

FX_{2N}

FX_{2N}-4AD-PT SPECIAL FUNCTION BLOCK

USER'S GUIDE

JY992D65601A

This manual contains text, diagrams and explanations which will guide the reader in the correct installation and operation of the FX_{2N}-4AD-PT special function block and should be read and understood before attempting to install or use the unit.

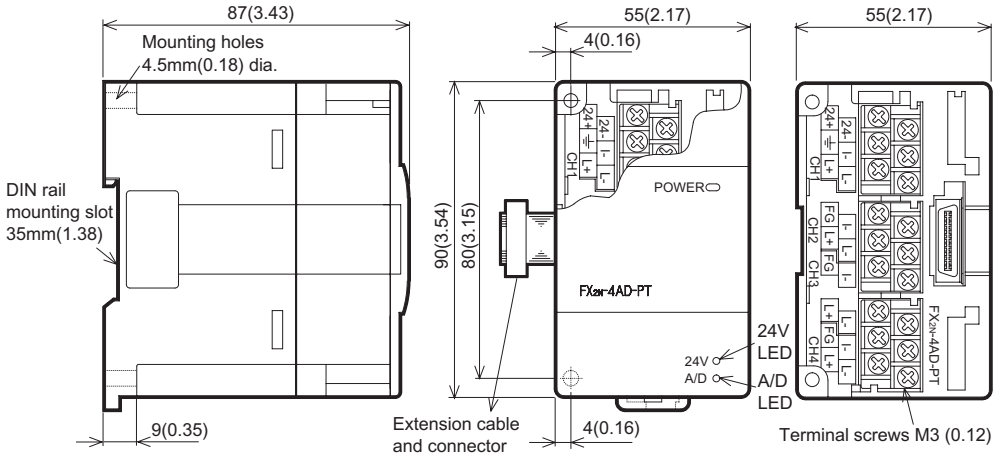
Further information can be found in the FX PROGRAMMING MANUAL and FX_{2N} SERIES HARDWARE MANUAL .

1 INTRODUCTION

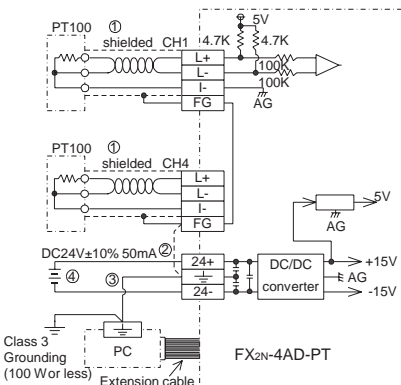
- The FX_{2N}-4AD-PT analog block amplifies the input from four platinum temperature sensors (PT 100, 3 wire, 100 Ω) and converts the data into 12 bit reading's stored in the Main Processing Unit (MPU). Both Centigrade (°C) and Fahrenheit (°F) can be read. Reading resolution is 0.2°C to 0.3°C / 0.36°F to 0.54°F.
- All data transfers and parameter setups are adjusted through software control of the FX_{2N}-4AD-PT ; by use of the TO/FROM applied instructions in the FX_{2N} PC.
- The FX_{2N}-4AD-PT occupies 8 points of I/O on the FX_{2N} expansion bus. The 8 points can be allocated from either in-puts or outputs. The FX_{2N}-4AD-PT draws 30mA from the 5V rail of the MPU or powered extension unit.

1.1 EXTERNAL DIMENSIONS

Weight : Approx. 0.3 kg (0.66 lbs) Dimensions : mm (inches)



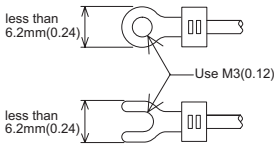
2 TERMINAL LAYOUTS



- ① The cable of the PT 100 sensor or a twisted shielded cable should be used for the analog input cable. This analog input cable should be wired separately from power lines or any other lines which may induce noise. The three wire method improves the accuracy of the sensors by compensating voltage drops.
- ② If there is electrical noise, connect the frame ground terminal (FG) with the ground terminal.
- ③ Connect the ground terminal on the FX_{2N}-4AD-PT unit with the grounded terminal on the base unit. Use class 3 grounding on the base unit, if grounding is possible.
- ④ Either an external or the 24V built-in supply in the programmable controller may be used.

For additional data regarding EMC considerations please see section 7.0.

