Input Ch 0	Analog input data	D760	D780	D800	D820	D840	D860	D880	R
	Analog input operating status	D761	D781	D801	D821	D841	D861	D881	R
	Analog input signal type	D762	D782	D802	D822	D842	D862	D882	R/W
	Analog input data type	D763	D783	D803	D823	D843	D863	D883	R/W
	Analog input data minimum value	D764	D784	D804	D824	D844	D864	D884	R/W
	Analog input data maximum value	D765	D785	D805	D825	D845	D865	D885	R/W
Analog Input Ch 1	Analog input data	D766	D786	D806	D826	D846	D866	D886	R
	Analog input operating status	D767	D787	D807	D827	D847	D867	D887	R
	Analog input signal type	D768	D788	D808	D828	D848	D868	D888	R/W
	Analog input data type	D769	D789	D809	D829	D849	D869	D889	R/W
	Analog input data minimum value	D770	D790	D810	D830	D850	D870	D890	R/W
	Analog input data maximum value	D771	D791	D811	D831	D851	D871	D891	R/W
Analog Output	Analog output data	D772	D792	D812	D832	D852	D872	D892	R/W
	Analog output operating status	D773	D793	D813	D833	D853	D873	D893	R
	Analog output signal type	D774	D794	D814	D834	D854	D874	D894	R/W
	Analog output data type	D775	D795	D815	D835	D855	D875	D895	R/W
	Analog output data minimum value	D776	D796	D816	D836	D856	D876	D896	R/W
	Analog output data maximum value	D777	D797	D817	D837	D857	D877	D897	R/W
– Reserved –		D778	D798	D818	D838	D858	D878	D898	R/W
		D779	D799	D819	D839	D859	D879	D899	R/W

Note: Data registers allocated to the unused analog I/O module numbers can be used as ordinary data registers.

Ladder Refresh Type Analog I/O Modules

When using a ladder refresh type analog input or output module, the first data register number can be designated in the ASNT macro dialog box. The quantity of required data registers depends on the model of the ladder refresh type analog input or output module.

Analog I/O Module	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1	FC4A-K2C1
Quantity of Data Registers for Analog I/O Operation	65	65	65	15

Data register numbers and parameters are shown in the table below.

Ladder Refresh Type Analog Input Module Data Register Allocation (FC4A-J4CN1, FC4A-J8C1, and FC4A-J8AT1)

Data Register Number Offset	Data Size (word)	Parameter	Channel	Default	R/W
+0 (Low Byte)	1	Analog input signal type	CH0	FFh	R/W
+0 (High Byte)		— Reserved —	All channels	00h	
+1	4	Analog input data configuration	CH0	0	R/W
+5	1	Analog input signal type	CH1	00FFh	R/W
+6	4	Analog input data configuration		0	R/W
+10	1	Analog input signal type	CH2	00FFh	R/W
+11	4	Analog input data configuration		0	R/W
+15	1	Analog input signal type	CH3	00FFh	R/W
+16	4	Analog input data configuration		0	R/W
+20	1	Analog input signal type	CH4 *	00FFh	R/W
+21	4	Analog input data configuration		0	R/W
+25	1	Analog input signal type	CH5 *	00FFh	R/W
+26	4	Analog input data configuration		0	R/W
+30	1	Analog input signal type	CH6 *	00FFh	R/W
+31	4	Analog input data configuration		0	R/W
+35	1	Analog input signal type	CH7 *	00FFh	R/W
+36	4	Analog input data configuration		0	R/W
+40	3	Thermistor parameters (FC4A-J8AT1 only)	CH0 to CH3	0	R/W
+43	3		CH4 to CH7 *	0	R/W
+46	1	Analog input data	CH0	—	R
+47	1		CH1	—	R
+48	1		CH2	—	R
+49	1		CH3	—	R
+50	1		CH4 *	—	R
+51	1		CH5 *	—	R
+52	1		CH6 *	—	R
+53	1		CH7 *	—	R
+54	1	Analog input operating status	CH0	—	R
+55	1		CH1	—	R
+56	1		CH2	—	R
+57	1		CH3	—	R
+58	1		CH4 *	—	R
+59	1		CH5 *	—	R
+60	1		CH6 *	—	R
+61	1		CH7 *	—	R
+62	3	— Reserved —	All channels	—	R

* Data registers for channels 4 through 7 are reserved on the FC4A-J4CN1.

Ladder Refresh Type Analog Output Module Data Register Allocation (FC4A-K2C1)

Data Register Number Offset	Data Size (word)	Parameter	Channel	Default	R/W
+0 (Low Byte)	1	Analog output signal type	CH0	FFh	R/W
+0 (High Byte)		— Reserved —	All channels	00h	
+1	3	Analog output data configuration	CH0	0	R/W
+4	1	Analog output signal type	CH1	00FFh	R/W
+5	3	Analog output data configuration		0	R/W
+8	1	Analog output data	CH0	0	R/W
+9	1		CH1	0	R/W
+10	1	Analog output operating status	CH0	—	R
+11	1		CH1	—	R
+12	3	— Reserved —	All channels	—	R

Analog Input Parameters

Analog input parameters include the analog input signal type, analog input data type, analog input minimum and maximum values, filter value, thermistor parameter, analog input data, and analog input operating status. This section describes these parameters in detail.

