FX-4AD

Foreword

- This manual provides technical information on the use of the FX-4AD special function block in connection with the FX programmable controller.

- Users should ensure that the details of this manual are studied and understood before attempting to install or use these units.

CONTENTS

Chapter 8 is concerned with the changing of the default settings. If you don't plan to change these defaults, you can skip this section.

1. INTRODUCTION

(1) Introduction

The FX-4AD analog input unit converts up to 4 channels of analog input (either voltage or current) into 12-bit digital readings and transfers the data to an FX series programmable controller. Optical coupling is used to ensure that voltage surges do not damage other areas of your equipment.

(2) Compatible PCs

Versions 2.0 or later of the FX series of programmable controllers (those with serial nos. 13XXXX or larger) may be used with the FX-4AD. (This is because the FROM and TO commands are required to transfer data between the programmable controller base unit and the FX-4AD.)

(3) Analog Input Range

Depending on the type of input mode you choose, voltage from -10V to +10V or current from -20mA to +20mA or +4mA to +20mA can be read on up to four input channels. The resolution is 5mV for voltage input or 20μA for current input.

(4) Unit Configuration

The enclosure of the FX-4AD unit resembles to that of the 16 I/O point extension blocks, but the number of I/O points occupied by the FX-4AD is actually 8 (you can count them as either input or output points). For the purposes of power consumption, the FX-4AD unit draws 30mA from the 5V supply of the base unit. Use this figure to calculate whether the base unit has enough power to support this and other special blocks.
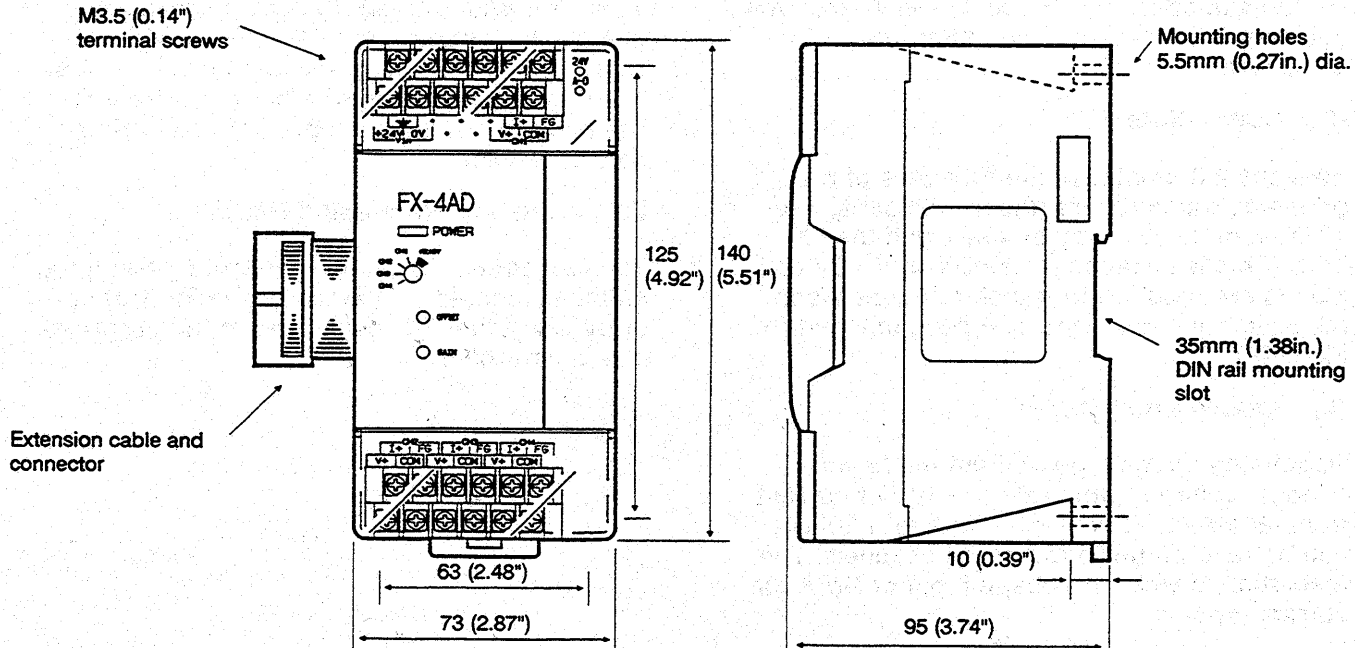
(5) Adjusting Gain and Offset

You can adjust the gain and offset by using the switches located on the top of the FX-4AD unit or by using the "TO" command in the programmable controller.

1

2. CONFIGURATION AND SPECIFICATIONS

(1) DIMENSIONS

- Weight: Approx. 0.5 kg (1.1lbs)

- Accessories: Self adhesive labels for special block number identification

M3.5 (0.14")
terminal screws

FX-4AD

POWER

125 (4.92") 140 (5.51")

Mounting holes
5.5mm (0.27in.) dia.

