TOSHIBA

UM-TS02***-E026

PROGRAMMABLE CONTROLLER

PROSEC **T2-series**

ANALOG I/O MODULES

AD268 / DA264 / TC218

USER'S MANUAL

TOSHIBA CORPORATION

Important Information

Misuse of this equipment can result in property damage or human injury.
Because controlled system applications vary widely, you should satisfy yourself as to the acceptability of this equipment for your intended purpose.
In no event will Toshiba Corporation be responsible or liable for either indirect or consequential damage or injury that may result from the use of this equipment.

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Safety Precautions

The AD268, DA264, and TC218 are the analog input/output modules for Toshiba's Programmable Controller PROSEC T2-series (T2/T2E/T2N).
Read this manual thoroughly before using this module. Also, keep this manual and related manuals so that you can read them anytime while this module is in operation.

Safety Symbols

The following safety symbols are used on the product and/or in the related manuals.
Pay attention to the information preceded by the following symbols for safety.

⚠ WARNING — Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION — Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

Safety Precautions

⚠ CAUTION

- Turn off power to the PLC (T2, T2E or T2N) and to this module (AD268, DA264 or TC218) before removing or mounting this module. Failure to do so can cause electrical shock or damage to this product.
- Read the Safety Precautions described in the T2, T2E or T2N User's Manual before using this module.
- Follow the instructions described in this manual and in the T2, T2E or T2N User's Manual when installing and wiring this module.
- This module has been designed for the T2/T2E/T2N. Use your AD268/DA264/TC218 only on the T2-series PLC rack.
- These modules consume the internal 5 Vdc power as shown below.
  AD268 ... 300 mA
  DA264 ... 230 mA
  TC218 ... 300 mA
  Confirm that the total 5 Vdc consumed current per one power supply module is within the limit (2.5 A). If it exceeds the limit, the T2/T2E/T2N cannot operate properly and this may cause unsafe situation.

About This Manual

About This Manual

This manual describes the specification and the operations of Toshiba's analog I/O modules (AD268, DA264 and TC218) for PROSEC T2 series programmable controllers.
Read this manual carefully for your correct operation of these modules.

This manual consists in three parts.

Part 1 ... 8 channel analog input module AD268
Part 2 ... 4 channel analog output module DA264
Part 3 ... 8 channel thermocouple input module TC218

Related Manual

The following related manuals are available for your reference.

T2E User's Manual (UM-TS02E∗∗-E001)
This manual describes the configuration, specification, installation, wiring, and maintenance of the basic hardware of the programmable controller T2E.
The functions of the T2E and how to use them, and the information necessary for creating user program are also described.

T2N User's Manual (UM-TS02N∗∗-E001)
This manual describes the configuration, specification, installation, wiring, and maintenance of the basic hardware of the programmable controller T2N.
The functions of the T2N and how to use them, and the information necessary for creating user program are also described.

T-series Instruction Set (UM-TS03∗∗∗-E004)
This manual describes the detailed specifications of instructions for Toshiba's T-series programmable controllers.

Note: In this manual, the T2 series programmable controllers (T2, T2E, and T2N) are called as T2 for ease of explanation.

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Part 1

8 Channel Analog Input Module AD268

1. Introduction

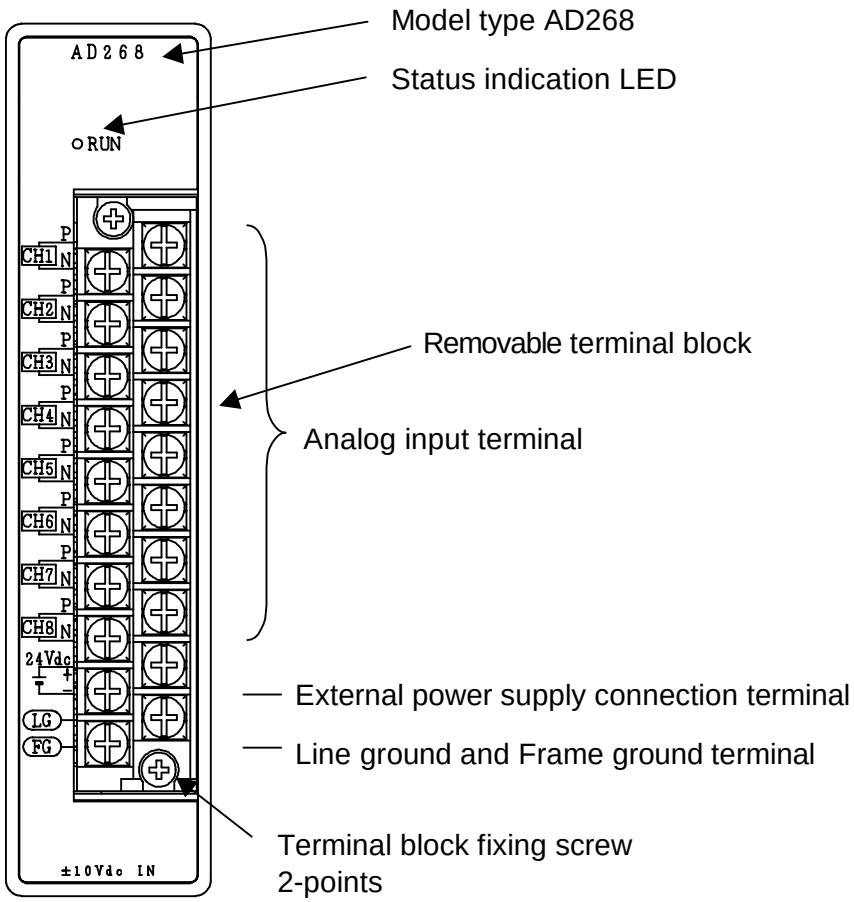
The AD268 is an 8 channel analog input module for the T2 series programmable controllers. The AD268 converts external analog signals (voltage or current) into digital values cyclically so that the T2 can process the analog signals.