Analog Input Signal Type

A total of 11 analog input signal types are available, depending on the analog I/O or analog input module. Select an analog input signal type for each analog input channel. When a channel is not used, select the default value or **Not used** for the channel.

	Parameter	FC4A-L03A1	FC4A-L03AP1	FC4A-J2A1	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1
0	Voltage input (0 to 10V DC)	X	—	X	X	X	—
1	Current input (4 to 20 mA DC)	X	—	X	X	X	—
2	Type K thermocouple	—	X	—	X	—	—
3	Type J thermocouple	—	X	—	X	—	—
4	Type T thermocouple	—	X	—	X	—	—
5	Pt 100 resistance thermometer	—	X	—	X	—	—
6	Pt 1000 resistance thermometer	—	—	—	X	—	—
7	Ni 100 resistance thermometer	—	—	—	X	—	—
8	Ni 1000 resistance thermometer	—	—	—	X	—	—
9	NTC type thermistor	—	—	—	—	—	X
10	PTC type thermistor	—	—	—	—	—	X
255	Not used	—	—	—	X	X	X

Analog Input Data Type

A total of five analog input data types are available, depending on the analog I/O or analog input module. Select an analog input data type for each analog input channel.

	Parameter	FC4A-L03A1	FC4A-L03AP1	FC4A-J2A1	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1
0	Binary data	X	X	X	X	X	X
1	Optional range	X	X	X	X	X	X
2	Celsius	—	X	—	X	—	NTC only
3	Fahrenheit	—	X	—	X	—	NTC only
4	Resistance	—	—	—	—	—	X

Binary Data

When Binary data is selected as an analog input data type, the analog input is linearly converted into digital data in the range described in the table below.

Type No.	FC4A-L03A1 FC4A-L03AP1 FC4A-J2A1	FC4A-J4CN1		FC4A-J8C1	FC4A-J8AT1
Analog Input Data	0 to 4095	Analog Input Signal Type Voltage/Current: Thermocouple: Pt100, Ni100: Pt1000, Ni1000:	Analog Input Data 0 to 50,000 0 to 50,000 0 to 6,000 0 to 60,000	0 to 50000	0 to 4000

Optional Range

When Optional range is selected as an analog input data type, the analog input is linearly converted into digital data in the range between the minimum and maximum values designated in the Configure Parameters dialog box.

Type No.	FC4A-L03A1	FC4A-L03AP1	FC4A-J2A1	FC4A-J4CN1	FC4A-J8C1	FC4A-J8AT1
Analog Input Data	Analog input data minimum value to maximum value (−32768 to 32767)					

Celsius and Fahrenheit

When Celsius or Fahrenheit is selected as an analog input data type, the analog input data range depends on the analog input signal type, scale value, and the type of the analog input module, FC4A-L03AP1, FC4A-J4CN1, and FC4A-J8AT1.

• **FC4A-L03AP1**

Analog Input Signal Type	Celsius		Fahrenheit	
	Temperature (°C)	Analog Input Data	Temperature (°F)	Analog Input Data
Type K thermocouple	0 to 1300	0 to 13000	32 to 2372	320 to 23720
Type J thermocouple	0 to 1200	0 to 12000	32 to 2192	320 to 21920
Type T thermocouple	0 to 400	0 to 4000	32 to 752	320 to 7520
Pt100 resistance thermometer	−100.0 to 500.0	−1000 to 5000	−148.0 to 932.0	−1480 to 9320

• **FC4A-J4CN1**

Analog Input Signal Type	Scale	Celsius		Fahrenheit	
		Temperature (°C)	Analog Input Data	Temperature (°F)	Analog Input Data
Type K thermocouple	×1	0 to 1300	0 to 1300	32 to 2372	32 to 2372
	×10	0.0 to 1300.0	0 to 13000	32.0 to 2372.0	320 to 23720
Type J thermocouple	×1	0 to 1200	0 to 1200	32 to 2192	32 to 2192
	×10	0.0 to 1200.0	0 to 12000	32.0 to 2192.0	320 to 21920
Type T thermocouple	×1	0 to 400	0 to 400	32 to 752	32 to 752
	×10	0.0 to 400.0	0 to 4000	32.0 to 752.0	320 to 7520
Pt100, Pt1000 resistance thermometer	×1	−100 to 500	−100 to 500	−148 to 932	−148 to 932
	×10	−100.0 to 500.0	−1000 to 5000	−148.0 to 932.0	−1480 to 9320
	×100	0.00 to 500.00 −100.00 to 327.67	0 to 50000 −10000 to 32767	0.00 to 655.35 −148.00 to 327.67	0 to 65535 −14800 to 32767
Ni100, Ni1000 resistance thermometer	×1	−60 to 180	−60 to 180	−76 to 356	−76 to 356
	×10	−60.0 to 180.0	−600 to 1800	−76.0 to 356.0	−760 to 3560
	×100	−60.00 to 180.00	−6000 to 18000	0.00 to 356.00 −76.00 to 327.67	0 to 35600 −7600 to 32767

