

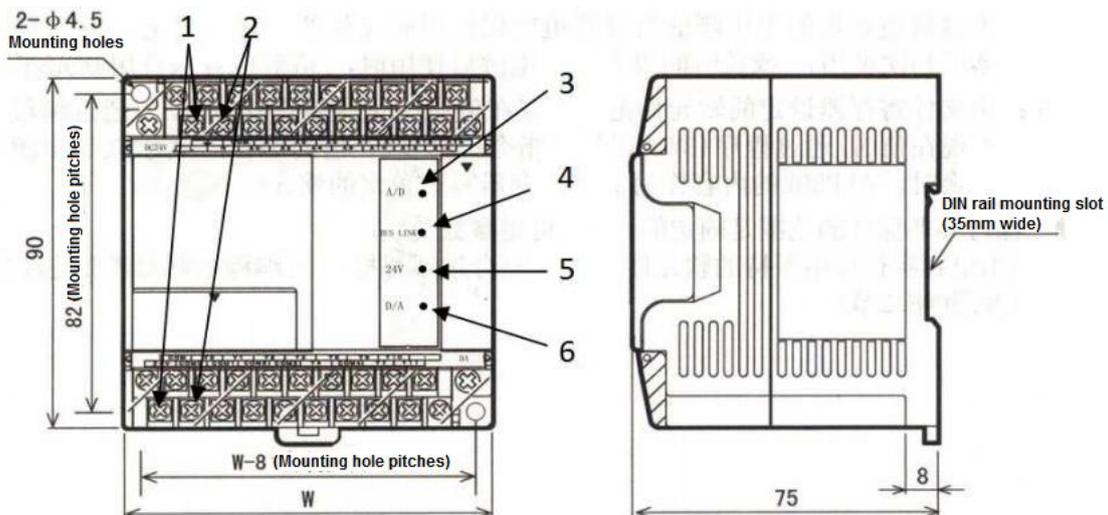
TX2N-4AD4DA Special Function Block
TX2N-4AD2DA Special Function Block

User's Guide

1. Introduction

- TX2N-4AD4DA analog special function block has four input channels, four output channels. The input channels receive analog signals and convert them into a digital value. This is called an A/D conversion. The output channels take a digital value and output an equivalent analog signal. This is known as a D/A conversion. TX2N-4AD4DA has a maximum resolution of 12 bits.
- TX2N-4AD2DA analog special function block has four input channels, two output channels. There's no CH3, CH4 compared with TX2N-4AD4DA. The function and performance of CH1, CH2 is same to the ones in TX2N-4AD4DA.
- In AD block, the selection of voltage or current based on input/output is by user wiring. Analog ranges of -10 to 10V DC (resolution: 5mV), and/or 4 to 20mA, -20 to 20mA (resolution: 20 μ A) may be selected.
- In DA block, the selection of voltage or current based on input/ output is by user wiring. Analog ranges of -10 to 10V DC (resolution: 5mV), and/ or 0 mA to 20 mA, 4 to 20mA (resolution: 20 μ A) may be selected.
- Data transfer between TX2N-4AD4DA (TX2N-4AD2DA) and main units is completed by buffer memory exchange. There are altogether 64 buffer memories, 32 in 4AD, 32 in 4DA(each of 16 bits).
- The TX2N-4AD4DA draws 30mA from the 5V rail of the main unit or powered extension unit.