35mm (1.38in.)
DIN rail mounting
slot

Extension cable and
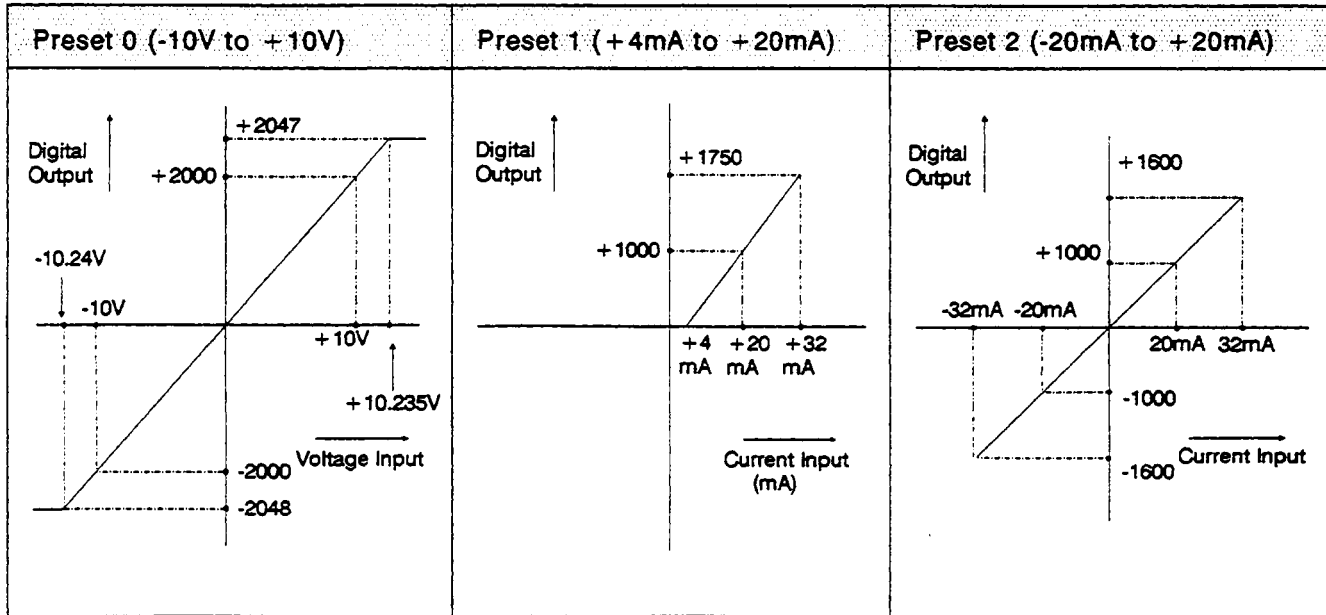connector

63 (2.48")

73 (2.87")

10 (0.39")

95 (3.74")

2. CONFIGURATION AND SPECIFICATIONS

(2) Performance Specifications

The environmental specifications for the FX-4AD are the same as those for your base unit. Isolation tests are made between the earth terminal and a common point of all other terminals (including FG terminal).

| Item	Voltage input	Current input
	Either voltage or current input can be selected with your choice of input terminal. Up to four Input points can be used at one time.	
Analog input range	DC -10V to +10V (input resistance: 200KΩ). Warning: this unit may be damaged by input voltages in excess of +/-15V.	DC -20mA to +20mA (input resistance: 250Ω). Warning: this unit may be damaged by input currents in excess of +/-32mA
Digital output	12-bit conversion stored in 16-bit 2's complement form. Maximum value: +2047 Minimum value: -2048	
Resolution	5mV (10V default range 1/2000)	20μA (20mA default range 1/1000)
Overall accuracy	+/-1% (for the range of -10V to +10V)	+/-1% (for the range of -20mA to +20mA)
Conversion speed	15ms per channel	
Isolation	Photo-coupler isolation between analog and digital circuits. DC/DC converter isolation from base unit. (No isolation between inputs)	
Power source	DC 24V +/-10% 50mA	
I/O Specifications	8 I/O points are occupied in the software (i.e. the base unit image table). They may be regarded as either inputs or outputs. Power consumption is 30mA from the 5V rail from the base unit.	

2. CONFIGURATION AND SPECIFICATIONS

Preset 0 (-10V to +10V)	Preset 1 (+4mA to +20mA)	Preset 2 (-20mA to +20mA)
Digital Output +2047 +2000 -10.24V -10V +10V +10.235V -2000 Voltage Input -2048	Digital Output +1750 +1000 +4 +20 +32 mA mA mA Current Input (mA)	Digital Output +1600 +1000 -32mA -20mA 20mA 32mA -1000 -1600 Current Input

Preset ranges are selected by an appropriate setting in buffer memory of the analog input block.

Current/voltage input selection must match the correct input terminal connections.

4

3. WIRING

(1) Wiring
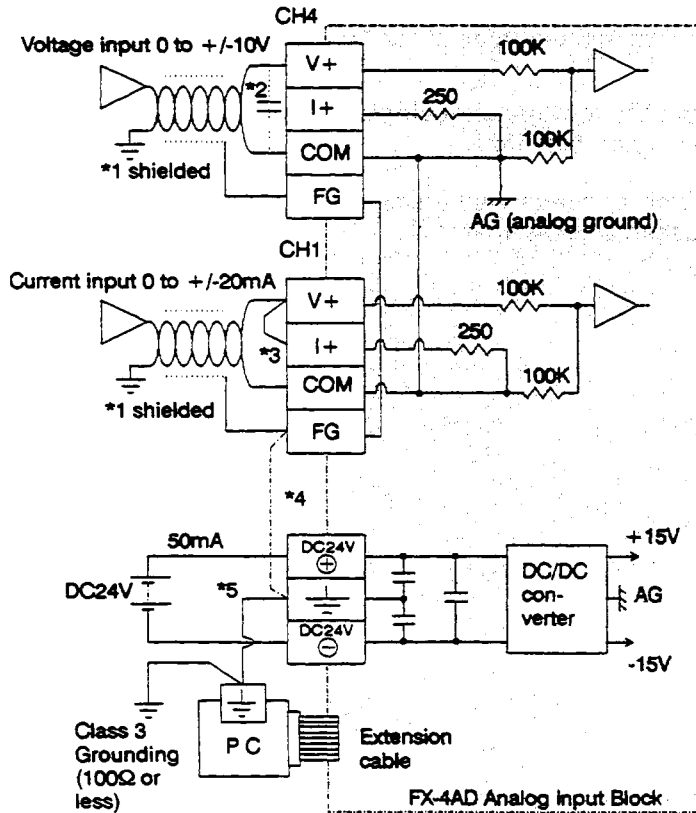
*1 The analog input is received through a twisted pair shielded cable. This cable should be wired separately from power lines or any other lines which may induce electrical noise.