• **FC4A-J8AT1**

Analog Input Signal Type	Scale	Celsius		Fahrenheit	
		Temperature (°C)	Analog Input Data	Temperature (°F)	Analog Input Data
NTC thermistor	×1	−50 to 150	−50 to 150	−58 to 302	−58 to 302
	×10	−50.0 to 150.0	−500 to 1500	−58.0 to 302.0	−580 to 3020

Resistance

When Resistance is selected as an analog input data type, the analog input is linearly converted into digital data in the range described in the table below. This option is available only when NTC or PTC type thermistor is selected for the FC4A-J8AT1.

• **FC4A-J8AT1**

Analog Input Signal Type	Resistance	
	Resistance (Ω)	Analog Input Data
NTC/PTC thermistor	0 to 100000	0 to 10000

Analog Input Minimum/Maximum Values

For analog input values, when Optional range is selected for the Data Type, designate the analog input data minimum and maximum values which can be –32,768 through 32,767.

In addition, when using resistance thermometers (Pt100, Pt1000, Ni100, or Ni1000) with the Celsius or Fahrenheit Data Type and the ×100 scale, select the analog input data minimum value from 0 or another value in the pull-down list. The maximum value is changed automatically according to the selected minimum value.

Filter Value

The filter function is available for the ladder input type FC4A-J4CN1, FC4A-J8C1, and FC4A-J8AT1 only. Filtering ensures smooth input of analog data into the CPU module. For the filtering function of analog input signals, see page 4-4.

Valid values are 0 through 255.

Thermistor Parameter

Thermistor parameters are enabled when selecting NTC thermistor for the analog input type of the FC4A-J8AT1. The same parameters are specified for four channels: CH0 to CH3 and CH4 to CH7.

Channel	NTC Thermistor Parameters (Values indicated on the thermistor)		Valid Range
CH0 to CH3 CH4 to CH7	R0:	Thermistor resistance value at the temperature (°C)	0 to 65535
	T0:	Temperature (°C)	–32768 to 32767
	B:	Thermistor B parameter (Kelvin)	0 to 65535

For NTC type thermistors, analog input data can be calculated from the following formula:

$$\text{Analog Input Data} = \frac{B \times T0}{B + T0 \times \log(r/R0)}$$

where, r = thermistor resistance (Ω)

For PTC type thermistors, linearize the analog input data using the XYFS instruction.

Analog Input Data

The analog input signal is converted into a digital value within the range specified by the analog input data type and applicable parameters, and is stored to a data register allocated to analog input data. The analog input data register number is shown under Data in the Configure Parameters dialog box.

END Refresh Type

The analog input signal is converted into a digital value and stored to a data register, such as D760 or D766, allocated to analog input channel 1 or 2 on analog module number 1 through 7 depending on the mounting position.

The analog input data stored in the allocated data register is updated whether the CPU module is running or stopped. When the CPU module is running, the update occurs at the END processing of every scan or 10 ms, whichever is longer. When the CPU module is stopped, the update occurs every 10 ms.

Ladder Refresh Type

The analog input signal is converted into a digital value and stored to a data register determined by the data register number selected in the Configure Parameters dialog box of the ANST macro. The analog input data stored in the allocated data register is updated when the RUNA instruction contained in the ANST macro is executed.

When a certain channel of a ladder refresh type analog input module is not used, data registers allocated to the unused channel will store indefinite values if the values are read out of the analog input module. Do not use the allocated data registers for other purposes.

Only when the analog input status code is 0, the analog input data is assured. Make sure that a user program reads analog input data only when the analog input status code is 0.

Analog Input Operating Status

The operating status of each analog input channel is stored to a data register allocated to analog input operating status. While the analog input is operating normally, the data register stores 0. The analog input operating status data register number is shown under Status in the Configure Parameters dialog box.

END Refresh Type

The operating status of each analog input channel is stored to a data register, such as D761 or D767, allocated to analog input channel 1 or 2 on analog module number 1 through 7 depending on the mounting position.

The analog input operating status data is updated whether the CPU module is running or stopped. When the CPU module is running, the update occurs at the END processing of every scan or 10 ms, whichever is longer. When the CPU module is stopped, the update occurs every 10 ms.

Status Code	Analog Input Operating Status (END refresh type)
0	Normal operation
1	Converting data (during the first data conversion after power-up)
2	Initializing
3	Invalid parameter or analog input channel not available on the installed analog module
4	Hardware failure (external power supply failure)
5	Incorrect wiring (input data over valid range)
6	Incorrect wiring (input data below valid range or current loop open)

Ladder Refresh Type

The operating status of each analog input channel is stored to a data register determined by the data register number selected in the Configure Parameters dialog box of the ANST macro.