1.1 External Dimensions

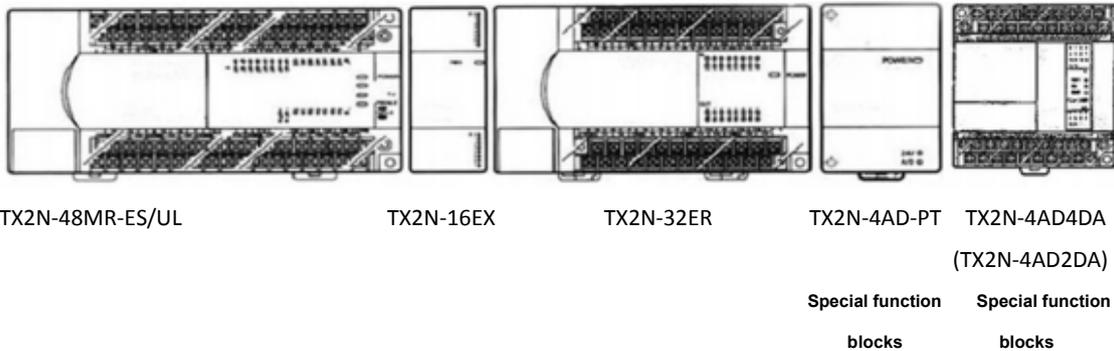


- | | |
|----------------------------------|-----------------------------------|
| 1. 24V power supply terminal | 2. 0V power supply terminal |
| 3. A/D conversion indicator lamp | 4. Bus power indicator lamp (LED) |
| 5. 24V Power indicator lamp | 6. D/A conversion indicator lamp |

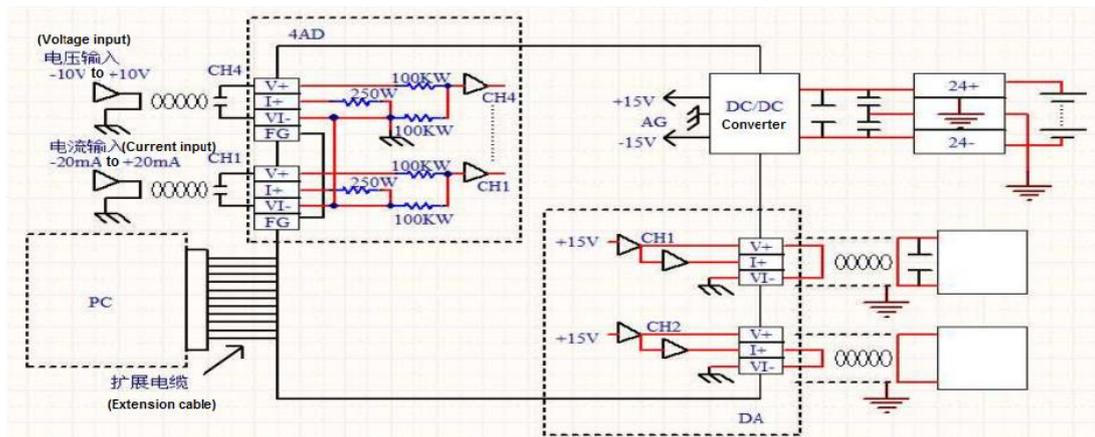
1.2 Connection with PLC

Various special function blocks controlled by FROM/TO instruction, such as analog input units, high speed counting units, can be connected to TX2N programmable controller(MPU) or the right of other expansion blocks or units. At most 8 special function blocks can be connected to a MPU from No.0 to No.7 in sequence. As TX2N-4AD4DA is the equivalent of 4AD, 4DA special function units(TX2N-4AD2DA is the equivalent of 4AD, 2DA special function units), if you want to connect these two special function units with others at the same time, TX2N-4AD4DA (TX2N-4AD2DA) must be connected at last. At most 6 special function blocks can be connected except TX2N-4AD4DA(TX2N-4AD2DA). Please note that the serial number of AD follows the one of DA in TX2N-4AD4DA (TX2N-4AD2DA) .

For example, if 6 special function units has been connected before TX2N-4AD4DA (TX2N-4AD2DA) , DA number of TX2N-4AD4DA (TX2N-4AD2DA) is No.6, but AD number is No.7.



2. Wiring



1. The analog input and output are received through twisted pair shielded cable. This cable should be wired away from power lines or any other lines which could induce noise.
2. If a voltage ripple occurs during I/O, or there is electrically induced noise on the external wiring, connect a smoothing capacitor of 0.1 to 0.47 μF , 25V.
3. If using current input, please connect the V+ and I+ terminal to each other.
4. If there is excessive voltage noise, connect the FG (frame ground) terminal with the

- grounded terminal on 4AD.
- Shorting voltage output terminal or connecting current output load to voltage output terminal may damage the TX2N-4AD4DA (TX2N-4AD2DA) in D/A conversion.
 - Connect the ground terminal on the TX2N-4AD4DA (TX2N-4AD2DA) unit with the grounded terminal on the main unit. Use 3-level grounding on the main unit, if available.