*2 If a voltage ripple occurs during input, or there is electrically induced noise on the external wiring, connect a smoothing capacitor of 0.1 to 0.47μF, 25V.

*3 If you are using current input, connect the V+ and I+ terminals to each other.

*4 If there is excessive electrical noise, connect the FG frame ground terminal with the grounded terminal on the FX-4AD.

*5 Connect the ground terminal on the FX-4AD unit with the grounded terminal on the base unit. Use class 3 grounding on the base unit, if available.

3. WIRING

(2) Using crimp terminations

Less than
6.8mm (0.27 in)

Use M3.5 (0.14 in)

Less than
6.8mm (0.27 in)
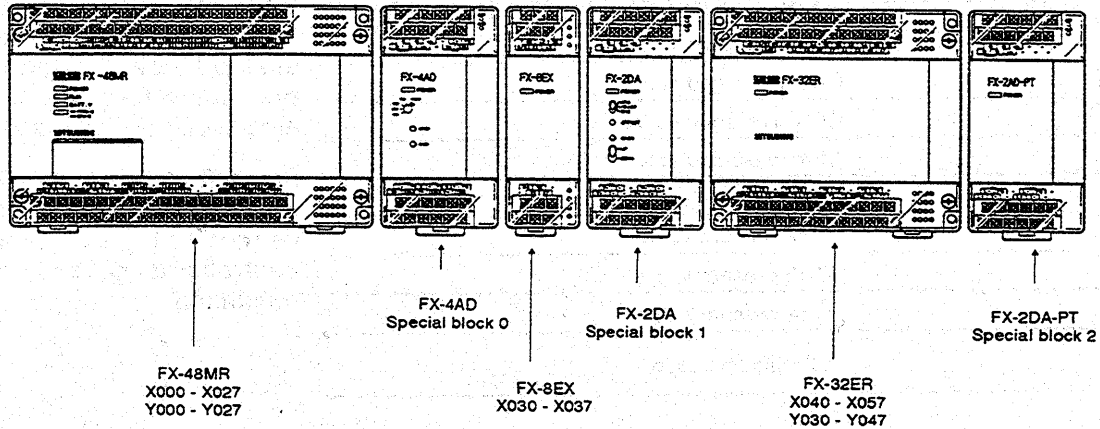
●Use crimp terminations of the type indicated on the left.

● Secure the termination using a tightening torque of between 5 and 8kg·cm.

●Wire only to the module terminals discussed in this manual. Leave all others vacant.

6

3. WIRING

(3) Use with other extension blocks

The FROM and TO commands are used by most of the Special Function Blocks, (e.g. the analog input blocks, analog output blocks, high-speed counter blocks). These may be connected directly to the FX Programmable Controller's extension port or to any other extension unit's right side extension port. Each unit or block is consecutively numbered from 0 to 7 beginning from the one closest to the base unit. A maximum of 8 special function blocks or units can be connected to one base unit.

FX-4AD
Special block 0

FX-2DA
Special block 1

FX-2DA-PT
Special block 2

FX-48MR
X000 - X027
Y000 - Y027

FX-8EX
X030 - X037

FX-32ER
X040 - X057
Y030 - Y047

4. BUFFER MEMORY ASSIGNMENT

Data transfer between the FX-4AD analog input unit and the Programmable Controller is through the FX-4AD's RAM buffer memory (32 addresses each of 16 bits).

BFM	Contents
* #0	Channel Initialization Default = H0000
* #1	Number of samples for averaging for CH1 (1 to 4096) Default = 8
* #2	Number of samples for averaging for CH2 (1 to 4096) Default = 8
* #3	Number of samples for averaging for CH3 (1 to 4096) Default = 8
* #4	Number of samples for averaging for CH4 (1 to 4096) Default = 8
#5	CH1 averaged value
#6	CH2 averaged value
#7	CH3 averaged value
#8	CH4 averaged value
#9	CH1 present value
#10	CH2 present value
#11	CH3 present value
#12	CH4 present value
#13-#19	Cannot be used

In buffer memory locations (BFMs) marked with an "*", data can be written from the programmable controller using the TO command.

Before reading from the analog block, ensure these settings have been sent to the analog block. Otherwise, the previous values held in the analog block will be used.

For buffer memories (BFMs) without the "*" mark, data can be read to the programmable controller using the FROM command.