1.1 AD268 Functions

The AD268 has the following functions.

1) 8 channels input per module
2) Selectable input type
   - ±5V
   - ±10V
   - 0 to 5V
   - 0 to 10V
   - 1 to 5V
   - 0 to 20mA
   - 4 to 20mA
3) 16-bit high-resolution A/D conversion
4) High-speed (1ms/channel) conversion cycle
5) Gain and offset calibration function
6) Input data averaging function
7) Unused channel skip function

1.2 External features



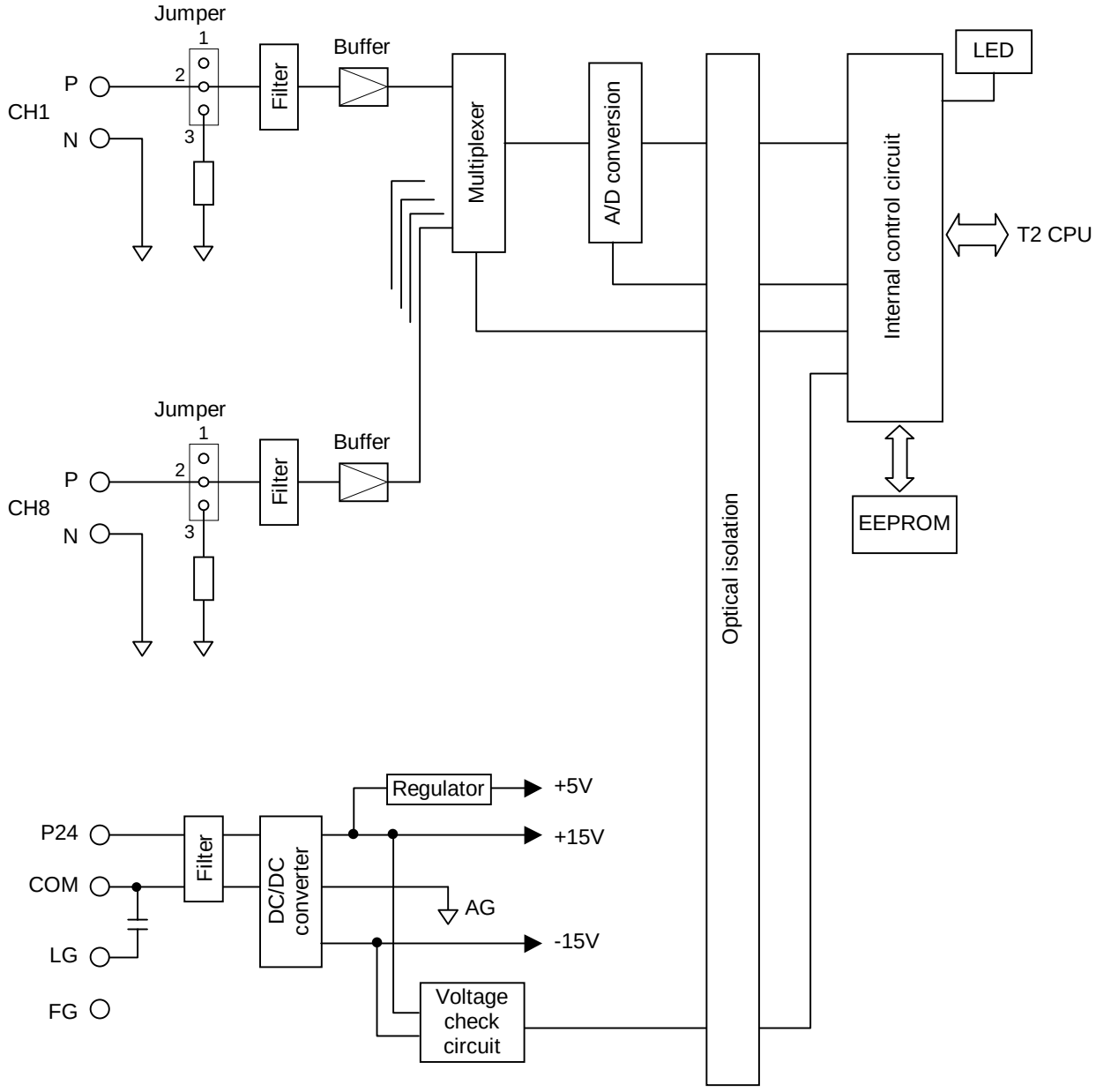
2. Specifications

This section describes the AD268 specifications.
The general specification for the AD268 conforms to the specification for the T2 PLC.

2.1 Specifications

Item		AD268	
Input type		Voltage input	Current input
Input range	Bipolar	-5 to 5V	
		-10 to 10V	
	Unipolar	0 to 5V	0 to 20mA
		0 to 10V	
		1 to 5V	4 to 20mA
Input impedance		1MΩ or more	250Ω
Number of input channels		8 channels	
I/O allocation type		X 8W (8 input registers XW are assigned)	
Resolution		16-bit	
Overall accuracy		±0.2% FS (at 25°C) ±0.5% FS (0 to 55°C) (FS: ±10V)	
Temperature drift		±100ppm/°C or less	
Conversion cycle		Approx. 1ms/channel (Approx. 8ms/8 channels)	
Insulation resistance		10MΩ or more	
Withstand voltage		1500Vac - 1 minute (between logic and analog circuits) 500Vac - 1 minute (between analog circuit and external 24V) 1500Vac - 1 minute (between analog circuit and FG/LG)	
