



# FX-4AD-TC SPECIAL FUNCTION BLOCK

## USER'S GUIDE

JY992D55901A

This manual contains text, diagrams and explanations which will guide the reader in the correct installation and operation of the FX-4AD-TC 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.

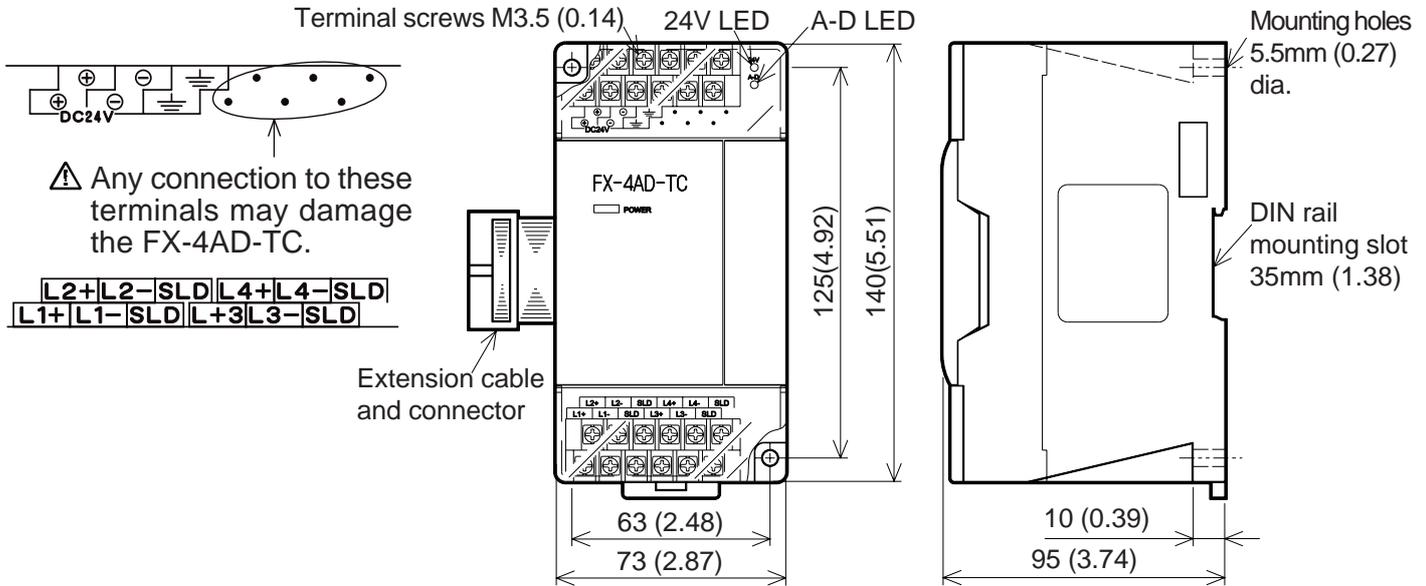
### 1

## INTRODUCTION

- The FX-4AD-TC analog block amplifies the signal from four thermocouple sensors (type K or J) and converts the data into 12 bit reading's stored in the FX base unit. Both Centigrade (°C) and Fahrenheit (°F) can be read. Reading resolution is 0.4°C/0.72°F of type K and 0.3°C/0.54°F of type J.
- All data transfers and parameter settings are adjusted through software control of the FX-4AD-TC ; by use of the TO/FROM applied instructions in the FX PC.  
*Note : 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. All FX2c Models may be used.*
- The FX-4AD-TC occupies 8 points of I/O on the FX expansion bus. The 8 points can be allocated from either inputs or outputs. The FX-4AD-TC draws 40mA from the 5V rail of the FX base unit or powered extension unit.
- Thermocouples with the following specifications can be used: Type K (JIS 1602-1981)  
Type J (JIS 1602-1981)