4. BUFFER MEMORY ASSIGNMENT

(1) Channel initialization is made by a 4 character HEX number H○○○○in buffer memory BFM#0. The least significant character controls channel 1 and the fourth character controls channel 4. Setting of each character is as follows:

　　　　　　　　　　　　○ = 0: Preset range (-10V to +10V)
　　　　　　　　　　　　○ = 1: Preset range (+4mA to +20 mA)
　　　　　　　　　　　　○ = 2: Preset range (-20mA to +20mA)
　　　　　　　　　　　　○ = 3: Channel OFF

　　Example: H3310

　　　　　　　　　　CH1: preset range (-10V to +10V)
　　　　　　　　　　CH2: preset range (+4mA to +20mA)
　　　　　　　　　　CH3, CH4: Channel OFF

(2) The present value of the input is assigned to buffer memory BFMs #9 to #12, and the averaged input values to BFMs #5 to #8.

(3) The number of samples to be averaged is assigned to BFMs #1 to #4. Only the range 1 to 4096 is valid. Values outside this range are ignored and the default value of 8 is used.

4. BUFFER MEMORY ASSIGNMENT

The buffer memory also gives a facility to adjust offset and gain by software as well as by panel switches of the FX-4AD unit.

BFM.		b7	b6	b5	b4	b3	b2	b1	b0
* #20	Reset to Defaults and Preset.		Default = 0						
* #21	Offset, Gain Adjust Prohibit.		Default = (0,1) Permit						
*#22	Offset, Gain Adjust	G4	O4	G3	O3	G2	O2	G1	O1
* #23	Offset Value		Default = 0						
* #24	Gain Value		Default = 5,000						
#25 to #28		Reserved							
#29		Error status (See P. 12)							
#30		Identification code K2010 (See P.13)							
#31		Cannot be used							

- In BFMs marked with an "*", data can be written from the programmable controller using the TO command. For the other BFMs, data can be read to the programmable controller using the FROM command.

- Offset (intercept): The analog input value when the digital output becomes 0.

- Gain (slope): The analog input value when the digital output becomes +1000.

4. BUFFER MEMORY ASSIGNMENT

(1) When buffer memory BFM #20 is activated by setting it to K1, all settings within the analog block are reset to their default settings. This is a very quick method to erase any undesired gain and offset adjustments.

(2) If (b1,b0) of BFM #21 is set to (1,0), gain and offset adjustments are prohibited to prevent inadvertent changes by the operator. In order to adjust the gain and offset values, bits (b1,b0) must be set to (0,1). The default is (0,1).

(3) Gain and offset values of BFM#23 and #24 are sent to non-volatile memory gain and offset registers of the specified input channels. Input channels to be adjusted are specified by the appropriate G-O (gain-offset) bits of BFM#22. Example: If bits G1 and O1 are set to 1, input channel 1 will be adjusted when BFM#22 is written to by a TO instruction.

Channels can be adjusted individually or together with the same gain and offset values.

(4) Gain and offset values in BFM #23 #24 are in units of mV or μA. Due to the resolution of the unit the actual response will be in steps of 5mV or 20μA.

5. STATUS INFORMATION

Status information BFM #29

Bit		ON	OFF
b0:	Error	When any of b1 to b4 is ON. If any of b2 to b4 is ON, A/D conversion of all the channels is stopped.	No error
b1:	Offset/Gain error	Offset/Gain data in EEPROM is corrupted or adjustment error.	Offset/Gain data normal
b2:	Power source abnormality	DC 24V power supply failure	Power supply normal
b3:	Hardware error	A/D converter or other hardware failure	Hardware normal
b4:	Program error	Incorrect installation or FROM/TO command misused	No error
b8:	Not READY	FX-4AD MODE switch is not set to READY.	READY mode
b10:	Digital range error	Digital output value is less than -2048 or more than +2047	Digital output value is normal
b11:	Averaging error	Number of averaging samples is 4097 or more or 0 or less (default of 8 will be used)	Averaging is normal (between 1 and 4096)
b12:	Offset/gain adjust prohibit	Prohibit - (b1,b0) of BFM#21 is set to (1,0)	Permit - (b1,b0) of BFM#21 is set to (0,1)

Note: ● *b5 to b7, b9 and b13 to b15 are undefined.*

5. STATUS INFORMATION

(1) Identification code BFM #30

The identification code number for a Special Block is read using the FROM command.

The code for the FX-4AD unit is K2010.

The user's program in the programmable controller can use this facility in the program to identify the special block before commencing data transfer from and to the special block.

CAUTION

- *Values of BFM#0, #23 and #24 are copied to EEPROM memory of the FX-4AD. BFM#21 and BFM#22 are only copied when data is written to the gain/offset command buffer BFM#22. Also, BFM#20 causes writing to the EEPROM memory. The EEPROM has a life of about 10,000 cycles (changes), so do not use programs which frequently change these BFMs.*

- *Because of the time needed to write to the EEPROM memory, a delay of 300 ms is required between instructions thet cause a write to the EEPROM.*
  Therefore, a delay timer should be used before writing to the EEPROM a second time.