3. Specification

3.1 Environment specification

Item	Specification
Environment specifications	Same as those on TX2N main unit
Dielectric withstand voltage	5000V AC, 1min (between all terminals and ground)

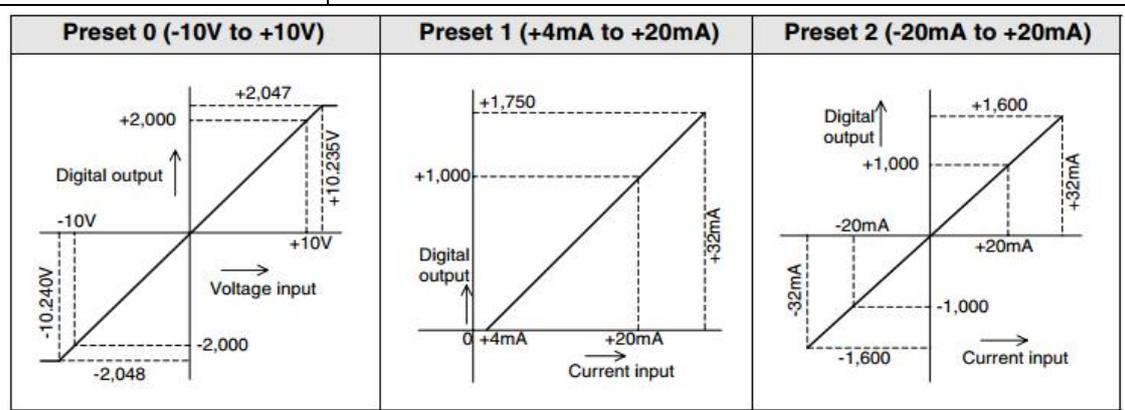
3.2 Power supply specification

Item	Specification
Analog circuits	24V DC \pm 10%, 55mA (External power supply from the main unit)
Digital circuits	5V DC, 30mA (Internal power supply from the main unit)

3.3 Performance specification

AD Analog Inputs

Items	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: 200K Ω)	DC -20mA to 20mA (Input resistance: 250 Ω)
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)	20A (20mA default range: 1/1000)
Overall accuracy	\pm 1% (for the range of -10V to +10V)	\pm 1% (for the range of -20mA to +20mA)
Conversion Speed	15ms/channel (Normal speed), 6ms/channel (High speed)	



DA Analog output

Item	Voltage output	Current output
Analog output range	DC -10V to 10V (External load resistance: 2KΩ to 1MΩ)	DC 0mA to 20mA (External load resistance: 500Ω)
Digital Input	16 bits, binary, with sign (Effective bits for numeric value:11 bits and sign bit (1 bit)) (Effective bits for numeric value: 11 bits and sign bit (1 bit))	
Resolution	5mV (10V*1/2000)	20 μA (20mA*1/1000)
Overall accuracy	±1% (for the range of -10V to +10V)	±1% (for the range of -20mA to +20mA)
Conversion speed	TX2N-4AD4DA, DA has 4 channels (TX2N-4AD2DA, DA has 2 channels) 2.1ms for each channel(Change in the number of channels used will not change the conversion speed)	
Isolation	Photo-coupler isolation between analog and digital circuits. DC/DC converter isolation of power from PLC main unit. No isolation between analog channels	
External power supply	24V DC±10% 200mA	
Number of occupied I/O points	The analog block occupies 8 I/O points. (can be either inputs or outputs)	
Power consumption	5V, 30mA (Internal power supply from MPU or powered extension unit)	
I/O Characteristics (Default: Mode 0)	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Mode 0 (Voltage output: -10V to +10V) At load resistance of 10kΩ</p> </div> <div style="text-align: center;"> <p>Mode 1 (Current output: +4mA to +20mA) At load resistance of 250Ω</p> </div> <div style="text-align: center;"> <p>Mode 2 (Current output: 0mA to +20mA) At load resistance of 250Ω</p> </div> </div> <p>Commands sent from the programmable controller can change the mode. The voltage/current output mode selected will determine the output terminals used.</p>	