2.1 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.

3

INSTALLATION NOTES AND USAGE

3.1 Environmental specification

Item	Specification
Environmental specifications (excluding following)	Same as those for the FX _{2N} base unit
Dielectric withstand voltage	500V AC, 1min (between all terminals and ground)

3.2 Power supply specification

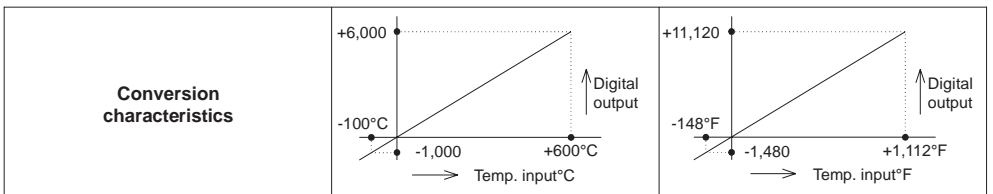
Item	Specification
Analog circuits	24V DC $\pm 10\%$, 50mA
Digital circuits	5V DC, 30mA (internal power supply from base unit)

3.3 Performance specification

Analog Inputs

Item	Centigrade	Fahrenheit
	Both °C and °F readings are available by reading the appropriate buffer memory area.	
Analog input signal	Platinum temperature PT 100 sensors (100 Ω), 3-wire, 4-channel (CH1, CH2, CH3, CH4), 3850 PPM/°C (DIN 43760, JIS C1604-1989)	
Current to sensor	1 mA. sensor : 100 Ω PT 100	
Compensated range	-100°C to +600°C	-148°F to +1112°F
Digital output	-1000 to 6000	-1480 to +11120
	12-bit conversion 11 data bits +1 sign bit	
Minimum resolvable temp.	0.2°C to 0.3°C	0.36°F to 0.54°F
Overall accuracy	$\pm 1\%$ full scale (compensated range) -see section 7.0 for special EMC considerations	
Conversion speed	15 ms for 4 channels	

Analog Inputs continued...



Miscellaneous

Item	Specification
Isolation	Photo-coupler isolation between analog and digital circuits. DC/DC converter isolation of power from FX _{2N} MPU. No isolation between analog channels.
Number of occupied I/O points	8 points taken from the FX _{2N} expansion bus (can be either inputs or outputs)

3.4 Buffer memory assignment

BFM	CONTENTS
*#1-#4	CH1 to CH4 Averaged temperature reading to be averaged (1 to 4,096) 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 K2040
#31	Reserved

The FX_{2N}-4AD-PT communicates with the programmable controller through use of buffer memories.

BFMs (buffer memories) #21 to #27 and #31 are reserved.

All BFMs data can be read by the programmable controller using the FROM command.

BFMs marked with an "*" can be written to from the programmable controller using the TO command.

- (1) The number of samples to be averaged are assigned in BFMs #1 to #4. Only the range 1 to 4096 is valid. Values outside this range are ignored. The default value of 8 is used.
- (2) A number of recently converted readings are averaged to give a smoother read out. The averaged data is stored in BFMs #5 to #8 and #13 to #16.
- (3) BFMs #9 to #12 and #17 to #20 store the current value of the input data. This value is in units of 0.1°C or 0.1°F, but the resolution is only 0.2°C to 0.3°C or 0.36°F to 0.54°F.

3.5 Status Information

- (1) Buffer Memory BFM #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
	High	Low	High	Low	High	Low	High	Low
Not used	CH4		CH3		CH2		CH1	

Low : Latches 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.

When an error occurs the temperature data before the error is latched. If the measured value returns to within valid limits the temperature data returns to normal operation. (Note: The error remains latched in (BFM #28))
An error can be cleared by writing K0 to BFM #28 using the TO instruction or turning off the power.

