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MITSUBISHI
PROGRAMMABLE CONTROLLERS
MELSEC-F

FX-2DA SPECIAL FUNCTION BLOCK

USER'S GUIDE

JY992D52801C

This manual contains text, diagrams and explanations which will guide the reader in the correct installation and operation of the FX-2DA special function block and should be read and understood before attempting to install or use the unit.
Further information can be found in the FX PROGRAMMING MANUAL and FX SERIES HARDWARE MANUAL.

1 INTRODUCTION

- The FX-2DA analog special function block has two output channels. The output channels take a digital value and output an equivalent analog signal. This is called a D/A conversion. The FX-2DA has a maximum resolution of 12 bits.

- The selection of voltage or current based input/output is by user wiring. Analog ranges of -10 to 10V (resolution: 5mV), and/or 4 to 20mA (resolution: 20μA) maybe selected.

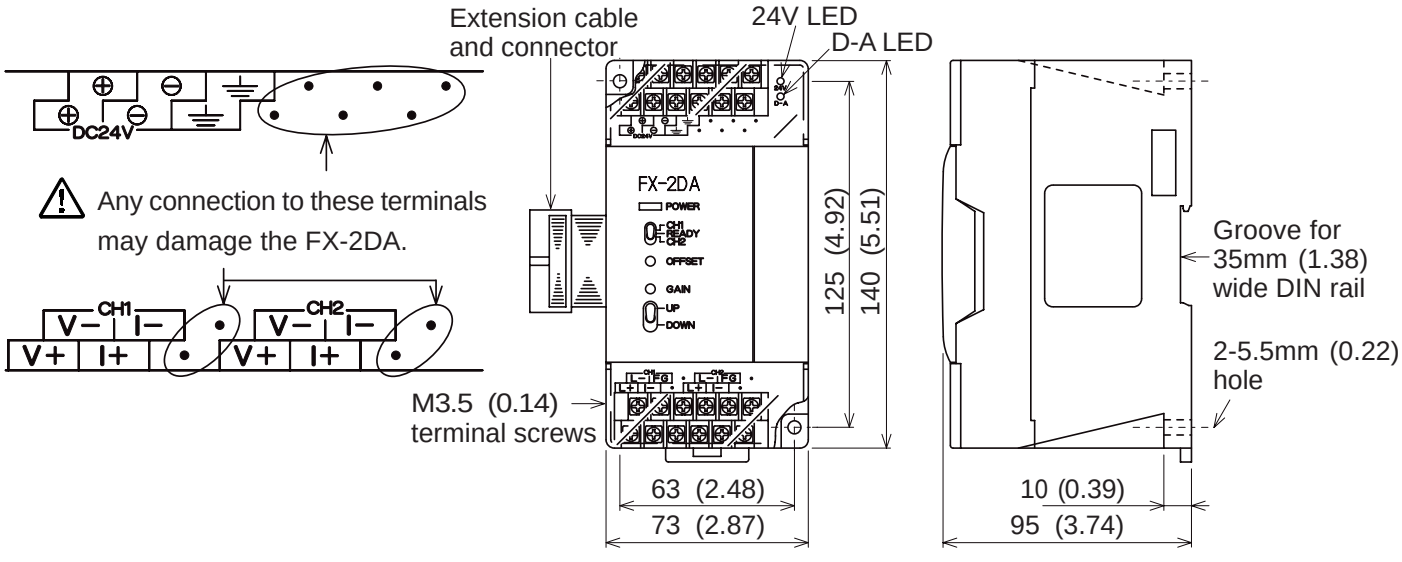
- FX programmable controllers versions 2.0 or later (those with serial number 13XXXX or larger) are required; as these units have the TO/FROM applied instructions in their instruction set. Data transfer between the FX-2DA and the FX base unit is by buffer memory exchange. There are 32 buffer memories (each of 16 bits) in the FX-2DA.

- The FX-2DA occupies 8 points of I/O on the FX, FX2C expansion bus. The 8 points can be allocated from either inputs or outputs. The FX-2DA draws 30mA from the 5V rail of the base unit or powered extension unit.