Operating Status Bit			Analog Input Operating Status (Ladder refresh type)
Bit 0	0	Operating status bit	Normal operation
	1		Initializing, changing configuration, hardware initialization error
Bit 1	0	Parameter bit	Parameter configuration normal
	1		Parameter configuration error
Bit 2	0	External power supply bit	External power supply normal
	1		External power supply error
Bit 3	0	Maximum value over bit	Within the maximum value
	1		Maximum value over error
Bit 4	0	Minimum value over bit	Within the minimum value
	1		Minimum value under error
Bit 5 to Bit 15	0	Reserved	Normal operation

Analog Output Parameters

Analog output parameters include the analog output signal type, analog output data type, analog output minimum and maximum values, analog output data, and analog output operating status. This section describes these parameters in detail.

Analog Output Signal Type

A total of three analog output signal types are available, depending on the analog I/O or analog output module. Select an analog output signal type for each analog output channel. When a channel is not used, select the default value or **Not used** for the channel.

	Parameter	FC4A-L03A1	FC4A-L03AP1	FC4A-K1A1	FC4A-K2C1
0	Voltage output	0 to 10V DC			−10 to +10V DC
1	Current output	4 to 20 mA DC			
255	Not used	—	—	—	X

Analog Output Data Type

A total of two analog output data types are available, depending on the analog I/O or analog output module. Select an analog output data type for each analog output channel.

	Parameter		FC4A-L03A1	FC4A-L03AP1	FC4A-K1A1	FC4A-K2C1
0	Binary data	Voltage	0 to 4095			−25000 to 25000
		Current				0 to 50000
1	Optional range	Voltage	Analog output data minimum value to maximum value (−32768 to 32767)			
		Current				

Analog Output Minimum/Maximum Values

For analog output values, when Optional range is selected for the Data Type, designate the analog output data minimum and maximum values which can be −32,768 through 32,767.

Analog Output Data

The analog output data is converted into an analog output signal within the range specified by the analog output data type and applicable parameters. The analog output data register number is shown under Data in the Configure Parameters dialog box.

END Refresh Type

The analog output data stored in a data register, such as D772, is converted into an analog output signal of voltage output (0 to 10V DC) or current output (4 to 20 mA) as designated by the value stored in the data register allocated to analog output signal type, such as D774.

While the CPU module is running, the analog output data stored in the allocated data register is updated at the END processing of every scan or 10 ms, whichever is longer. While the CPU module is stopped, the analog output data remains at 0 or the designated analog output data minimum value, so the generated analog output signal remains at the minimum value of 0V DC or 4 mA DC.

Ladder Refresh Type

While the CPU module is running, the analog output data stored in the allocated data register is updated when the RUNA instruction contained in the ANST macro is executed. While the CPU module is stopped, the analog output data is not updated. But the analog output signal can be changed by using the STPA instruction. For details, see page 4-21.

Analog Output Operating Status

The operating status of each analog output channel is stored to a data register allocated to analog output operating status. While the analog output is operating normally, the data register stores 0. The analog output operating status data register number is shown under Status in the Configure Parameters dialog box.

END Refresh Type

The operating status of each analog output is stored to a data register, such as D773. While the analog output is operating normally, the data register stores 0. The analog output operating status data is updated whether the CPU module is running or stopped. The update occurs at the END processing of every scan or 10 ms, whichever is longer.

Status Code	Analog Output Operating Status (END refresh type)
0	Normal operation
1	(reserved)
2	Initializing
3	Invalid parameter or analog output channel not available on the installed analog module
4	Hardware failure (external power supply failure)

Ladder Refresh Type

The operating status of each analog output channel is stored to a data register determined by the data register number selected in the Configure Parameters dialog box of the ANST macro.

Operating Status Bit			Analog Output Operating Status (Ladder refresh type)
Bit 0	0	Operating status bit	Normal operation
	1		Initializing, changing configuration, hardware initialization error
Bit 1	0	Parameter bit	Parameter configuration normal
	1		Parameter configuration error
Bit 2	0	External power supply bit	External power supply normal
	1		External power supply error
Bit 3	0	Output data error bit	Output data normal
	1		Output data range error
Bit 4 to Bit 15	0	Reserved	Normal operation

Example: Analog I/O

The following example demonstrates a program of analog I/O control using an NTC thermistor. Two analog I/O modules are mounted in the slots shown below.