- (2) Buffer Memory BFM #29: Error status

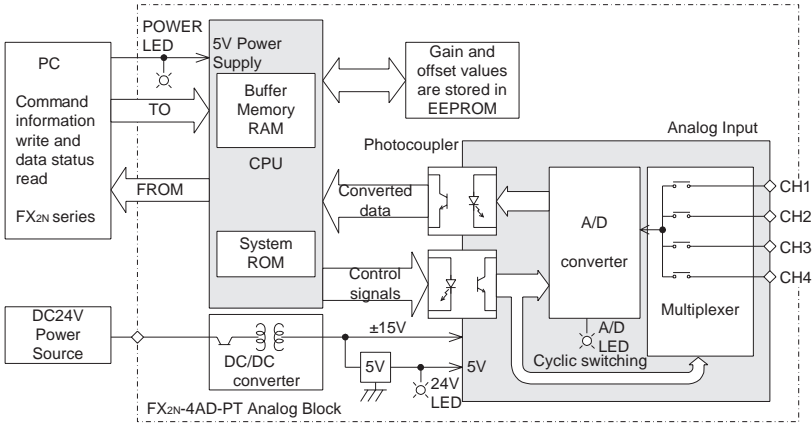
Bit devices of BFM #29	ON	OFF
b0 : Error	When any of b1 to b3 is ON A/D conversion is stopped for the error channel	No error
b1 : Reserved	Reserved	Reserved
b2 : Power source	24VDC power supply failure	Power supply normal
b3 : Hardware error	A/D converter or other hardware failure	Hardware Normal
b4 to b9 : Reserved	Reserved	Reserved
b10 : Digital range error	Digital output/analog input value is outside the specified range.	Digital output value is normal.
b11 Averaging error	Selected number of averaged results is outside the available range. -see BFM #1 to #4	Averaging is normal. (between 1 to 4096)
b12 to b15 : Reserved	Reserved	Reserved

- (3) Identification Code Buffer Memory BFM #30

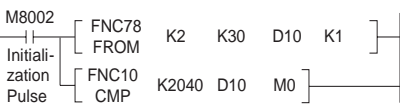
The identification code or ID number for a Special Block is read from buffer memory BFM #30 using the FROM command.

This number for the FX_{2N}-4AD-PT unit is K2040.

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



In the program shown below, the FX_{2N}-4AD-PT block occupies the position of special block number 2 (that is the third closest block to the programmable controller). The averaging amount is four. The averaged values in degrees C of input channels CH1 to CH4 are stored respectively in data registers D0 to D3.



Block No.2 BFM #30 → (D10)
Identification code

When (K2040) = (D10), M1 = ON i.e.
When identification code is K2040, M1 = ON

This initial step checks that the special function block placed at position 2 is actually an FX_{2N}-4AD-PT, i.e. its unit identification number is 2040 (BFM #30). This step is optional, but it provides a software check that the system has been configured correctly.



Block No.2 BFM #29 → (K4M10)
Transfer the error status to (M25 to M10).
When error is found, M10 = ON.
Represents b0 BFM #29

This step provides optional monitoring of the FX_{2N}-4AD-PT Error Buffer Memory (#29). If there is an Error on the FX_{2N}-4AD-PT, 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_{2N} programmable controller (M3 in this example). Additional Error devices can be output in a similar manner, i.e. b10 BFM #29. (see below)



Represents b0 BFM #29

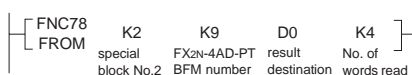
Represents b10 BFM #29



(K4) → (BFM #1 to #4)
Number of samples is changed four on CH1 to CH4.

(BFM #5 to #8) → (D0 to D3)
Transfer the averaged temperature value in °C to the data registers.

This step is the actual reading of the FX_{2N}-4AD-PT input channels. It is essentially the only program step which is needed. The "TO" instruction in this example, sets the input channels, CH1 to CH4, to take the average reading of four samples. The "FROM" instruction reads the average temperatures (BFM #5 to #8) for input channels CH1 to CH4 of the FX_{2N}-4AD-PT. If direct temperature readings are required BFM #9 to #12 should be read instead, ex.



special FX_{2N}-4AD-PT result No. of
block No.2 BFM number destination words read

6.1 Preliminary checks

- I. Check whether the input/output wiring and/or extension cables are properly connected on FX_{2N}-4AD-PT analog special function block
- II. Check that the FX_{2N} 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 an MPU or a powered extension unit varies according to the number of extension blocks or special function blocks connected.
- V. Put the Main Processing Unit (MPU) into RUN.