6. OPERATION PROCEDURE

(1) Example (1)

If the offset and gain settings are left at their default values, and the status information is ignored, you can use the simple program which follows.
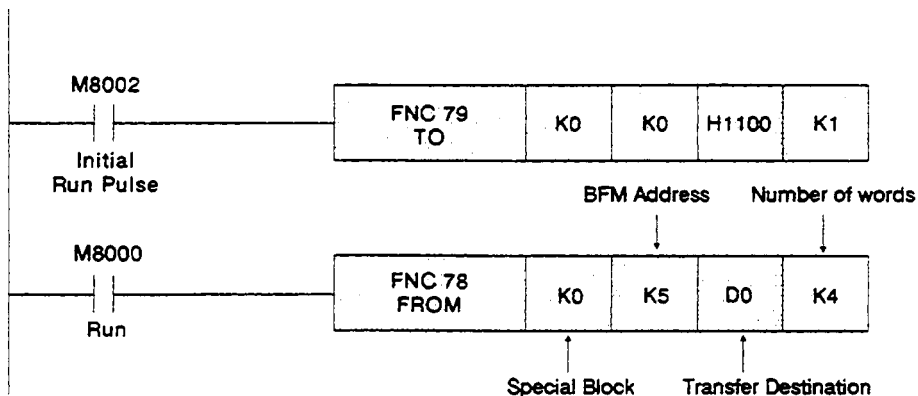
Program Result :

H1100 transferred to BFM#0

BFM#5 transferred to D0 (CH1) (-10V to +10V)

BFM#6 transferred to D1 (CH2) (-10V to +10V)

BFM#7 transferred to D2 (CH3) (+4mA to +20mA)

BFM#8 transferred to D3 (CH4) (+4mA to +20mA)

6. OPERATIONAL PROCEDURE

1) Procedure

    1. Write the program into the programmable controller.

    2. Turn off the power to the programmable controller.

    3. Connect the FX-4AD block to the base unit at the closest position.

    4. Set the MODE switch on the FX-4AD panel to READY.

    5. Turn on the programmable controller and the FX-4AD unit.

2) Result

The values on data registers D0 to D3 will vary according to the analog input in each input channel of the FX-4AD unit.

(-2000 to +2000 for voltage input -10V to +10V)
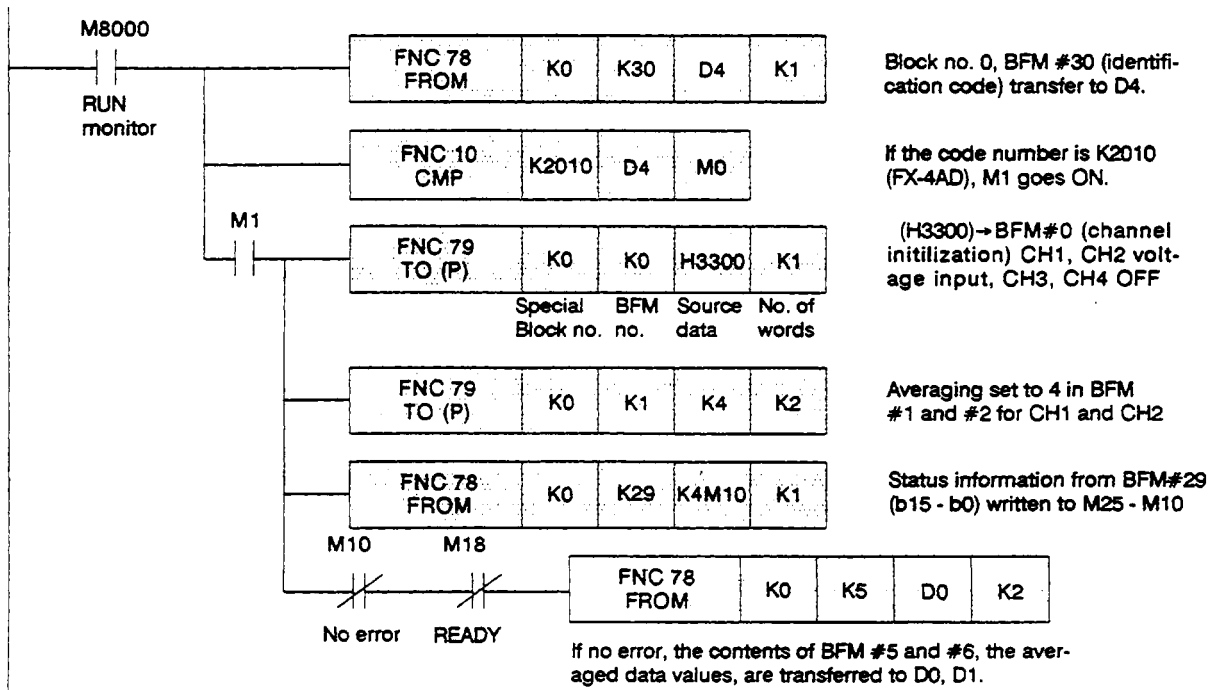(-1000 to +1000 for current input -20mA to +20mA)

In this example the FX-4AD unit occupies the position of special block No.0 (that is the closest unit to the base unit). Input data averaged from 8 samples (default) from channels CH1 to CH4 is transferred to the corresponding data registers D0 to D3.

6. OPERATION PROCEDURE

(2) Example (2)

In the following example only inputs on channels CH1 and CH2 are used and are read as voltage inputs. The FX-4AD block is connected at the position of special block No.0. Averaging is set at 4 and data registers D0 and D1 of the programmable controller receive the averaged digital output.

M8000 RUN monitor	FNC 78 FROM	K0	K30	D4	K1	Block no. 0, BFM #30 (identification code) transfer to D4.

	FNC 10 CMP	K2010	D4	M0	If the code number is K2010 (FX-4AD), M1 goes ON.

M1

	FNC 79 TO (P)	K0	K0	H3300	K1	(H3300)→BFM#0 (channel initilization) CH1, CH2 voltage input, CH3, CH4 OFF

Special Block no. / BFM no. / Source data / No. of words

	FNC 79 TO (P)	K0	K1	K4	K2	Averaging set to 4 in BFM #1 and #2 for CH1 and CH2

	FNC 78 FROM	K0	K29	K4M10	K1	Status information from BFM#29 (b15 - b0) written to M25 - M10

M10   M18

	FNC 78 FROM	K0	K5	D0	K2

No error   READY

If no error, the contents of BFM #5 and #6, the averaged data values, are transferred to D0, D1.