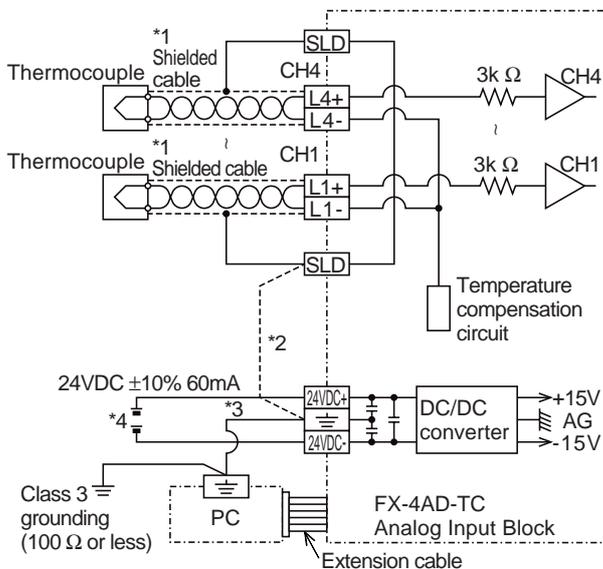
## 1.1 External dimensions

Weight : Approx. 0.5kg (1.1 lbs)    Dimensions: mm (inches)  
 Accessories : Self adhesive labels for special function block number identification.



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## TERMINAL LAYOUTS



\*AG : Analog Ground

\*1 : The compensating cables that can be used for connecting with the thermocouple are the following.

Type K: KX-G, KX-GS, KX-H, KX-HS, WX-G, WX-H, VX-G

Type J: JX-G, JX-H

For every 10  $\Omega$  of line resistance, the compensating cable will indicate a temperature 0.12°C higher than actual. Check the line resistance before using.

Long compensating cables are more prone to noise interference, therefore a short (less than 100m) compensating cable is recommended.

Unused channels should have a wire link connected between their + and - terminals to prevent an error being detected on that channel.

\*2 : If there is excessive electrical noise, connect the SLD terminal to the ground terminal on the unit.

\*3 : Connect the ground terminals of the FX-4AD-TC unit and the base unit. Use class 3 grounding on the base unit.

\*4 : The 24V DC built-in supply of the programmable controller may be used as the power supply .

### 3.1 General specification

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

### 3.2 Power supply specification

Item	Specification
Analog circuits	24V DC $\pm$ 10%, 60mA
Digital circuits	5V DC, 40mA (internal power supply from base unit)