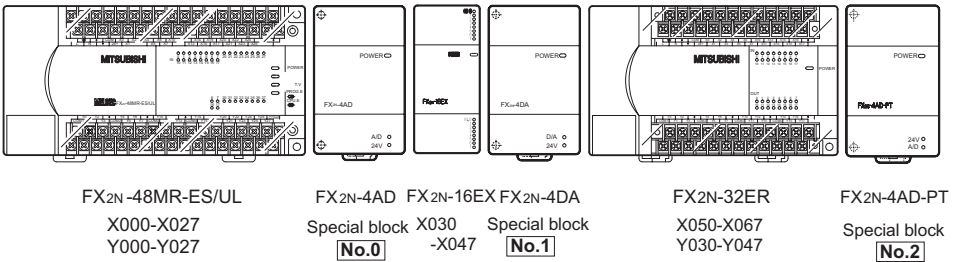
6.2 Error checking

If the FX_{2N}-4AD-PT 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 for the "24V" LED (top right corner of the FX_{2N}-4AD-PT).
 - Lit : FX_{2N}-4AD-PT is ON, 24V DC power source is ON.
 - Otherwise : Possible 24VDC power failure, if ON possible FX_{2N}-4AD-PT failure.
- Check the status for the "A/D" LED (top right corner of the FX_{2N}-4AD-PT).
 - Lit : A/D conversion is proceeding normally.
 - Otherwise : Check buffer memory #29 (error status). If any bits (b0, b2, 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_{2N} programmable controller or to the right side of other extension blocks or units. Each special block is consecutively numbered from 0 to 7 beginning from 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_{2N}-4AD-PT.

Mitsubishi recommend that the PT 100 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 $\overline{\text{FG}}$ \perp terminals as shown in section 2.0.

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 FX₂N-4AD-PT

- 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 FX₂N-4AD-PT 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 FX₂N-4AD-PT 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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Manual revision : A

Date : JUNE 1997

 **MITSUBISHI ELECTRIC CORPORATION**

HEAD OFFICE: MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
HIMEJI WORKS: 840, CHIYODA CHO, HIMEJI, JAPAN

FX_{2N}

FX_{2N}-4AD-PT SPECIAL FUNCTION BLOCK USER'S GUIDE

JY992D65601A

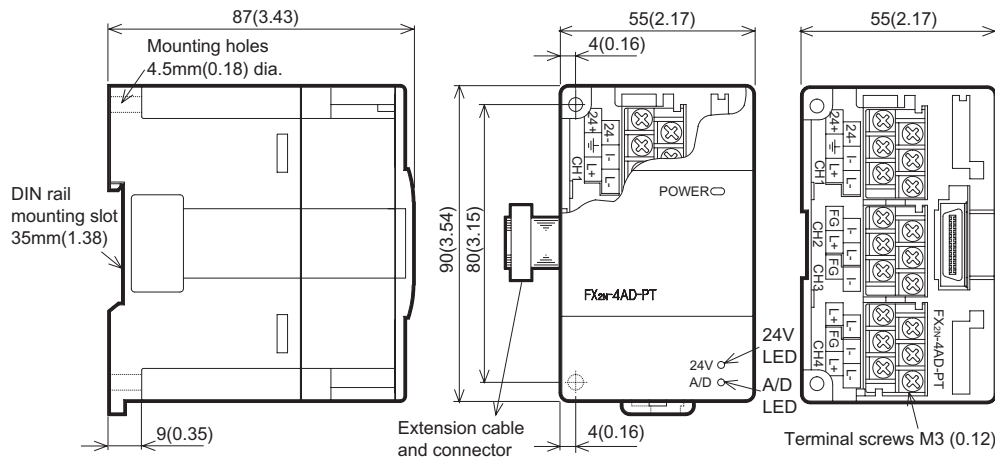
This manual contains text, diagrams and explanations which will guide the reader in the correct installation and operation of the FX_{2N}-4AD-PT special function block and should be read and understood before attempting to install or use the unit.
Further information can be found in the FX PROGRAMMING MANUAL and FX_{2N} SERIES HARDWARE MANUAL.