4. Allocation of buffer memory(BFM)

4.1 Allocation of AD buffer memory(BFM)

BFM	Contents	
*#0	Channel initialization Default = H0000	
*#1	Channel 1	Contains the number of samples (1 to 4096) to be used for an averaged result. The default setting is 8- normal speed. High speed operation can be selected with a value of 1.
*#2	Channel 2	
*#3	Channel 3	
*#4	Channel 4	
#5	Channel 1	These buffer memories contain the averaged input values for the number of samples entered for the channel in buffer memories #1 to #4 respectively.
#6	Channel 2	
#7	Channel 3	

#8	Channel 4	
#9	Channel 1	These buffer memories contain the present value currently being read by each input channel.
#10	Channel 2	
#11	Channel 3	
#12	Channel 4	
#13-#14	Reserved	
#15	Selection of A/D conversion speed	When set to 0, a normal speed is selected of 15ms/channel
		When set to 1, a high speed is selected of 6ms/channel

- In buffer memory locations (BFMs) marked with an “*”, data can be written from the PLC using the TO instruction.
- For buffer memories (BFMs) without “*” mark, data can be read by the PLC using the FROM instruction.
- Before reading from the analog special function block, ensure that the appropriate settings have been sent to the analog special function block. Otherwise, the previous values held in the analog block will be used.

BFM		b7	b6	b5	b4	b3	b2	b1	b0
#16-#19	Reserved								
*#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-#28	Reserved								
#29	Error status								
#30	Identification code K2010								
#31	Cannot be used								

- The buffer memory also gives a facility to adjust the offset and gain via software.
- Offset (intercept): The analog input value when the digital output becomes 0.
- Gain (slope): The analog input value when the digital output becomes +1000.

1) Channel selection

Channel selection is made by a 4 character HEX number HOOOO in buffer memory BFM #0.

The least significant character controls channel 1 and the 4th character controls channel 4.

Setting of each character is as follows:

O = 0: Preset range (-10V to +10V) O = 2: Preset range (-20mA to +20mA)

O = 1: Preset range (+4mA to +20mA) O = 3: Channel OFF

Example: H3310

CH1 : Preset range (-10V to +10V)

CH2 : Preset range (+4mA to +20mA)

CH3, CH4: Channel OFF

2) Analog to digital conversion speed change

By writing 0 or 1 to BFM #15 of the AD Block, the speed at which A/D conversion is performed can be changed.

3) Adjusting Gain and Offset values

a) When buffer memory BFM #20 is activated by setting it to K1, all settings within the analog special function block are reset to their default settings.

b) 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)

c) Offset and gain values in BFM #23 and #24 are in units of mV or μ A.

4) Status information BFM#29

Bit device of BFM#29	ON	OFF
b0: Error	When any of b1 to b4 is ON, A/D conversion of all the channels is stopped.	No error
b1: Offset/Gain error	Offset/Gain data in the EEPROM is corrupted or adjustment error.	Offset/Gain data normal
b2: Power source abnormality	24V DC power supply failure	Power supply normal
b3: Hardware error	A/D converter or other hardware failure	Hardware normal
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	Averaging is normal.
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 (1,0)

4.2 Allocation of DA buffer memory(BFM)

BFM		Contents
W	#0E	Output mode selection. Factory setting H000
	#1	
	#2	
	#3(Not used in TX2N-4AD2DA)	
	#4(Not used in TX2N-4AD2DA)	
	#5E	Data holding mode. Factory setting H000
#6, #7		Reserved

1) [BFM #0] Output mode selection: The value of BFM #0 switches the analog output between voltage and current on each channel. It takes the form of a 4 digit hexadecimal number. The first digit will be the command for channel 1 (CH1), and the second digit for channel 2 (CH2) etc. The numeric values of these four digits respectively represent the following items:

O=0: Sets the voltage output mode (-10 V to +10 V)

H O=1: Sets the current output mode (+4mA to + 20mA)

CH4 CH3 CH2 CH1 O=2: Sets the current output mode (0mA to + 20mA)

new data to BFM #10 through to #17. The units of the data to be written is mV or μ A. The data should be written and then BFM #8 and #9 set. Note that the data value will be rounded down to the nearest 5mV or 20 μ A.