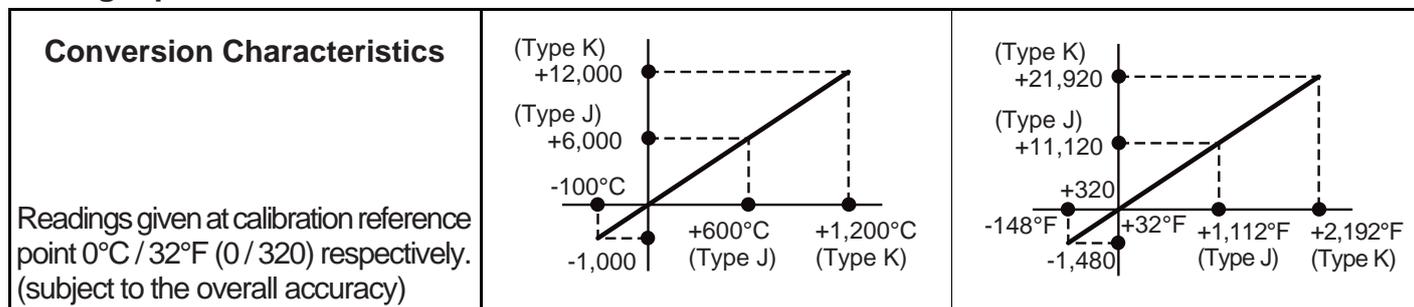
### 3.3 Performance specifications

#### Analog inputs

Item	Centigrade (°C)		Fahrenheit (°F)	
	Both °C and °F are available by reading the appropriate buffer memory (BFM).			
Input signal	Thermocouple: type K or J (either can be used for each channel), 4 channels, JIS 1602-1981			
Rated temperature range	Type K	-100°C to +1,200°C	Type K	-148°F to +2,192°F
	Type J	-100°C to +600°C	Type J	-148°F to +1,112°F
Digital output	12 bit conversion stored in 16 bit 2's complement form			
	Type K	-1,000 to +12,000	Type K	-1,480 to +21,920
	Type J	-1,000 to +6,000	Type J	-1,480 to +11,120
Resolution	Type K	0.4°C	Type K	0.72°F
	Type J	0.3°C	Type J	0.54°F
Overall accuracy / Calibration point	$\pm$ (0.5% full scale +1°C) / Freezing point of pure water 0°C / 32°F			
Conversion speed	(240ms $\pm$ 2%) $\times$ 4 channels (unused channels are not converted)			

Note : Earth-tipped thermocouples are not suitable for use with this unit.

## Analog inputs continued.....



## Miscellaneous

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

## 3.4 Buffer memory assignment

BFM	CONTENTS
*# 0	Thermocouple type K or J selection mode, At shipment : H0000
*# 1-# 4	CH1 to CH4 Averaged temperature reading to be averaged (1 to 256) Default = 8
# 5-# 8	CH1 to CH4 Averaged temperature in 0.1°C units
# 9-#12	CH1 to CH4 Present temperature in 0.1°C units
#13-#16	CH1 to CH4 Averaged temperature in 0.1°F units
#17-#20	CH1 to CH4 Present temperature in 0.1°F units
#21-#27	Reserved
*#28	Digital range error latch
#29	Error status
#30	Identification code K2030
#31	Reserved

The FX-4AD-TC communicates with the programmable controller through use of buffer memories.

BFMs #21 to #27 and #31 are reserved. All non reserved BFMs can be read by the programmable controller using the FROM command.

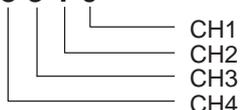
BFMs (buffer memories) marked with an "\*" can be written to, from the programmable controller using the TO command.

## 3.5 Status Information

### (1) Buffer Memory BFM #0: Thermocouple type K or J selection mode

BFM #0 is used to select K or J type thermocouples for each channel. Each digit of a 4 digit hexadecimal number corresponds to one channel, the least significant digit being channel 1.

[ Example ] H 3 3 1 0



0= K type  
1= J type  
3= Not used

- A/D conversion time is 240ms per channel. When "3"(not used) is set for a channel, A/D conversion is not executed for that channel and so the total conversion time is decreased. In the above example, the conversion time is as follows:

$$\underline{240\text{ms}(\text{conversion time per channel}) \times 2\text{channels}(\text{number of channels being used})=480\text{ms}(\text{total conversion time})}$$

### (2) Buffer Memory BFMs #1 to #4: Number of temperature readings to be averaged

When the number of temperature readings to be averaged is specified for BFMs #1 to #4, the averaged data is stored in BFMs #5 to #8(°C) and #13 to #16(°F).

Only the range 1 to 256 is valid for the number of temperature readings to be averaged. If a value outside of this range is input, the default value of 8 is used.

### (3) Buffer Memory BFMs #9 to #12 and #17 to #20: Present temperature

These BFMs store the present value of the input data. This value is stored in units of 0.1°C or 0.1°F, but the resolution is only 0.4°C or 0.72°F for type K and 0.3°C or 0.54°F for type J.

### (4) Buffer Memory BFMs #28: Digital range error latch

BFM#29 b10(Digital range error) is used to judge whether the measured temperature is within the unit's range or not. BFM#28 latches the error status of each channel and can be used to check for thermocouple disconnection.

b15 or b8	b7	b6	b5	b4	b3	b2	b1	b0
Not used	High	Low	High	Low	High	Low	High	Low
	CH4		CH3		CH2		CH1	

Low : Turns ON when temperature measurement data goes below the lowest temperature measurement limit.

High : Turns ON when temperature measurement data goes above the highest temperature measurement limit, or when a thermocouple is disconnected.

An error can be cleared by writing K0 to BFM#28 using the TO instruction. In case of disconnection, temperature data before disconnection is latched.