1 INTRODUCTION

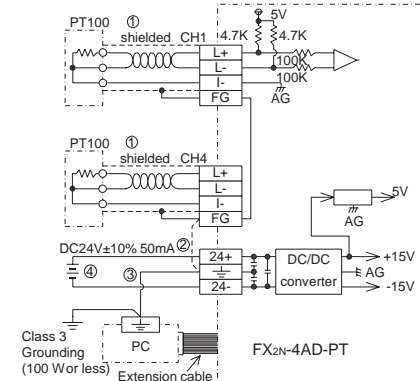
- The FX_{2N}-4AD-PT analog block amplifies the input from four platinum temperature sensors (PT 100, 3 wire, 100 Ω) and converts the data into 12 bit reading's stored in the Main Processing Unit (MPU). Both Centigrade (°C) and Fahrenheit (°F) can be read. Reading resolution is 0.2°C to 0.3°C / 0.36°F to 0.54°F.
- All data transfers and parameter setups are adjusted through software control of the FX_{2N}-4AD-PT ; by use of the TO/FROM applied instructions in the FX_{2N} PC.
- The FX_{2N}-4AD-PT occupies 8 points of I/O on the FX_{2N} expansion bus. The 8 points can be allocated from either inputs or outputs. The FX_{2N}-4AD-PT draws 30mA from the 5V rail of the MPU or powered extension unit.

1.1 EXTERNAL DIMENSIONS

Weight : Approx. 0.3 kg (0.66 lbs) Dimensions : mm (inches)



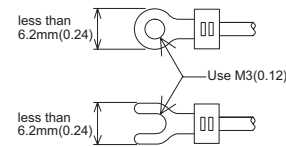
2 TERMINAL LAYOUTS



- The cable of the PT 100 sensor or a twisted shielded cable should be used for the analog input cable. This analog input cable should be wired separately from power lines or any other lines which may induce noise. The three wire method improves the accuracy of the sensors by compensating voltage drops.
- If there is electrical noise, connect the frame ground terminal (FG) with the ground terminal.
- Connect the ground terminal on the FX_{2N}-4AD-PT unit with the grounded terminal on the base unit. Use class 3 grounding on the base unit, if grounding is possible.
- Either an external or the 24V built-in supply in the programmable controller may be used.

For additional data regarding EMC considerations please see section 7.0.

2.1 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.

3 INSTALLATION NOTES AND USAGE

3.1 Environmental specification

Item	Specification
Environmental specifications (excluding following)	Same as those for the FX _{2N} base unit
Dielectric withstand voltage	500V AC, 1min (between all terminals and ground)

3.2 Power supply specification

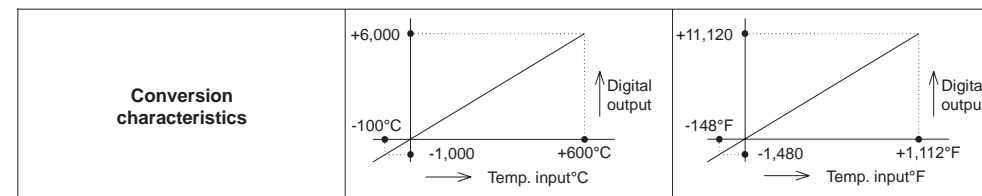
Item	Specification
Analog circuits	24V DC ±10%, 50mA
Digital circuits	5V DC, 30mA (internal power supply from base unit)

3.3 Performance specification

Analog Inputs

Item	Centigrade	Fahrenheit
	Both °C and °F readings are available by reading the appropriate buffer memory area.	
Analog input signal	Platinum temperature PT 100 sensors (100 Ω), 3-wire, 4-channel (CH1, CH2, CH3, CH4), 3850 PPM/°C (DIN 43760, JIS C1604-1989)	
Current to sensor	1 mA. sensor : 100 Ω PT 100	
Compensated range	-100°C to +600°C	-148°F to +1112°F
Digital output	12-bit conversion 11 data bits +1 sign bit	
Minimum resolvable temp.	0.2°C to 0.3°C	0.36°F to 0.54°F
Overall accuracy	±1% full scale (compensated range) -see section 7.0 for special EMC considerations	
Conversion speed	15 ms for 4 channels	

Analog Inputs continued...



Miscellaneous

Item	Specification
Isolation	Photo-coupler isolation between analog and digital circuits. DC/DC converter isolation of power from FX _{2N} MPU. No isolation between analog channels.
Number of occupied I/O points	8 points taken from the FX _{2N} expansion bus (can be either inputs or outputs)

3.4 Buffer memory assignment

BFM	CONTENTS
*#1-#4	CH1 to CH4 Averaged temperature reading to be averaged (1 to 4,096) Default = 8
#5-#8	CH1 to CH4 Averaged temprature in 0.1°C units
#9-#12	CH1 to CH4 Present temprature in 0.1°C units
#13-#16	CH1 to CH4 Averaged temprature in 0.1°F units
#17-#20	CH1 to CH4 Present temprature in 0.1°F units
#21-#27	Reserved
*#28	Digital range error latch
#29	Error status
#30	Identification code K2040
#31	Reserved

The FX_{2N}-4AD-PT communicates with the programmable controller through use of buffer memories.