6) [BFM #20] Initialize: When K1 is written in BFM #20, all values will be initialized to the factory-default. (Note that the BFM #20 data will override the BFM #21 data.) The initial function is convenient when you have an error in adjustment.

7) [BFM #21] I/O characteristics adjustment inhibit: Setting BFM #21 to 2 inhibits user from inadvertent adjustment of I/O characteristics. The adjustment inhibit function, once set, will be valid until the Permit command (BFM#21=1) is set. The initial vale is 1(Permit). The set value will be retained even after power-OFF.

8) [BFM #29] Error status: When error occurs, use the FROM command to read out the details of error.

Bit	Name	Status when bit is set to "1" (turned on)	Status when bit is set to "0" (turned off)
b0	Error	Error if any of b1 through b4 is turned on	No error
b1	O/G error	Offset/gain data in EEPROM is abnormal or a data setting error occurs	Offset/ gain data normal
b2	Power supply error	24V DC power failure	Power supplied normally
b3	Hardware error	Defective D/A converter or other hardware	Non-defective hardware
b10	Range error	The digital input or analog output value is out of the specified range.	The input and output value is in the specified range.
b12	G/O-adjustment prohibit status	BFM#21 is not set to "1".	Adjustable status (BFM#21=1)

Bits b4 through b9, b11, b13 to b15 are not defined.

9) [BFM #30] The identification code for a special function block is read using the FROM instruction. The identification code for 4DA is K3020. The main unit can use this facility in the program to identify the special block before commencing any data transfers from and to the special function block.

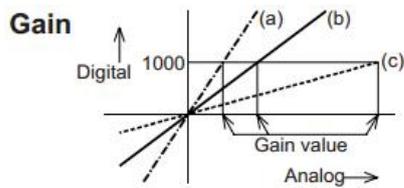
Note: BFM #'s marked E/ (E) .

- Values of BFM #0, #5, and #21, (marked E) are stored in the EEPROM memory of the TX2N-4AD4DA. BFM #10 to #17 are copied to EEPROM when the gain/offset setting command BFM #8, #9 is used. Also, BFM #20 causes the 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 BFM's.

- A mode change of BFM #0 automatically involves a change of the corresponding offset and gain values . Because of the time needed to write the new values to the internal EEPROM memory, a delay of 3s is required between instructions changing BFM #0 and instructions writing to the corresponding BFM #10 through BFM #17. Therefore, a delay timer should be used before writing to BFM #10 through #17.

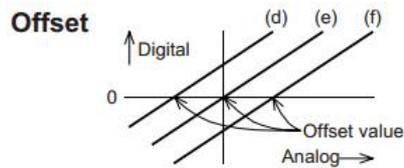
5 Defining gain and offset

5.1 AD gain and offset



Gain determines the angle or slope of calibration line, identified at a digital value of 1000.

- a) Small gain value: Large steps in digital reading
- b) Zero gain value: Default(5V or 20mA)
- c) Big gain value: Small steps in digital reading



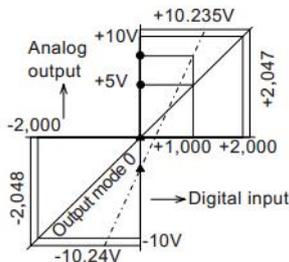
Offset is the 'position' of calibration line, identified at a digital value of 0.

- d) Negative offset
- e) Zero offset: Default(0V or 4mA)
- f) Positive offset

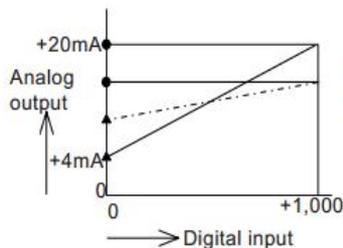
5.2 DA gain and offset

The standard characteristics (factory default) are shown by the solid lines in the figure below. These characteristics can be adjusted according to the conditions of the user's system.

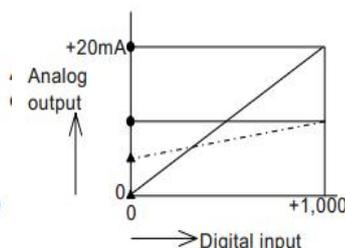
Standard characteristics of voltage output



Standard characteristics of current output (+4mA to +20mA)



Standard characteristics of current output (0mA to +20mA)



- Gain value Analog output value when digital input is +1,000.
- ▲ Offset value Analog output value when digital input is 0.