## (5) Buffer Memory BFM #29: Error status

Bit devices of BFM #29	ON	OFF
b0:Error	When either b2 or b3 is ON A/D conversion is stopped for all channels	No error
b1:Not used	—————	—————
b2:Power source	DC 24V power supply failure	Power supply normal
b3:Hardware error	A/D converter or other hardware failure	Hardware normal
b4 to b9:Not used	—————	—————
b10: Digital range error	Digital output/analog input value is outside the specified range.	Digital output value is normal.
b11: Averaging number error	Selected number of averaged results is outside the available range -see BFM #1 to #4	Averaging is normal. (between 1 and 256)
b12 to b15:Not used	—————	—————

## (6) Identification Code Buffer Memory BFM #30

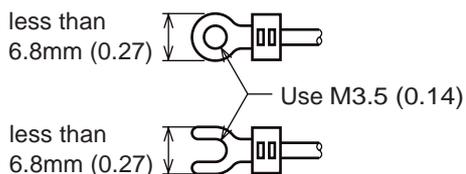
The identification code or ID number for a Special Block is read from buffer memory BFM #30 using the FROM command. This number for the FX-4AD-TC unit is K2030.

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

## 3.6 Installation location

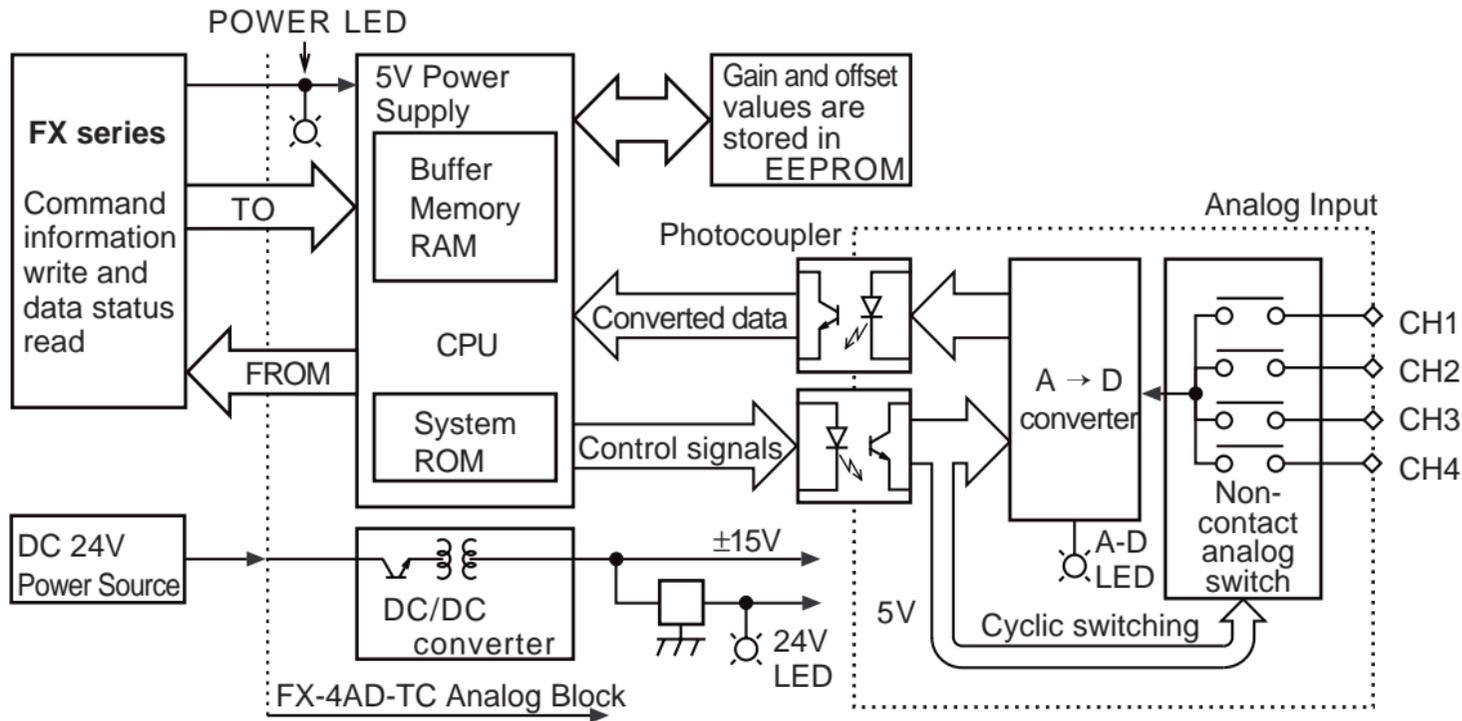
This unit measures temperature according to the temperature difference between the temperature measurement part (thermocouple) and the terminal block. If this unit is installed in a place where the temperature of the terminal block varies rapidly, a measuring error may occur. For this reason, the unit should be installed in a place free from excessive temperature variation.