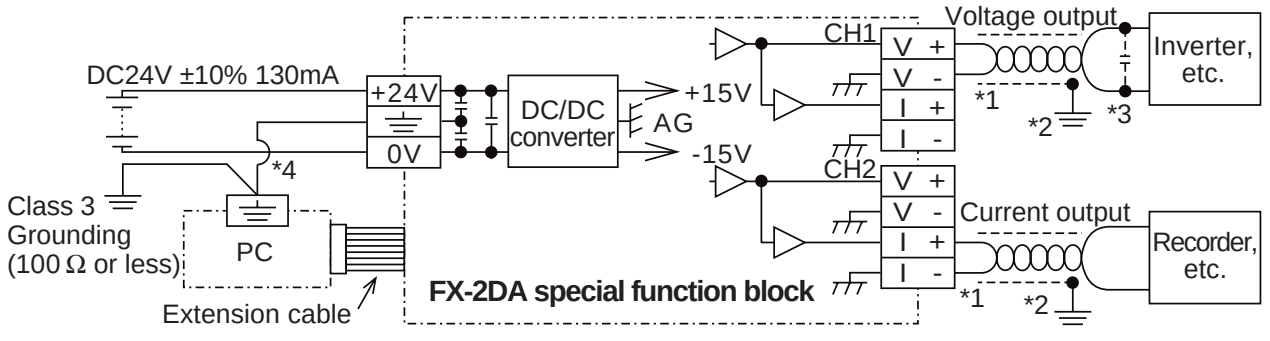
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1.1 External dimensions

Weight : Approx. 0.5kg (1.1 lbs) Dimensions : mm (inches)



2 Wiring



*1 Use a twisted pair shielded cable for the analog output. This cable should be wired away from power lines or any other lines which could induce noise.

*2 Apply 1-point grounding at the load side of the output cable (class 3 grounding: 100 Ω or less). If electrical noise is caused from grounding, disconnect from grounding.

*3 If electrical noise or a voltage ripple exists at the output, connect a smoothing capacitor of 0.1 to 0.47 μF, 25V.

*4 Connect the ground terminal on the FX-2DA with the ground terminal on the base unit of the programmable controller. Use class 3 grounding on the base unit, if available.

Caution;

(a) The same output channel cannot drive current and voltage output loads at the same time!

(b) Shorting the voltage output terminals may damage the unit!

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3 INSTALLATION NOTES AND USAGE

3.1 Environment specification

Item	Specification
Environment specifications	Same as those for the FX base unit

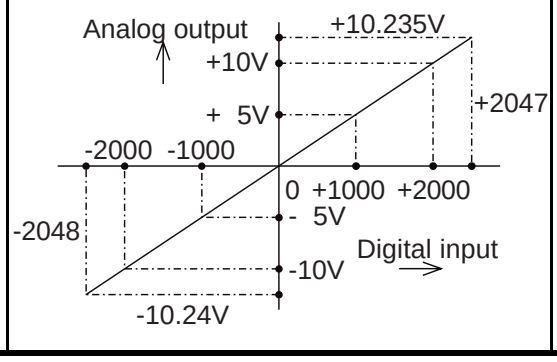
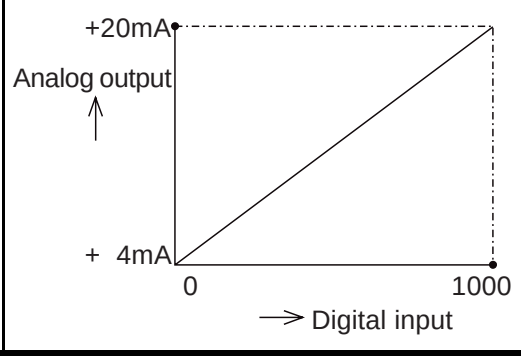
3.2 Power supply specifications

Item	Specification
Analog circuits	24V DC ±10% 130mA (external power supply)
Digital circuits	5V DC, 30mA (internal power supply from base unit)

3.3 Performance specifications

Item	Voltage output	Current output
	Voltage or current outputs can be individually selected with each output terminal. There are a total of 2 output points.	
Max. convertible output range	DC -10V to +10V (external load: 1kΩ to 1MΩ)	DC+4mA to +20mA (external load: 500 Ω or less)
Digital input	Voltage = -2048 to +2047	Current = 0 to +1000
Resolution	5mV (10V full scale 1/2000)	20μA (20mA full scale 1/1000)
Overall accuracy	±1% full scale (10V range)	±1% full scale (20mA range)
Conversion speed	18ms for 2 channels (normal speed), 3.5ms for 2 channels (high speed).	

Analog output continued...

Factory Presets Load: **= 10kΩ (voltage Output)** **= 250Ω (current Output)**		

Gain and offset can be adjusted using the procedure described in chapter 4.