System Setup
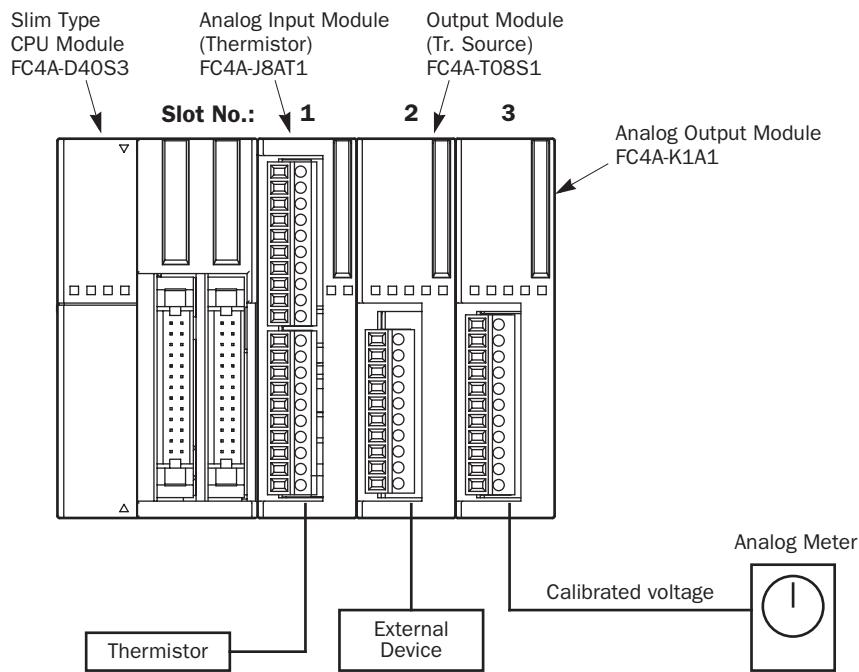
Operation

In this example, the input value from the NTC thermistor is calibrated. When the temperature reaches the preset value, the output is turned off. The thermistor temperature is monitored on an analog meter.

Wiring Diagram

FC4A-J8AT1 (Analog Input Module)

Terminal No.	Channel
24V	24V DC
0V	
⏚	
NC	—
A	IN0
B	
A	IN1
B	
A	IN2
B	

A	IN3
B	
A	IN4
B	
A	IN5
B	
A	IN6
B	
A	IN7
B	

• Thermistor Specifications

Type No.	NT731ATTD103K38J (KOA)
Type	NTC
RO	10,000Ω
TO	298K (25°C)
B Parameter	3,800K
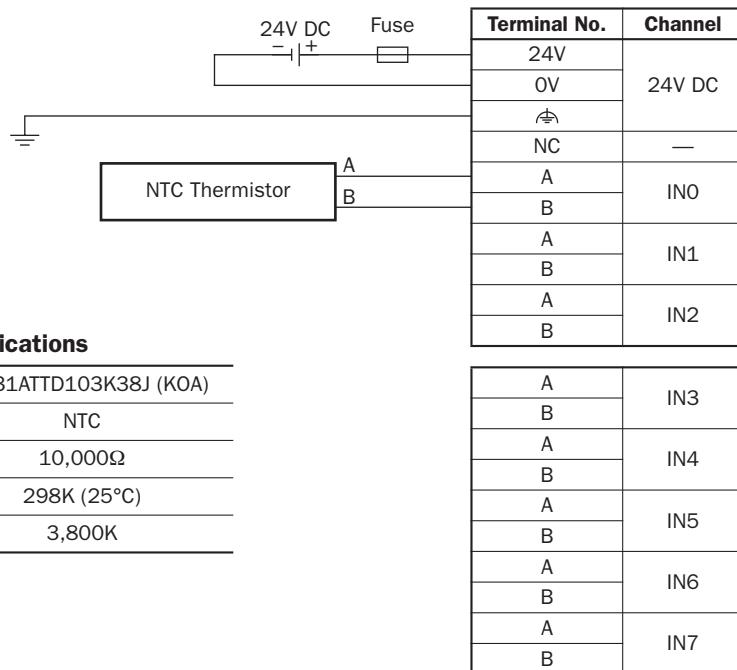
FC4A-T08S1 (8-point Transistor Source Output Module)

Terminal No.	Output
0	Q0
1	Q1
2	Q2
3	Q3
4	Q4
5	Q5
6	Q6
7	Q7
COM(+)	COM(+)
−V	−V

FC4A-K1A1 (Analog Output Module)

Terminal No.	Channel
+	24V DC
−	
⏚	
+	OUT
−	
NC	—
NC	
NC	
NC	—
NC	
NC	
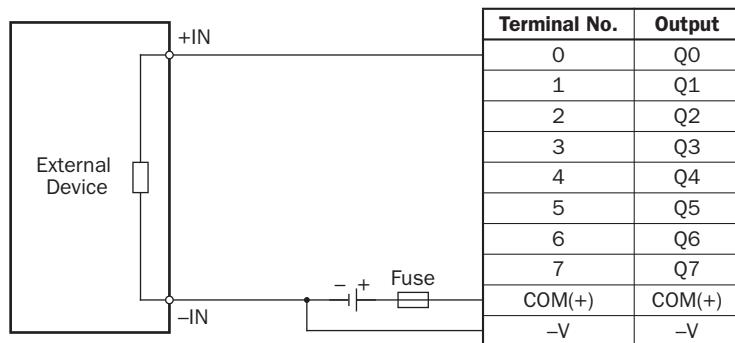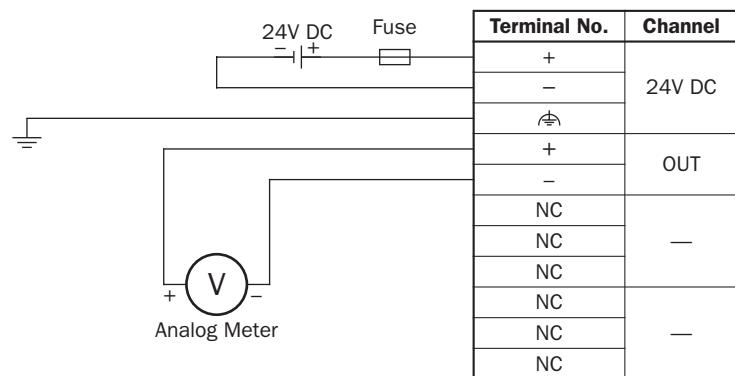
WindLDR Programming