## 3.7 Using crimp terminations

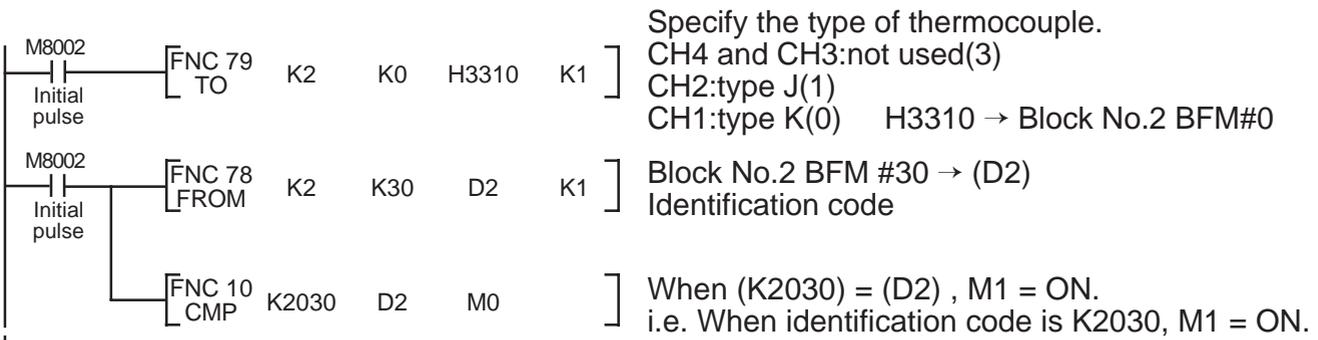


- Use crimp terminations of the type indicated on the left.
- Secure the termination using a tightening torque of between 5 and 8 kg•cm.
- Wire only to the module terminals discussed in this manual. Leave all others vacant.