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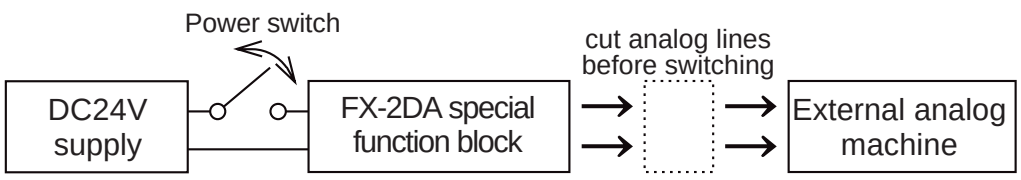
Miscellaneous

Item	Specification
Isolation	Photo-coupler isolation between analog and digital circuits. DC/DC converter isolation of power from FX base unit. No isolation between analog channels.
Number of occupied I/O points	8 points taken from the FX expansion bus (can be either inputs or outputs)

ATTENTION FOR WHEN SWITCHING SYSTEM ON/OFF

Due to the inevitable timing difference of the DC24V for the analog circuits and other power lines of the base unit, the output of the FX-2DA special function block may behave erroneously before settling down to operational conditions in approximately 1sec. Therefore, ensure that this behavior is taken into account such that the end performance of the system is not degraded.

(example)



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3.4 Allocation of buffer memories (BFM)

BFM	contents	
***# 0**	channel Initialization (Default = H00)	
***# 1**	channel 1	
***# 2**	channel 2	
# 3-# 4	Reserved	
***# 5**	Last data reset (Default = 0)	
# 6	Reserved	
***# 7**	selection of A-D conversion speed see note	When set to 0, normal speed is selected 18ms
		When set to 1, high speed is selected 3.5ms
# 8-#19	Reserved	

In BFM's (buffer memory) with an " ***** ", data can be written from the programmable controller using the TO command.

These BFM's should always be given when the programmable controller goes from STOP to RUN. Buffer memory (BFM's) are reset to their default settings upon power on.

BFM		b 3	b 2	b 1	b 0
***#20**	Reset all to default default value: 0				
***#21**	Gain/offset adjust prohibit Initial value (0,1)			Pro-hibit	Permit
***#22**	Offset/gain setting command	G 2	O 2	G 1	O 1
***#23**	Offset data (in mV or μA units) default value: 0				
***#24**	Gain data (in mV or μA units) default value: 5,000				
#25-#28	Reserved				
#29	Error status (See next page)				
#30	Identification code K3010 (See next page)				
#31	Reserved				

- The buffer memory also handles information used to adjust the gain and offsets of the FX-2DA unit. Status of the unit such as errors are also available.
- From BFM #29 and #30, data can be read via the FROM command.
- Offset value : the actual output value when the digital input is 0.
- Gain value : the actual output value when the digital input is +1000.

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(1) Channel Selection

Switching between voltage and current output modes. The value of BFM #0 switches the analog output between voltage and current on channels CH1 and CH2. It takes the form of a 2-character HEX number. The least significant character controls CH1 and the other controls CH2.

Control of each O HEX character of
HOO :
O=0 :Voltage output (-10V to +10V) O=1 :Current output (+4mA to +20mA)
Example : H10 CH1 : Voltage output CH2 : Current output

(2) Last data reset

If the programmable controller is changed to the STOP state, the FX-2DA will continue to output the last value. To reset the output to the offset value, set the HEX characters of BFM #5 to one of the appropriate settings below:

H01 : CH2=Hold, CH1=Reset
H10 : CH2=Reset, CH1=Hold
H11 : CH2=Reset, CH1=Reset
Both channels are held when BFM #5 = H00.

(3) Digital to Analog conversion speed change

By writing 0 or 1 into BFM #7 of the FX-2DA, the speed at which D-A conversion is performed can be changed. However the following points should be noted:

Note : •The conversion speed does not depend on the number of channels being used.
•On power up, the FX-2DA is set for normal speed conversion and BFM #7 contains 0.

(4) Adjusting Gain and Offset Values

(a) When BFM #20 is set to K1, all settings in the buffer memory are reset to their default settings. This allows the buffer memory settings to be set from the beginning again when many settings have been corrupted.

(b) If (b1, b0) of BFM #21 is set to (1, 0), gain and offset adjustments are prohibited. This is to prevent inadvertent misuse by the operator. To adjust the gain and offset, (b1, b0) of BFM #21 must have the values (0, 1). The default is set at (0, 1).