Status indication		1 green LED (On when normal)	
Special function		Gain and offset calibration function Input data averaging function Unused channel skip function External 24Vdc power voltage drop detection	
External power supply		24Vdc ±10% - 120mA	
Internal 5Vdc current consumption		300mA or less	
External connection		20-pin removable terminal block	
Weight		Approx. 300g	

2.2 Internal block diagram



The AD268 performs the following operations.
The external analog signals come to the buffer amplifier through the filter. The multiplexer sequentially selects CH1 to CH8 to convert the input analog signals into digital data via the A/D converter. The converted digital data reaches to the internal control circuit through optical isolator. Every time when the T2 CPU requests to read the converted data, the internal control circuit sends the data to the T2 CPU. The AD268's parameters are stored in the EEPROM.

3. Input Type Setting

The AD268 supports multiple input ranges, ±5V, ±10V, 0 to 5V, 0 to 10V, 1 to 5V, 0 to 20mA, or 4 to 20mA. The input range is selected by jumper plug setting and the parameter writing by the T2 program.

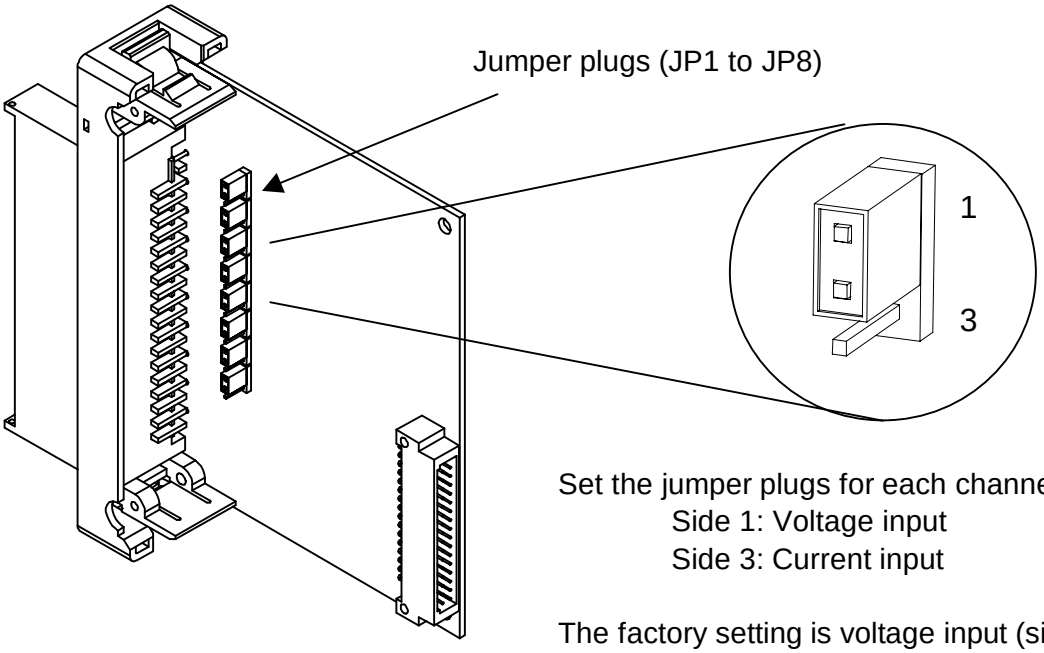
The general flow for setting the input type is as follows.