When the slope of the I/O characteristic line is steep:

Slight changes to the digital input will greatly increase or reduce the analog output.

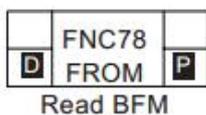
When the slope of the I/O characteristic line is gentle:

Slight changes to the digital input will not always change the analog output

Note that the resolution (minimum possible change of analog output) of the DA is fixed

6 Example program

6.1 Outline of FROM and TO commands

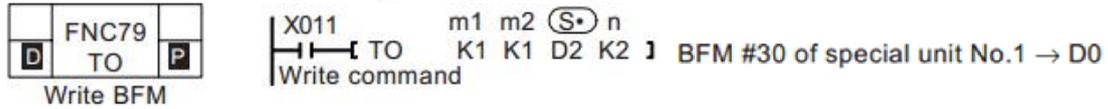


m1: Special unit or block number (K0 to K7, numbered from the MPU)

m2: Buffer memory head address (K0 to K31)

D*: Head device number of destination data. T, C, D, KnM, KnY, KnS, V, and Z can be used to designate the head device. Each device number can be qualified using an index.

n: Number of transfer points (K1 to K32) (K1 to K16 for 32-bit command)



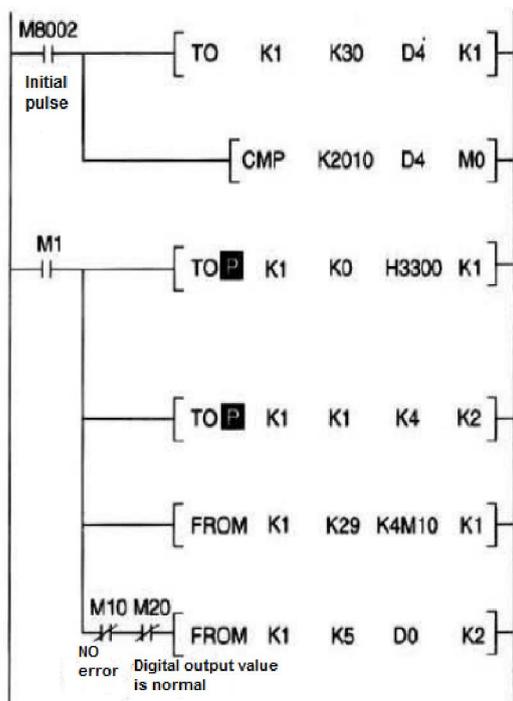
m1, m2, n: Same as above

S*: Head device number of source data. T, C, D, KnX, KnM, KnY, KnS, V, Z, K, and H can be used to designate the head device. Each device number can be qualified using an index.

When X010 and X011 are off, transfer will not be executed, therefore the destination data value will not be changed.

6.2 AD Basic program

In the following example, CH1 and CH2 are used as voltage input. The TX2N-4AD4DA AD block is connected at the position of special function block NO.1. The number of averaged samples is set at 4 and data registers D0 and D1 of the main unit receive the averaged digital data.



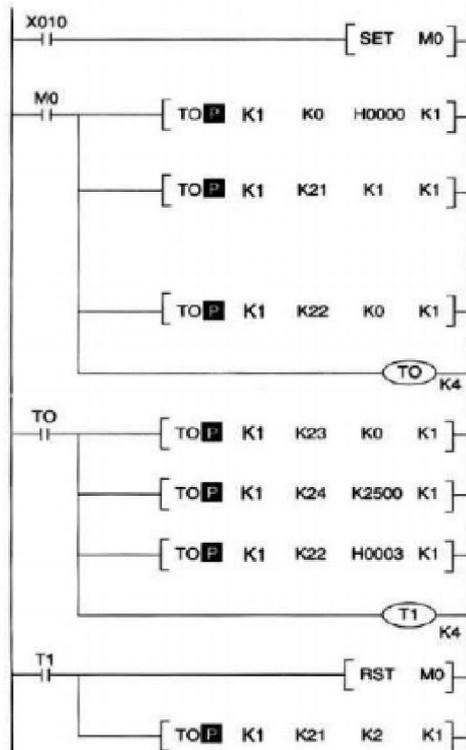
The ID code for the special function block at position "1" is read from BFM #30 of that block and stored at D4 in the main unit. This is compared with K2010 to check that the block is AD block, if OK M1 is turned ON.