(c) Each time a TO instruction is used to send data to BFM #22 (gain/offset setting command), the designated gain and offsets of each channel (G2 O2 G1 O1) are adjusted with the values in BFM #23 and #24. This action causes the adjustments to be written to internal non-volatile EEPROM memory. Limit this action to as little as possible to preserve the life of the EEPROM memory.

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

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(5) Status information BFM #29

Bit	ON	OFF
b 0 : error	When any of b1 to b3 is ON D/A conversion is stopped for the error channel	No error
b 1 : Offset/Gain error	Offset/Gain data in EEPROM is corrupted or adjustment error	Offset/Gain data normal
b 2 : Power abnormality	DC 24V power supply failure	Power supply normal
b 3 : Hardware error	D/A converter or other hardware failure	Hardware normal
b 8 : Not READY	FX-2DA MODE switch is not set to READY.	READY mode
b10: Range error	Digital input value or analog output is outside the specified range.	Analog output value is normal.
b12: Offset/Gain adjust prohibit	Prohibit-(b1, b0) of BFM #21 is set at (1, 0).	Permit-(b1, b0) of BFM #21 is set at (1, 0).

Bits b4 to b7, b9, b11 and b13 are undefined.

(6) Model code number BFM #30

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

The identification code for the FX-2DA unit is K3010.

The PC can use this facility in the program to identify the special block before commencing any data transfer from and to the special block.

CAUTION

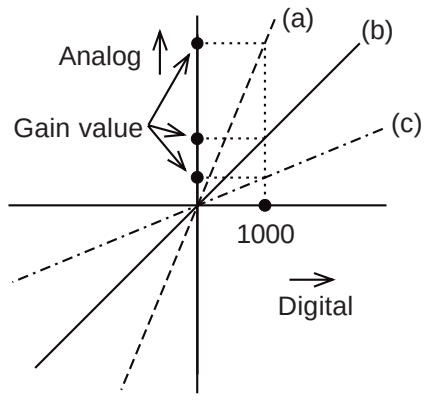
- Values of BFM #0, #5, #21, #23 and #24 are stored in EEPROM memory of the FX-2DA. BFM #23 and BFM #24 are only copied when the gain/offset setting command BFM #22 is used. Also, BFM #20 causes resetting of the EEPROM memory. The EEPROM has a life of about 10,000 cycles (changes), so do not use programs which frequently change these BFMs.

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

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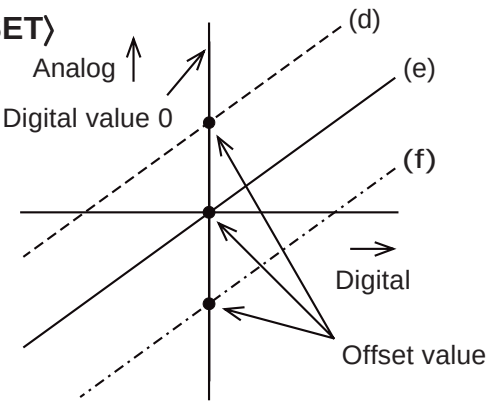
4 DEFINING GAIN AND OFFSET

⟨GAIN⟩



Gain is the angle or slope of the calibration line identified at a digital value of 1000.
(a) Large gain – low reading resolution
(b) Zero gain - – default 5V or 20mA
(c) Small gain – high reading resolution

⟨OFFSET⟩



Offset is the 'Potion' of the calibrated line, identified at a digital value of 0.
(d) Positive offset
(e) Zero offset – default (4-20mA default is 4mA)
(f) Negative offset

Offset and gain can be used independently or together. Reasonable offset ranges are -5V to +5V or -20mA to 20mA, and gain-offset difference 1V to 15V or 4mA to 32mA. Gain and offset can be adjusted by software in the FX base unit (see program example 2) or by the switches on the FX-2DA (with the aid of a voltmeter/ammeter).

- Bit device's b0, b1 of the gain/offset BFM (#21) should be set to 0, 1 to allow adjustment.
  Once adjustment is complete these bit device should be set to 1, 0 to prohibit any further changes.
- Channel initialization (BFM #0) should be set to the nearest range, i. e. voltage/current etc.

1. Power up the system the FX base unit can be in either RUN or STOP mode.
2. Connect the load and voltmeter or ammeter to the CH1 terminals.
3. Set the FX-2DA MODE switch to output CH1.
4. Press the OFFSET button once. The offset value is output. Use the UP/DOWN switch to reach the desired offset value.
5. Press the GAIN button once. The gain value is output. Use the UP/DOWN switch to reach the desired offset value.
6. Repeat operations 3 to 5 for each channel you wish to use.
7. Set the FX-2DA MODE switch to READY to complete gain and offset adjustment.