Analog I/O modules are programmed using the ANST macro in WindLDR. Program the ANST macro as shown below.

• **Analog Input Module FC4A-J8AT1 on Slot 1**
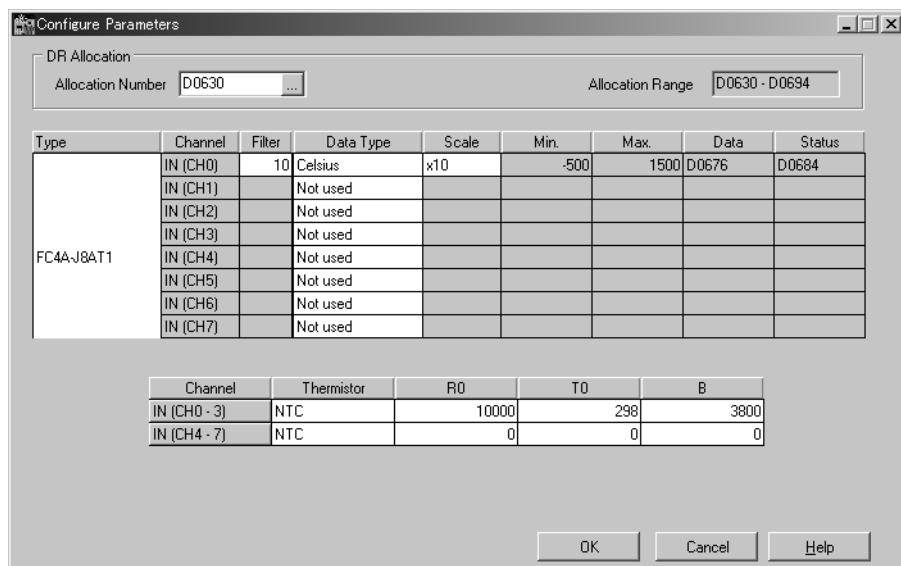
DR Allocation Range			Designation	Description
D630 - D694			D630	Optional range allocation, 65 words
I/O	Channel	Item	Designation	Description
IN	CH0	Filter	10	Averages input values
		Data Type	Celsius	Analog input range –50 to 150°C
		Scale	×10	Analog input data –500 to 1500
	CH1	Data Type	Not used	Unused channel
	CH2	Data Type	Not used	Unused channel
	CH3	Data Type	Not used	Unused channel
	CH4	Data Type	Not used	Unused channel
	CH5	Data Type	Not used	Unused channel
	CH6	Data Type	Not used	Unused channel
	CH7	Data Type	Not used	Unused channel
	CH0 - CH3	Thermistor Type	NTC	NTC thermistor
		R0	10,000	Resistance value at the absolute temperature = 10 kΩ
		T0	298	Absolute temperature = 298K (25°C)
		B	3,800	B parameter = 3,800K

Note: When CH4 through CH7 are not used, thermistor settings are not required.

• **Analog Output Module FC4A-K1A1 on Slot 3**
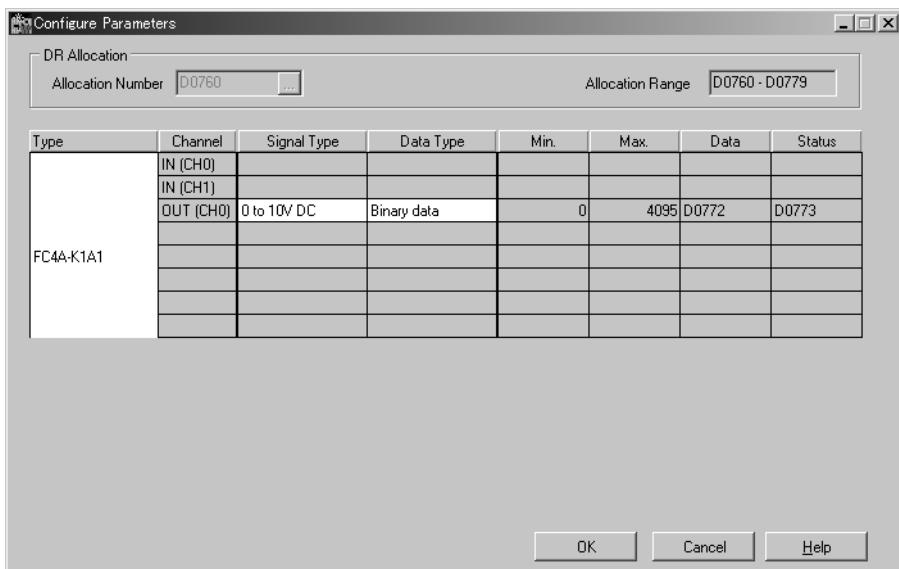
DR Allocation Range			Designation	Description
D760 - D779			—	Automatic range allocation, 20 words
I/O	**Channel**	**Item**	**Designation**	**Description**
OUT	CH0	Signal Type	0 to 10V DC	Voltage output
		Data Type	Binary data	0 to 4095