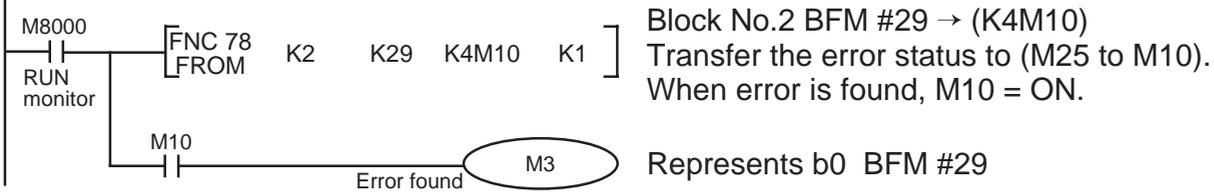
# SYSTEM BLOCK DIAGRAM



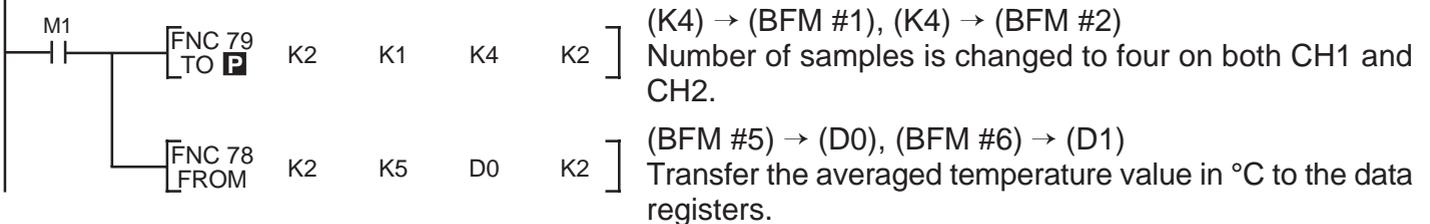
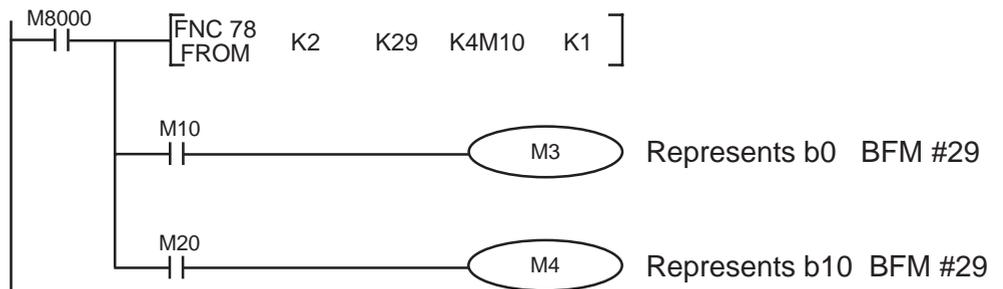
In the program shown below, the FX-4AD-TC occupies the position of special block number 2 (that is the third closest block to the programmable controller). A type K thermocouple is used on CH1 and a type J on CH2. CH3 and CH4 are not used. The averaging count is four. The averaged values in degrees C of input channels CH1 and CH2 are stored respectively in data registers D0 and D1.



This initial step checks that the special function block placed at position 2 is actually an FX-4AD-TC, i.e. its unit identification number is 2030 (BFM #30). This step is optional, but it provides a software check that the system has been configured correctly.

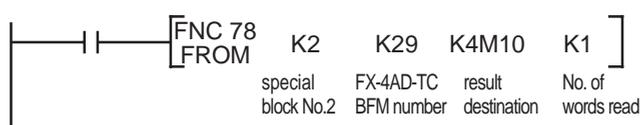


This step provides optional monitoring of the FX-4AD-TC Error Buffer Memory (#29). If there is an Error on the FX-4AD-TC, bit b0 of BFM #29 will be set on. This can be read by this program step, and output as a bit device in the FX programmable controller (M3 in this example). Additional Error devices can be output in a similar manner, e.g. b10 BFM #29 Digital range error. (see below)



This step is the actual reading of the FX-4AD-TC input channels. It is essentially the only program step which is needed. The "TO" instruction in this example, sets the input channels, CH1 and CH2, to take the average reading of four samples.

The "FROM" instruction reads the average temperatures (BFM #5 and #6) for input channels CH1 and CH2 of the FX-4AD-TC. If direct temperature readings are required BFM #9 and #10 should be read instead, e.g.



## **6.1 Preliminary checks**

- I. Check whether the input/output wiring and/or extension cables are properly connected on FX-4AD-TC analog special function block.
- II. Check that the FX system configuration rules have not been broken, i.e. the number of special function blocks does not exceed 8 and the total system I/O is equal or less than 256, I/O.
- III. Ensure that the correct operating range has been selected for the application.
- IV. Check that there is no power overload on either the 5V or 24V power sources, 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.
- V. Put the FX base unit into RUN.