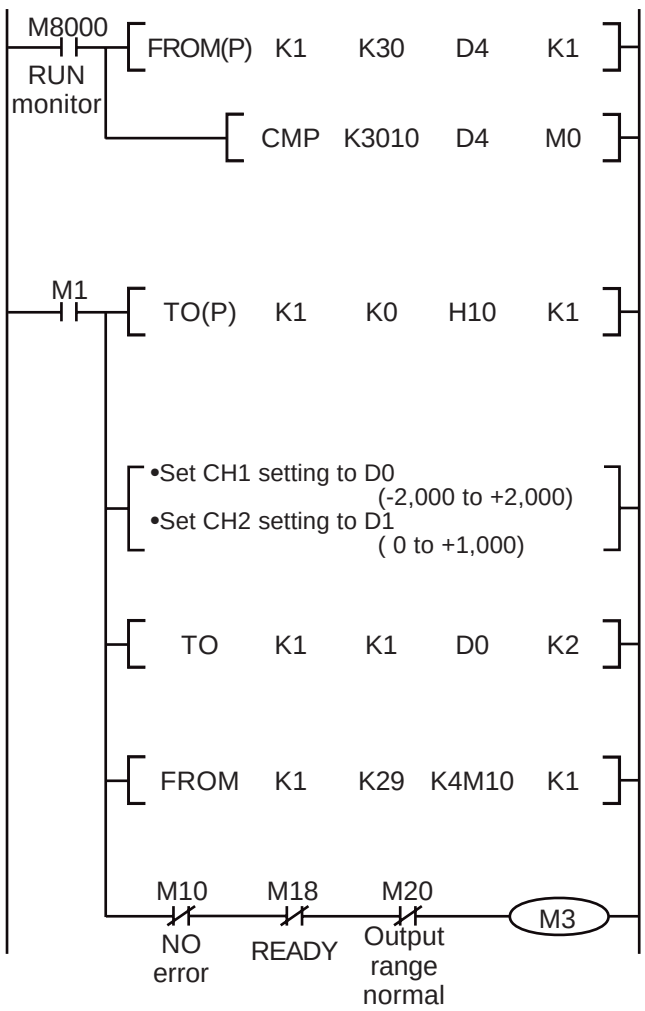
NOTE : If the MODE switch is not set to a channel number, the FX-2DA is regarded as being in the READY status and no adjustments can be made.

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5 EXAMPLE PROGRAM

5.1 Basic program

In the following example, channel CH1 is set to voltage output, while CH2 is set to current output. The FX-2DA unit is connected at the position of special function block No.1. If the programmable controller is changed to the STOP mode, the last data sent will remain and the outputs will hold.



The ID code for the special function block at position "1"is read from BFM #30 of that block and stored at D4 in the FX base unit. This is compared to check the block is an FX-2DA, if OK M1 is turned ON. These two program steps are not strictly needed to perform an analog output. They are however a useful check and are recommended as good practice.

The analog output channels (CH1, CH2) are set up by writing H10 to BFM #0 of the FX-2DA.

(D0 → BFM #1 (output to CH1))
(D1 → BFM #2 (output to CH2))

The operational status of the FX-2DA is read from BFM #29 and output as bit devices at the FX base unit.