Ladder Diagram

As shown in the ladder diagram below, when initialize pulse special internal relay M8120 is used for the ANST macro in parallel with another instruction, load M8120 again for the other instruction.
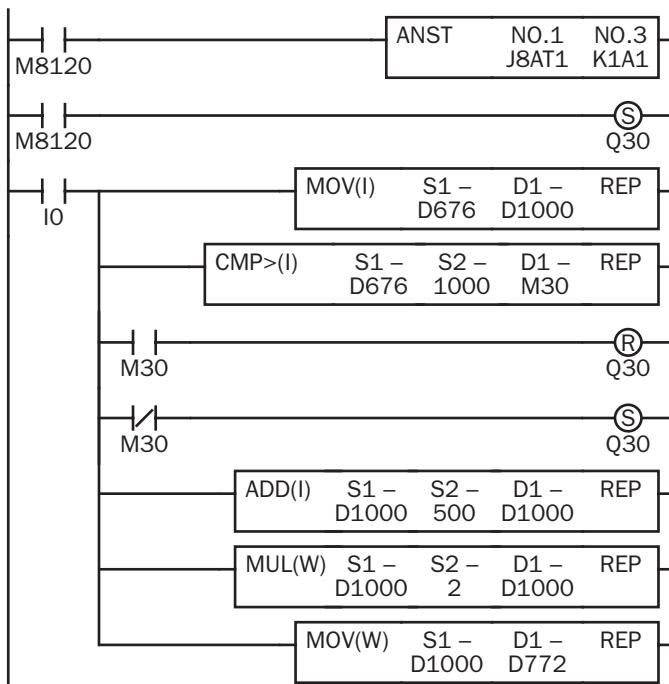
M8120 is the initialize pulse special internal relay.

When the CPU starts to run, ANST stores parameters to data registers to configure analog I/O modules and Q30 is turned on.

When I0 is turned on, analog input data is moved from D676 to D1000.

The temperature is compared with the alarm temperature of 100°C.

When the temperature is higher than 100°C, Q30 is turned off.

When the temperature is not higher than 100°C, Q30 is turned on.

Analog input data of –500 to +1500 is converted to 0 to 2000.

Analog input data of 0 to 2000 is converted to 0 to 4000.

Analog input data of 0 to 4000 is moved to D772 (analog output data) of the analog output module.

Note: The above ladder diagram is only an example and should be modified as required.

Changing Analog Output While CPU is Stopped

When using the FC4A-K2C1 analog output module, the analog output value can be changed while the CPU module is stopped. To change the analog output value, store a required output value to the memory addresses allocated to the analog output data.

Example: Memory Allocation of Ladder Refresh Type Analog Output Module FC4A-K2C1

Memory Address (data address used for STPA)	Data Size (bytes)	R/W	Parameter	
+20	2	R/W	Analog Output Data	CH0
+22	2	R/W		CH1

STPA instruction when FC4A-K2C1 is mounted on slot 4
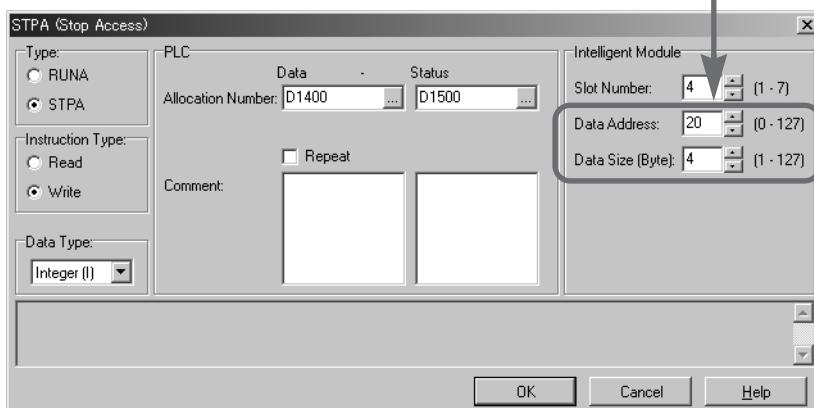
Ladder Diagram
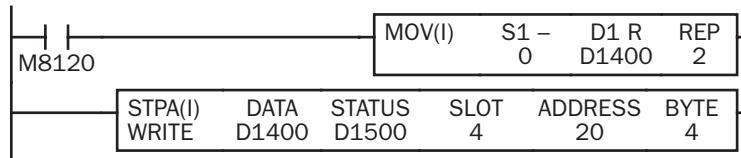
M8120 is the initialize pulse special internal relay.