BFMs (buffer memories) #21 to #27 and #31 are reserved.

All BFM's data can be read by the programmable controller using the FROM command.

BFMs marked with an "*" can be written to from the programmable controller using the TO command.

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

(2) A number of recently converted readings are averaged to give a smoother read out. The averaged data is stored in BFM's #5 to #8 and #13 to #16.

(3) BFM's #9 to #12 and #17 to #20 store the current value of the input data. This value is in units of 0.1°C or 0.1°F, but the resolution is only 0.2°C to 0.3°C or 0.36°F to 0.54°F.

3.5 Status Information

(1) Buffer Memory BFM #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 : Latches 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.

When an error occurs the temperature data before the error is latched. If the measured value returns to within valid limits the temperature data returns to normal operation. (Note: The error remains latched in (BFM #28))
An error can be cleared by writing K0 to BFM #28 using the TO instruction or turning off the power.

(2) Buffer Memory BFM #29: Error status

Bit devices of BFM #29	ON	OFF
b0 : Error	When any of b1 to b3 is ON A/D conversion is stopped for the error channel	No error
b1 : Reserved	Reserved	Reserved
b2 : Power source	24VDC power supply failure	Power supply normal
b3 : Hardware error	A/D converter or other hardware failure	Hardware Normal
b4 to b9 : Reserved	Reserved	Reserved
b10 : Digital range error	Digital output/analog input value is outside the specified range.	Digital output value is normal.
b11 Averaging error	Selected number of averaged results is outside the available range. -see BFM #1 to #4	Averaging is normal. (between 1 to 4096)
b12 to b15 : Reserved	Reserved	Reserved

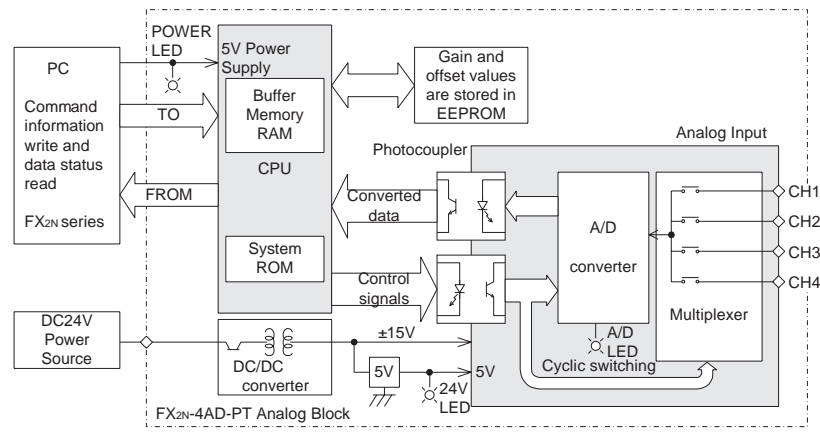
(3) Identification Code Buffer Memory BFM #30

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_{2N}-4AD-PT unit is K2040.

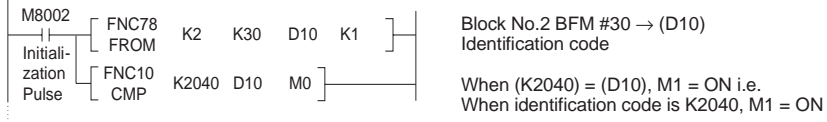
The programmable controller can use this facility in its program to identify the special block before commencing data transfer from and to the special block.