16

7. PRELIMINARY CHECKS

(1) Standard Operation

1. Check that the analog input cable, power line, and extension cable are all properly connected.

2. 5V 30mA is supplied from the base or extension units for the FX-4AD. Check that there is no power overload caused by this and other special blocks.

3. When DC 24V power is supplied from the base and extension units of the programmable controller, check that the current is below the allowable limit (this varies according to the number of extension blocks connected).

4. Set the MODE switch on the FX-4AD to "READY" and turn the DC 24V power on.

5. Put the programmable controller into RUN mode.

(2) Troubleshooting

The following LEDs on the front cover of the FX-4AD can help you troubleshoot the unit.

(a) The POWER LED

This lights up when 5V power is supplied from the programmable controller. If it is not lit, check to see if the extension cable is properly connected.
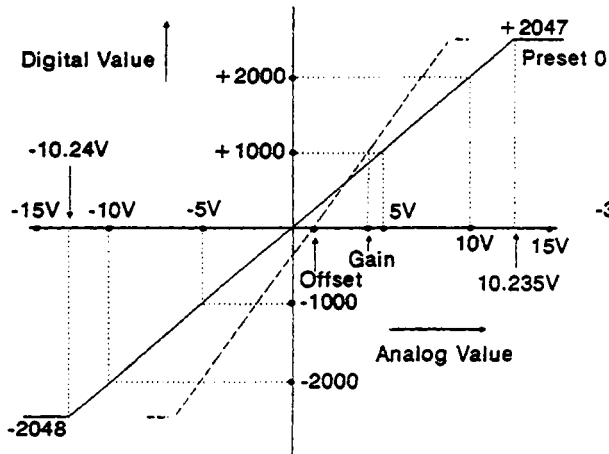
(b) The 24V LED

This lights up when DC 24V power is supplied to the FX-4AD. If it is not lit, even if DC 24V +/- 10% is being supplied, failure of the FX-4AD unit may have occurred.
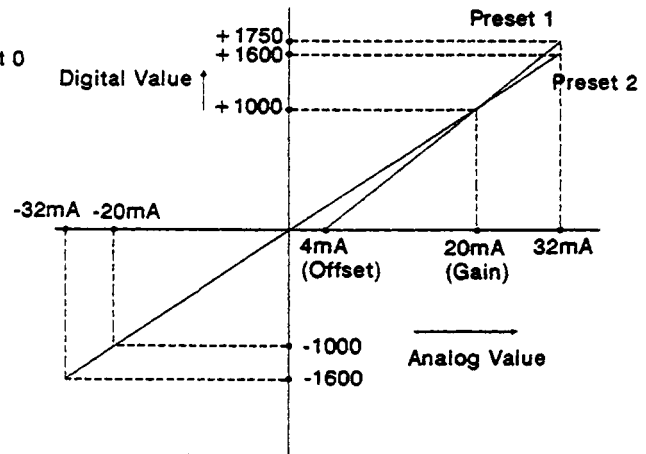
(c) The A-D LED

This lights up when A/D conversion is proceeding normally. If any of b1 to b4 of buffer memory #29 (error status) is ON for all channels this LED turns OFF.

8. ADJUSTING GAIN AND OFFSET

(1) Voltage Input Characteristics

Digital Value

+2047
+2000 ······ Preset 0
-10.24V +1000
-15V -10V -5V 5V 10V 15V
Gain
Offset 10.235V
-1000
-2000
Analog Value
-2048

(2) Current Input Characteristics

Preset 1
+1750
+1600
Digital Value
+1000
Preset 2
-32mA -20mA
4mA 20mA 32mA
(Offset) (Gain)
-1000
-1600
Analog Value

8. ADJUSTING GAIN AND OFFSET

(a) Defining Gain and Offset

The solid lines show the conversion characteristics when the gain and offset are left at their default settings. The dashed lines show examples of adjustments to these settings.

- Offset value (the analog input value when the digital output is 0); reasonable range:

  -5V to +5V or -20mA to +20mA

- Gain value (the analog input value when digital output is +1000); reasonable range:

  Gain value - offset value = 1V to 15V or 4mA to 32mA

When the gain value is small (implying a steep slope), a small change in analog input will produce a large change in digital output.

When the gain value is large (implying a gentle slope), a large change in analog input will only produce a small change in digital output.

Gain and offset adjustments will remain even if power is low.

Caution:

Resolution is degraded when the gain is large.

8. ADJUSTING GAIN AND OFFSET

(1) Adjustment by Switches on the FX-4AD Unit

Gain and offset can be adjusted by using the switches on the FX-4AD panel with the aid of a voltmeter and ammeter which are connected to the FX-4AD. When you use these procedures there is still a need to set BFM#0.

- After (b1, b0) of BFM #21 (gain/offset adjust prohibit) is changed to (1,0), you can no longer adjust the gain and offset. You should therefore write (0,1) to (b1,b0) of BFM#21 prior to adjusting the gain and offset. (Note: (0,1) is the default value)

- Remember to set BFM#0 (channel initialization) to the nearest preset ranges. The HEX character should be 0 for voltage input and 1 or 2 for current input.

1　Turn on DC 24V power of the FX-4AD. The 24V LED lights up.

2　Turn on the FX series programmable controller connected with the FX-4AD. POWER LED lights up. (The programmable controller may be in either RUN or STOP mode.)