MOV stores output values at the OFF state.

When the CPU stops, STPA updates the analog output value of the analog output module.

Note: The above ladder diagram is only an example and should be modified as required.

## Precautions for Programming ANST Macro

When using the ANST macro, do not make a branch from the ladder line of the ANST macro.

Incorrect

Delete the branch from the ANST macro, and start another line by inserting a LOD instruction.

Correct

IDEC
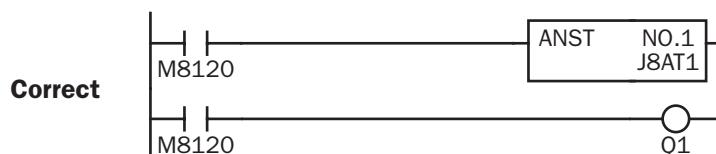
5: TROUBLESHOOTING

Introduction

This chapter describes the procedures to determine the cause of trouble and actions to be taken when any trouble occurs while operating the analog I/O modules. When a trouble occurred, check the points and take the actions described below. If the trouble cannot be solved, call IDEC for assistance.

Troubleshooting Diagrams

Analog I/O module does not work correctly (END Refresh Type)

```
┌─────────────────────────────┐
│ Analog I/O module does not  │
│ work correctly (END Refresh │
│ Type).                      │
└─────────────────────────────┘
              │
              ▼
         Does the Status              YES    ┌────────────────────────────────┐
         DR store status code 4  ──────────▶ │ Supply the rated power voltage  │
         (hardware failure)?                  │ to the analog I/O module.       │
              │                               │ See pages 4-14 and 4-16.        │
              │ NO                            └────────────────────────────────┘
              ▼
         Does the Status              YES    ┌────────────────────────────────┐
         DR store status code 3  ──────────▶ │ Make sure of correct parameters.│
         (invalid parameter)?                 └────────────────────────────────┘
              │
              │ NO
              ▼
         After changing settings,    NO     ┌────────────────────────────────┐
         was the CPU stopped and  ──────────▶│ Stop and restart the CPU to     │
         restarted?                           │ configure the analog I/O        │
              │                               │ settings.                       │
              │ YES                           └────────────────────────────────┘
              ▼
         Are data registers          YES    ┌────────────────────────────────┐
         duplicated?             ──────────▶ │ Change data register numbers to │
              │                               │ eliminate duplicated data       │
              │ NO                            │ registers.                      │
              ▼                               └────────────────────────────────┘
┌─────────────────────────────┐
│ Call IDEC for assistance.   │
└─────────────────────────────┘
```

Analog I/O module does not work correctly (Ladder Refresh Type)

```
┌────────────────────────────────┐
│ Analog I/O module does not work │
│ correctly (Ladder Refresh Type).│
└────────────────────────────────┘
                │
                ▼
      ◇ Is the status LED turned on? ◇ ──NO──▶ ◇ Does the Status DR store status code 4 (external power supply error)? ◇ ──YES──▶ ┌──────────────────────────────┐
                │                                              │                                                          │ Supply the rated power voltage │
               YES                                            NO                                                         │ to the analog I/O module.      │
                │                                              │                                                          │ See pages 4-14 and 4-16.       │
                │                                              ▼                                                          └──────────────────────────────┘
                │                              ◇ Does the Status DR store status code 1 (initializing)? ◇ ──YES──▶ ┌──────────────────────────────┐
                │                                              │                                                    │ Program M8120 (initialize pulse)│
                │                                             NO                                                   │ as an input for the ANST macro, │
                │                                              │                                                    │ and stop and restart the CPU.   │
                │                                              │                                                    └──────────────────────────────┘
                ▼                                              │
  ◇ Does the Status DR store status code 2 (parameter configuration error)? ◇ ──YES──▶ ┌──────────────────────────────┐
                │                                                                        │ Make sure of correct parameters.│
               NO                                                                       └──────────────────────────────┘
                │
                ▼
  ◇ Is "Not used" selected for the Signal Type? ◇ ──YES──▶ ┌──────────────────────────────┐
                │                                            │ Select a required Signal Type for│
               NO                                           │ the channel to be used.          │
                │                                            └──────────────────────────────┘
                ▼
  ◇ After changing settings, was the CPU stopped and restarted? ◇ ──NO──▶ ┌──────────────────────────────┐
                │                                                           │ Stop and restart the CPU to      │
               YES                                                         │ configure the analog I/O settings.│
                │                                                           └──────────────────────────────┘
                ▼
  ◇ Are data registers duplicated? ◇ ──YES──▶ ┌──────────────────────────────┐
                │                               │ Change data register numbers to  │
               NO                              │ eliminate duplicated data registers.│
                │                               └──────────────────────────────┘
                ▼
┌────────────────────────┐
│ Call IDEC for assistance.│
└────────────────────────┘
```

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