The analog input channels (CH1, CH2) are setup by writing H3300 to the BFM #0 of the AD block. The number of average samples for CH1 and CH2 is set to 4 by writing 4 to BFM #1 and #2 respectively.

The operational status of 4AD is read from BFM #29. If there are no errors in the operation of the AD, then the averaged data BFM's are read.

In the case of this example BFM #5 and #6 are read into the main unit and stored in D0 and D1. These devices contain the averaged data for CH1 and CH2 respectively.

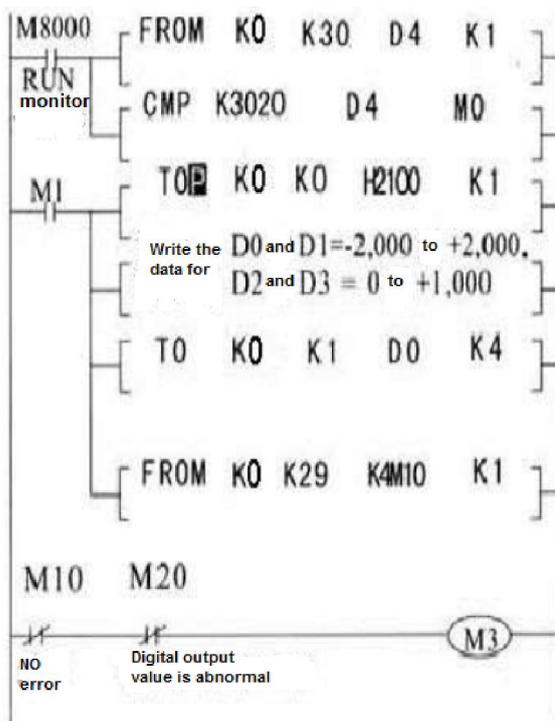
The push-button switch of PLC input terminal can adjust the gain/offset of 4AD in PLC programming. The following is an example of changing the offset value on input channel CH1 to 0V and the gain value to 2.5V. The 4AD block is in the position of block No.1.



Adjustment starts.
 (H000)→BFM #0 (input channels selection)
 Input instruction as shown in the left and PC run.
 (K1)→BFM #21
 BFM #21 (gain/offset prohibition) must be set to permission with (b1, b0) = (0,1)
 (K0)→BFM #22 (Offset/gain adjustment)
 Reset adjustment bits.
 (K0)→BFM #23 (Offset)
 (K2500)→BFM #24(Gain)
 (H003)→BFM #22(Offset/gain adjustment)
 3= 0011 i. e. O1 = 1, G1 = 1
 Channel 1 is adjusted.
 End of adjustment.
 (K1)→BFM #21(Offset/gain adjustment)
 BFM#21 gain/offset prohibition

6.3 DA basic program

In the following example, CH1 and CH2 of 4DA block (connected in the position of special function block NO.2) are used as voltage output. CH3 is used as current output channel (+4mA through +20mA). When MPU is in STOP status, output reserved. Moreover, status information is used.