Output data normal

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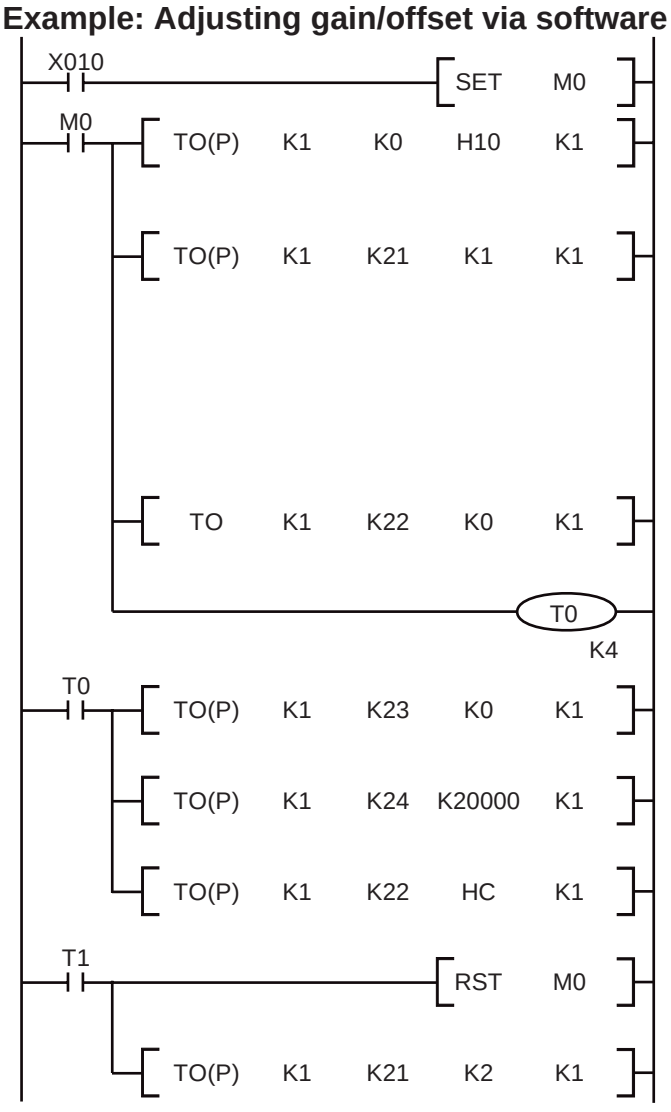
5.2 Using gain and offset in a program

I/O characteristics of the FX-2DA can be adjusted by changing the gain and offset parameters. These can be changed by the switches of the FX-2DA with the aid of Voltage & Current meters or simply changed by writting these settings from the programmable controller.

Only the gain and offset values in the memory of the FX-2DA need be adjusted. A voltmeter or an ammeter for the analog output is not needed. A program for the programmable controller will be needed however.

The following is an example; changing the offset value to 0mA and gain value to 20mA on output channel CH2 of the FX-2DA connected as block No.1.

Example: Adjusting gain/offset via software settings



- Adjustment start.
- (H10) → BFM #0 (initialize input channels)
  In the program shown at left, the programmable controller should be in RUN status, and MODE switch of the FX-2DA in the READY position.
- (K1) → BFM #21
  BFM #0 should be of HEX value H10, and (b1, b0) of BFM #21 should be (0, 1).
- (K0) → BFM #22 (offset/adjust)
  Reset adjust bits.
- (K0) → BFM #23 (offset)
  This statement may be omitted if BFM #23 is already at its default value.
- (K20000) → BFM #24 (gain)
- (HC) → BFM #22 (offset/gain set)
  A delay of 300ms may be needed between setting BFM #0 and #22 (see section 3.4 “caution”)
- Adjustment end.
- (K2) → BFM #21
  BFM #21 gain/offset adjust prohibit.

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6 DIAGNOSTICS

6.1 Preliminary checks

1. Check whether the output wiring and/or expansion cables are properly connected on FX-2DA analog special function block.

2. Check that the FX system configuration rules have not been broken, i.e. the number of blocks does not exceed 8 and the total system I/O is equal or less than 256 I/O.

3. Ensure that the correct operating range has been selected for the application.

4. Check that the MODE switch on the FX-2DA panel is set to the READY position.

5. Check that there is no power overload on either the 5V or 24V power source, remember the loading on the FX base unit or a powered extension unit varies according to the number of extension blocks or special function blocks connected.

6. Pit the main processing unit into RUN.

6.2 Error checking

If the FX-2DA special function block does not seem to operate normally, check the following items.

- Check the status of the POWER LED.
  Lit. : The extension cable is properly connected.
  Otherwise : Check the connection of the extension cable.

- Check the external wiring.

- Check the status of“24V”LED (top right cover of the FX-2DA).
  Lit. : FX-2DA is OK, 24V DC power source is OK.
  Otherwise : Possible 24V DC power failure, if OK then possible FX-2DA failure.

- Check the status of th“D/A”LED (top right cover of the FX-2DA)
  Lit. : D/A conversion is proceeding normally
  Otherwise : Check buffer memory #29 (error status). If any bits (b2 and b3) are ON, then this is why the D/A LED is OFF.

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Guidelines for the safety of the user and protection of the FX-2DA special function block

- This manual has been written to be used by trained and competent personnel. This is defined by the European directives for machinery, low voltage and EMC.
- If in doubt at any stage during the installation of the FX-2DA always consult a professional electrical engineer who is qualified and trained to the local and national standards. If in doubt about the operation or use of the FX-2DA please consult the nearest Mitsubishi Electric distributor.
- Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.
- All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

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