3　Set the MODE switch to the channel to be adjusted.

4　Apply the offset analog input to the input terminal of the channel to be adjusted (-5V to +5V or -20mA to +20mA)

5　Press the OFFSET button once with a ball point pen. The digital offset value (converted from the analog input value) is read into EEPROM.

6　Apply the gain analog input to the input terminal of the channel to be adjusted (gain - offset value = 1 to 15V or 4 to 32 mA)

7　Press the GAIN button once with a ball point pen. The digital gain value (converted from the analog input value) is read into EEPROM.

8. ADJUSTING GAIN AND OFFSET

8 Repeat operations 3 to 7 for each channel you wish to use.

9 After you have finished adjusting each channel you want, set the MODE switch to READY. Gain and offset adjustment is completed.

(When the MODE switch is set to an empty position other than CH1 to CH4, the MODE switch is regarded as being in the READY status. Adjustments cannot be made once the MODE switch is in the READY status.)

8. ADJUSTING GAIN AND OFFSET

(1) Adjusting Gain and Offset Using the Programmable Controller
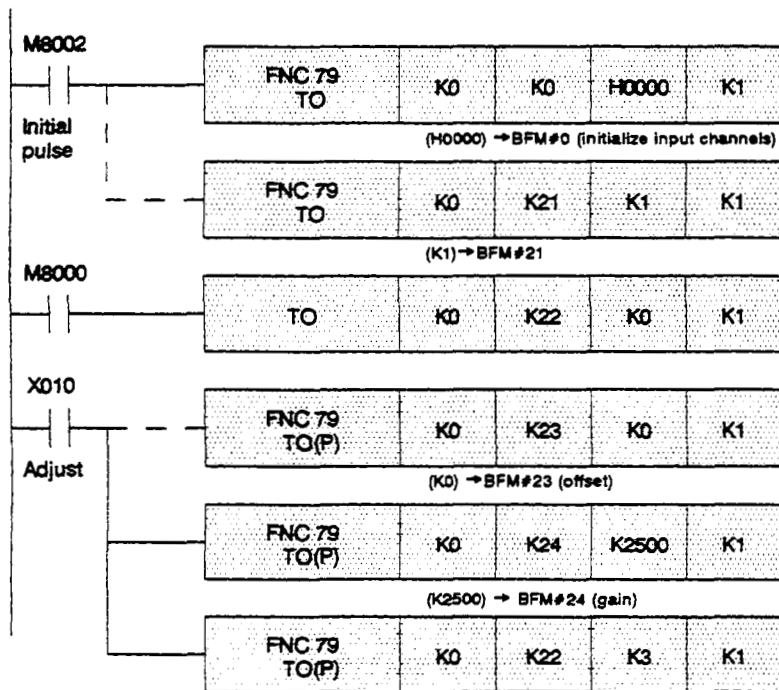
The gain and offset of the FX-4AD can be adjusted using push-button switches on the input terminal of the programmable controller. It can also be adjusted using the software settings sent from the programmable controller.

Only the gain and offset values in the memory of the FX-4AD need be adjusted. A voltmeter or an ammeter for the analog input is not needed. A program for the programmable controller will be needed however.

The following is an example of changing the offset value on input channel CH1 to 0V and the gain value to 2.5V. The FX-4AD block is in the position of Block #0 (i.e. closest to the base unit).

8. ADJUSTING GAIN AND OFFSET

Example: Adjusting gain/offset via software settings

			block no.	BFM #	data number	no. of data sent
M8002 ‖ Initial pulse	FNC 79 TO	K0	K0	H0000	K1
			(H0000) →BFM#0 (initialize input channels)		
	FNC 79 TO	K0	K21	K1	K1
			(K1)→BFM#21		
M8000 ‖	TO	K0	K22	K0	K1
X010 ‖ Adjust	FNC 79 TO(P)	K0	K23	K0	K1
			(K0) →BFM#23 (offset)		
	FNC 79 TO(P)	K0	K24	K2500	K1
			(K2500) → BFM#24 (gain)		
	FNC 79 TO(P)	K0	K22	K3	K1

- Enter the instructions on the left and RUN the programmable controller with the MODE switch of the FX-4AD set to READY.

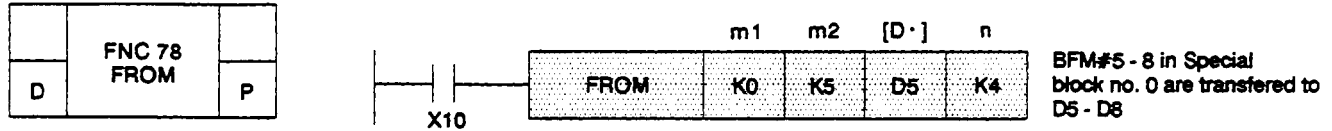- BFM#21 (gain/offset adjust prohibit) must be set to permit with $(b1,b0) = (0,1)$.

- $(K3) \rightarrow$ BFM#22 (offset/gain adjust)
  K3 = 0011 i.e. O1 = 1, G1 = 1.
  Therefore channel 1 is adjusted.

23

9. FROM / TO COMMANDS

(1) FROM / TO Commands Explained

	FNC 78 FROM	
D		P

```
                              m1    m2    [D·]    n
  | |  | |─────────────────────────────────────────      BFM#5 - 8 in Special
  X10                    FROM   K0    K5    D5     K4      block no. 0 are transfered to
                                                          D5 - D8
```

- m1: Special function unit or block number. These are numbered consecutively from K0 to K7 starting from the one closest to the base unit.