(1) Set the jumper plugs to select voltage input or current input.
(2) Mount the AD268 onto the T2 rack.
(3) Turn on power to the T2 system.
(4) Execute I/O allocation.
(5) Program the "input type setting program". (see the next page)
(6) Turn the T2 to RUN mode.

3.1 Jumper plug setting

8 jumper plugs are provided on the AD268 board.
The jumper plug setting is for selecting either voltage input or current input.

JP1 is for channel 1, JP2 is for channel 2, ... JP8 is for channel 8.



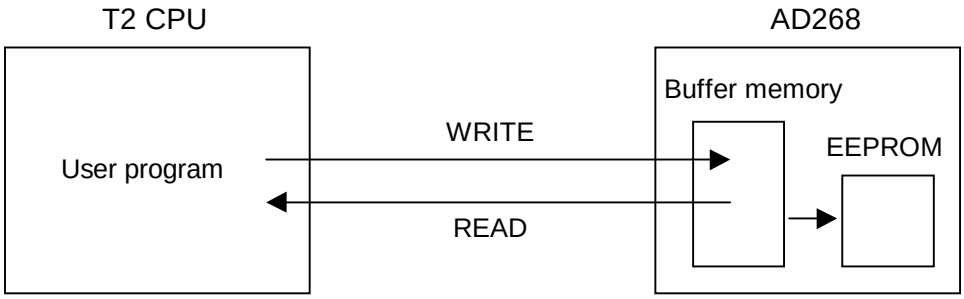
Set the jumper plugs for each channel.
Side 1: Voltage input
Side 3: Current input

The factory setting is voltage input (side 1).

- Use a pair of tweezers to set the jumper plug.
- Pay attention not to touch the components on the board other than the jumper plug.

3.2 Parameter setting by software

The input range of the AD268 is specified by writing the following parameter data into the AD268's buffer memory. To access the buffer memory, T2 user program (READ and WRITE instructions) is required.
When the parameter is set to the AD268, it is saved in the AD268's built-in EEPROM. Therefore, once the input type parameter is set, there is no need to execute the input type setting operation.



Input type parameter data:

Parameter data	Input type	
	Voltage input	Current input
0	0 to 5V	0 to 20mA
1	0 to 10V	
2	1 to 5V	4 to 20mA
4	±5V	
5	±10V	

AD268 buffer memory address:

H8018	Input type for channel 1
H8019	Input type for channel 2
H801A	Input type for channel 3
H801B	Input type for channel 4
H801C	Input type for channel 5
H801D	Input type for channel 6
H801E	Input type for channel 7
H801F	Input type for channel 8

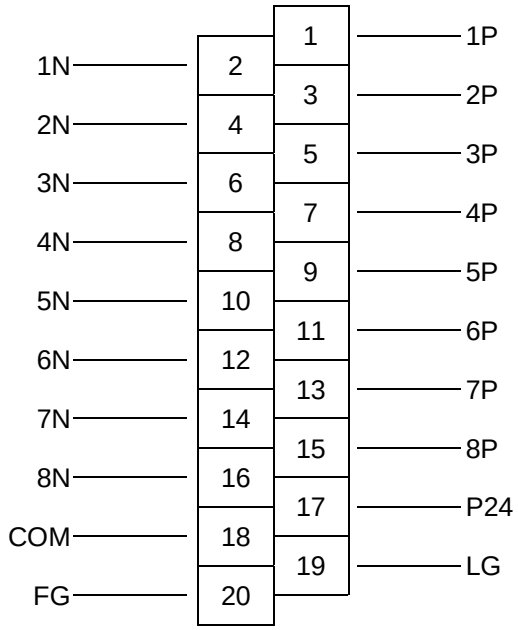
The factory setting is ±10V range.