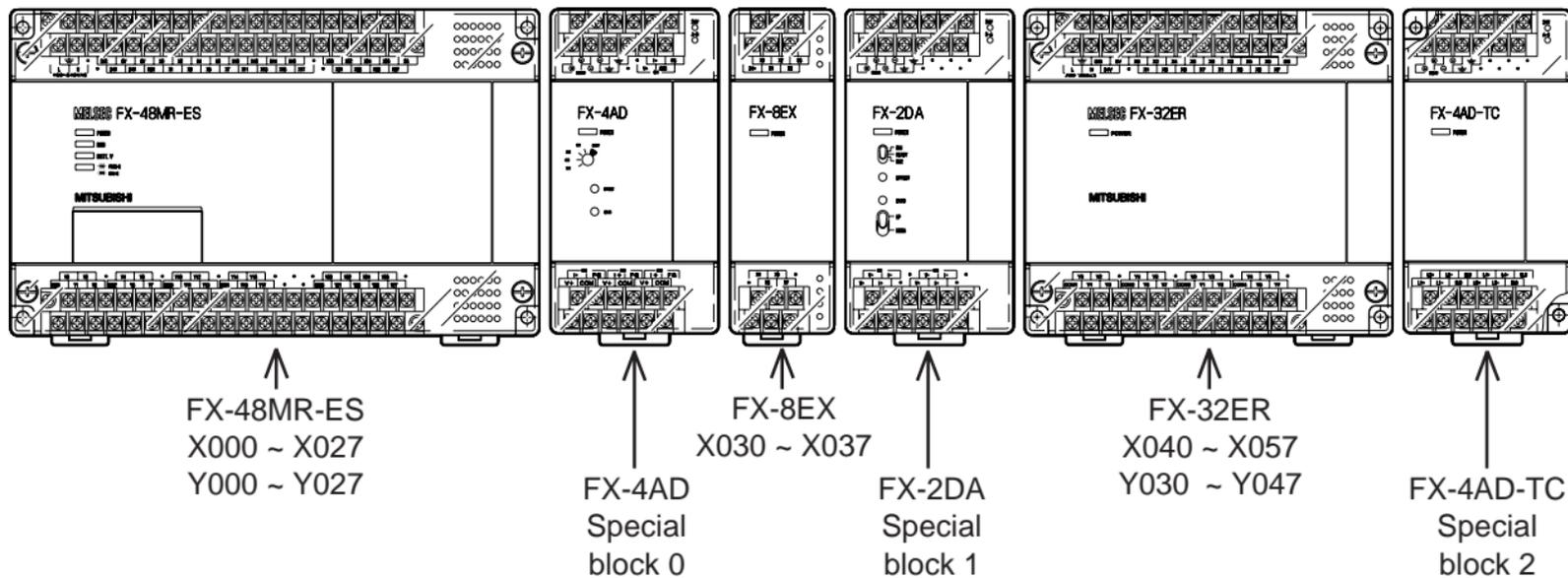
## **6.2 Error checking**

If the FX-4AD-TC 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 the "24V" LED (top right corner of the FX-4AD-TC).  
Lit : FX-4AD-TC is ON, 24V DC power source is ON.  
Otherwise : Possible 24V DC power failure, if ON possible FX-4AD-TC failure.
- Check the status of the "A-D" LED (top right corner of the FX-4AD-TC).  
Lit : A-D conversion is proceeding normally.  
Otherwise : Check buffer memory #29 (error status). If any bits (b2 or b3) are ON, then this is why the A-D LED is OFF.

## 6.3 Checking special function block numbers

Other special units or blocks that use FROM/TO commands, such as analog input blocks, analog output blocks and high-speed counter blocks, can be directly connected to the base unit of the FX programmable controller or to the right side of other extension blocks or units. Each special block is consecutively numbered from 0 to 7 beginning with the one closest to the base unit. A maximum of eight special blocks can be connected.



Electromagnetic compatibility or EMC must be considered before using the FX-4AD-TC.

Mitsubishi recommend that the thermocouple sensors used, should be fitted with a form of shield or screening as protection against EMC noise.

If some form of cable protection is used, the "Shield" must be terminated at the **SLD**  terminals as shown in chapter 2.

Because of the delicate nature of all analog signals, failure to take good EMC precautions could lead to EMC noise induced errors ; up to  $\pm 10\%$  of actual values. This is an absolute worst case figure, users who do take good precautions can expect operation within normal tolerances.

EMC considerations should include selection of good quality cables, good routing of those cables away from potential noise sources.

Additionally it is recommended that signal averaging is used as this will reduce the effects of random noise "spikes".

## **Guidelines for the safety of the user and protection of the FX-4AD-TC 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-4AD-TC 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-4AD-TC 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.

Manual number : JY992D55901

Manual revision : A

Data : February 1996



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