- m2: Buffer memory head address. (m2 = K0 to K31)

- [D·]: Transfer destination head address. T,C,D, KnM, KnY, KnS, V or Z can be specified. This argument can be coupled with an index register.

- n: The number of words to be transferred (n = K1 to K32)

	FNC 79 TO	
D		P

```
                              m1    m2    [S·]    n
  | |  | |─────────────────────────────────────────      D1 - D4 transferred to special
  X11                    TO     K0    K1    D1     K4      block no. 0
                                                          BFM#1 - 4
```
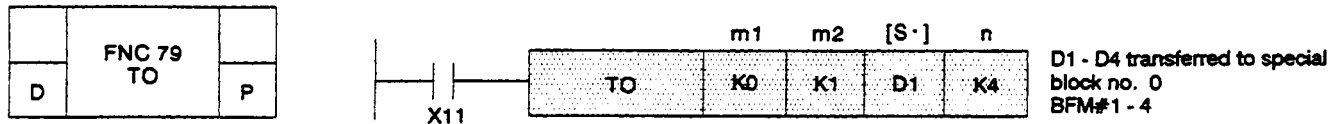
- m1, m2, n: The same as above.

- [S·]: Transfer destination head address. T, C, D, KnX, KnY, KnM, KnS, V, Z,K or H can be specified. This argument can be coupled with an index register.

Note   • When X10 or X11 is OFF, the related transfer will not be executed.

10. REFERENCE

(1) Block Diagram

FX-4AD Analog Block
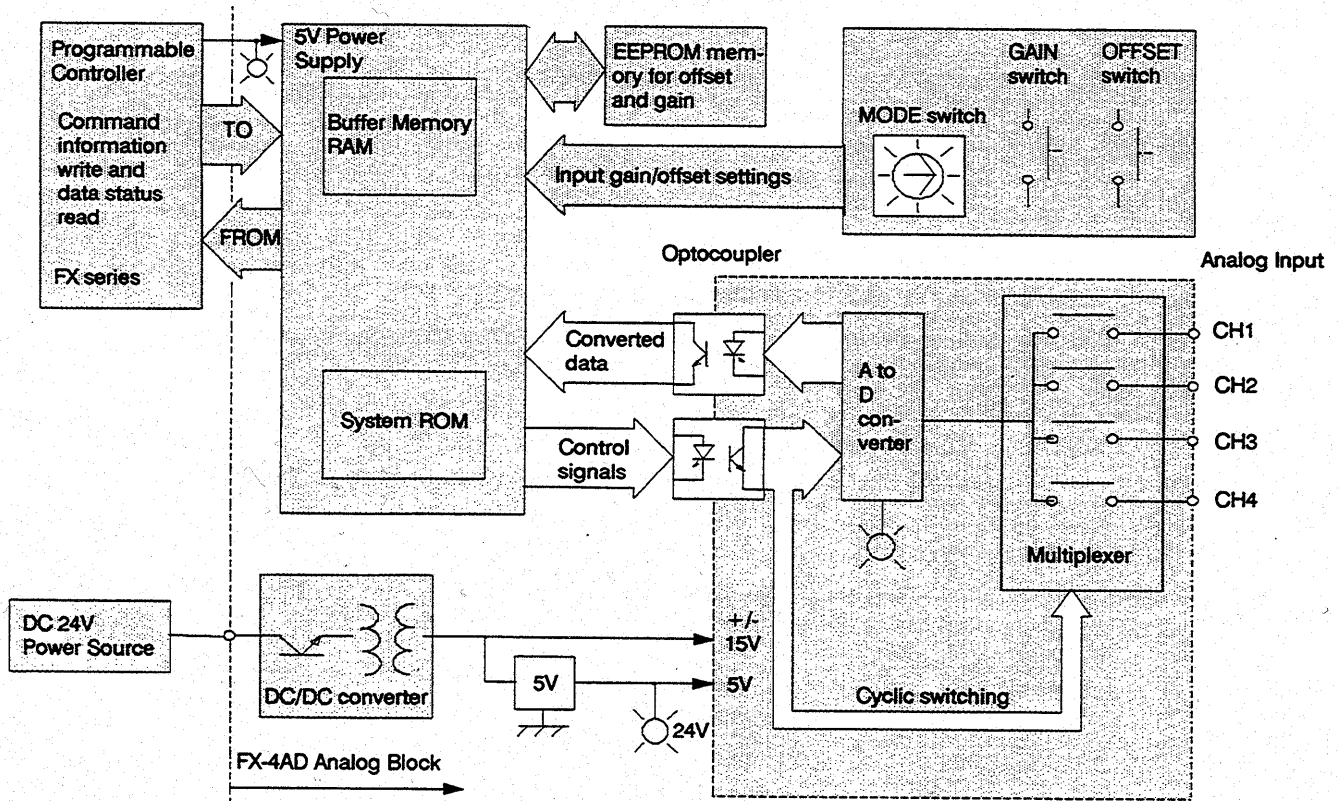
Revisions

EDITION DATE	MANUAL NUMBER	REVISION
Jun. 1991	JY992D28101A	First edition
Aug. 1991	JY992D28101B	P.12 b0 row of table changed. P.23 Example changed.
Nov. 1991	JY992D28101C	P.3 Isolation test sentence added.
Jan. 1993	JY992D28101D	TEXT : Pages 7, 15, 23 EEPROM CAUTION : Page 13

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