4 SYSTEM BLOCK DIAGRAM

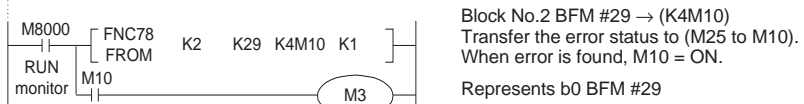


5 EXAMPLE PROGRAM

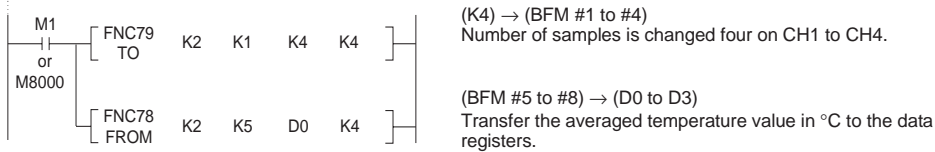
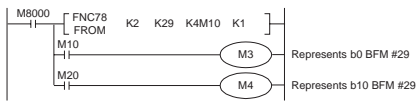
In the program shown below, the FX2N-4AD-PT block occupies the position of special block number 2 (that is the third closest block to the programmable controller). The averaging amount is four. The averaged values in degrees C of input channels CH1 to CH4 are stored respectively in data registers D0 to D3.



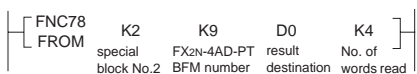
This initial step checks that the special function block placed at position 2 is actually an FX2N-4AD-PT, i.e. its unit identification number is 2040 (BFM #30). This step is optional, but it provides a software check that the system has been configured correctly.



This step provides optional monitoring of the FX2N-4AD-PT Error Buffer Memory (#29). If there is an Error on the FX2N-4AD-PT, 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 FX2N programmable controller (M3 in this example). Additional Error devices can be output in a similar manner, i.e. bit1 BFM #29. (see below)



This step is the actual reading of the FX2N-4AD-PT input channels. It is essentially the only program step which is needed. The "TO" instruction in this example, sets the input channels, CH1 to CH4, to take the average reading of four samples. The "FROM" instruction reads the average temperatures (BFM #5 to #8) for input channels CH1 to CH4 of the FX2N-4AD-PT. If direct temperature readings are required BFM #9 to #12 should be read instead, ex.



6 DIAGNOSTICS

6.1 Preliminary checks

- I. Check whether the input/output wiring and/or extension cables are properly connected on FX2N-4AD-PT analog special function block
- II. Check that the FX2N 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 an MPU or a powered extension unit varies according to the number of extension blocks or special function blocks connected.
- V. Put the Main Processing Unit (MPU) into RUN.

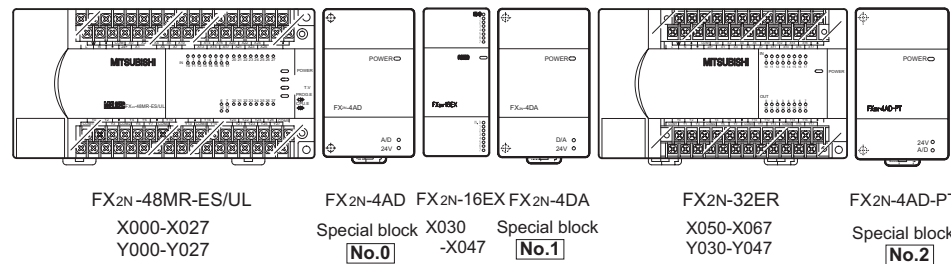
6.2 Error checking

If the FX2N-4AD-PT 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 for the "24V" LED (top right corner of the FX2N-4AD-PT).
 - Lit : FX2N-4AD-PT is ON, 24V DC power source is ON.
 - Otherwise : Possible 24VDC power failure, if ON possible FX2N-4AD-PT failure.
- Check the status for the "A/D" LED (top right corner of the FX2N-4AD-PT).
 - Lit : A/D conversion is proceeding normally.
 - Otherwise : Check buffer memory #29 (error status). If any bits (b0, b2, b3) are ON, then this is why the A/D LED is OFF.

6.3 Checking special function block numbers

Other special units of 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 FX2N programmable controller or to the right side of other extension blocks or units. Each special block is consecutively numbered from 0 to 7 beginning from the one closest to the base unit. A maximum of eight special blocks can be connected.



Guidelines for the safety of the user and protection of the FX2N-4AD-PT

- 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 FX2N-4AD-PT 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 FX2N-4AD-PT 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.

7 EMC CONSIDERATIONS

Electromagnetic compatibility or EMC must be considered before using the FX2N-4AD-PT.

Mitsubishi recommend that the PT 100 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 $\overline{\text{FG}}$ terminals as shown in section 2.0.

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".

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