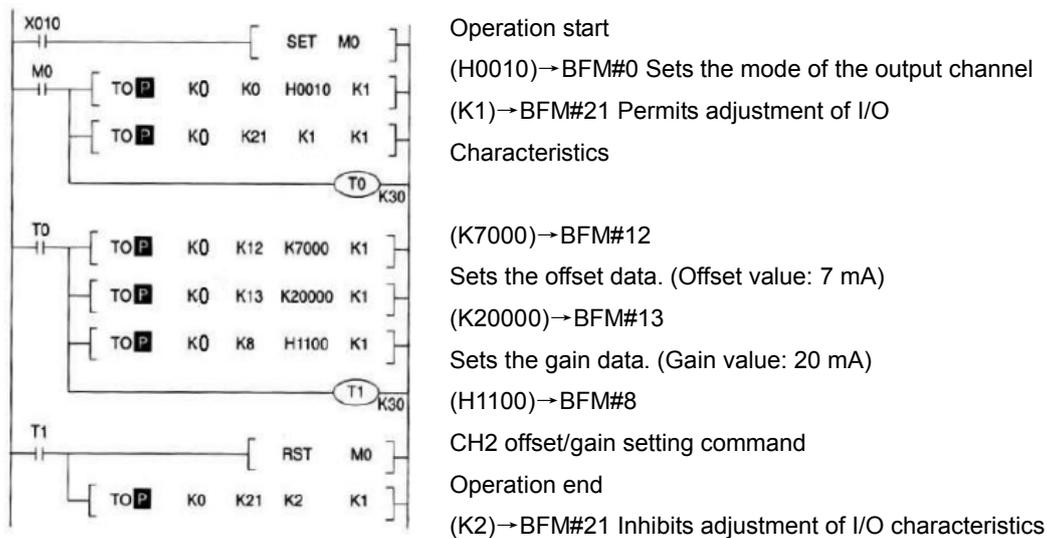


The BFM#30 data(model code) in block NO.0 will be transferred to data register D4. M1 will be turned on when the model code is set to K3020.

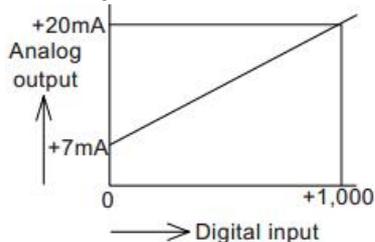
H2100→BFM #0 (NO.0 unit)
 CH1 and CH2: voltage output; CH3: current output (+4mA to +20mA); CH4:current output(0mA to +20mA)
 D0→BFM #1 (CH1 output) D1→BFM #2 (CH2 output)
 D2→BFM #3 (CH3 output) D3→BFM #4(CH3 output)
 BFM #29(b15 to b0) →(M25 to M10)
 Reads out the status data.

Adjustment of I/O characteristics

To adjust the I/O characteristics, either the push-button switch connected to PLC input terminal or forced ON/OFF function on programming panel can set offset/gain value in 4DA. To change the offset/gain, just change the conversion constant of 4DA. There is no need to be adjusted by instrument measure analog output. However, programming is needed in MPU. An example program for adjustment is shown below. The example shows that for channel CH2 of 4DA block No.1, the offset value is changed to 7 mA, and the gain value to 20 mA. Note that for CH1,CH3, and CH4, the standard voltage output characteristics are set.



After adjustment, the I/O characteristics will be as follows.



7 Diagnostics

If the TX2N-4AD4DA special function block does not operate properly, check the following items.

- 1) Check the external wiring
- 2) Check status of the BUS LINK power indicator lamp (LED) of the TX2N-4AD4DA.
 - ON: The extension cable is properly connected.
 - OFF or Flash: Check the connection of extension cable. Also check the 5V power supply capacity.
- 3) Check status of the 24 V power indicator lamp (LED) of the TX2N-4AD4DA.

ON: 24V DC is supplied.

OFF: Supply 24V DC ($\pm 10\%$) to the TX2N-4AD4DA

4) Check status of the A/D conversion indicator lamp (LED) of the TX2N-4AD4DA

ON: A/D conversion is proceeding normally.

Otherwise: Check buffer memory #29(error status). If any bits (b2 and b3) is ON, then this is why A/D LED is OFF.

5) Check status of the D/A conversion indicator lamp(LED) of the TX2N-4AD4DA.

Flash : D/A conversion is normal.

ON or OFF: The ambient conditions are suitable for TX2N-4AD4DA, or the TX2N-4AD4DA D/A is defective.

6) Check the external load resistance connected to each analog output terminals does not exceed the capacity of TX2N-4AD4DA DA drive. (Voltage output : $2K \Omega$ to $1M \Omega$ /current output: 500Ω)

7) Check the output voltage or current value using a voltmeter or ammeter, and confirm that the output meets the I/O characteristics. If the output does not meet the I/O characteristics, adjust the offset and gain again.

Note: To test the withstand voltage of the TX2N-4AD4DA, connect all the terminals to the grounding terminal.