For details of the procedure to set the input type parameter, refer to section 6.

4. Wiring

4.1 Terminal arrangement

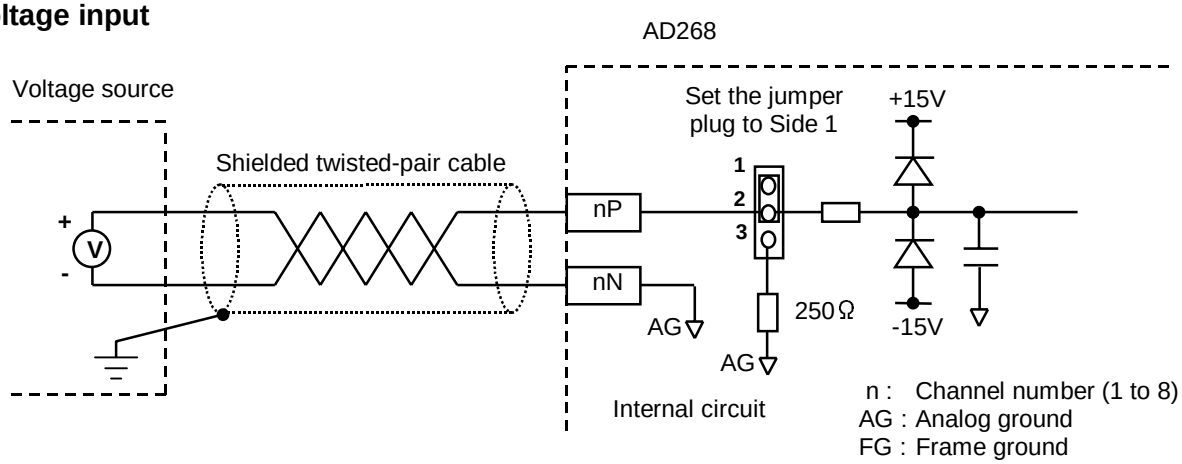
AD268 terminal block



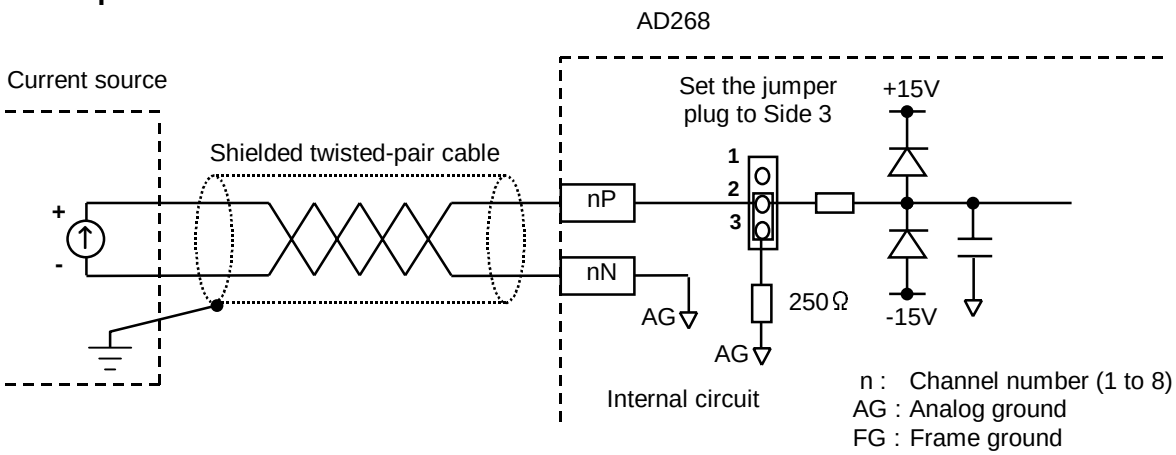
Terminal No.	Signal name	Function
1	1P	Channel 1 input
2	1N	
3	2P	Channel 2 input
4	2N	
5	3P	Channel 3 input
6	3N	
7	4P	Channel 4 input
8	4N	
9	5P	Channel 5 input
10	5N	
11	6P	Channel 6 input
12	6N	
13	7P	Channel 7 input
14	7N	
15	8P	Channel 8 input
16	8N	
17	P24	External 24Vdc power (+)
18	COM	External 24Vdc power (-)
19	LG	Line filter ground
20	FG	Frame ground

4.2 Signal wiring

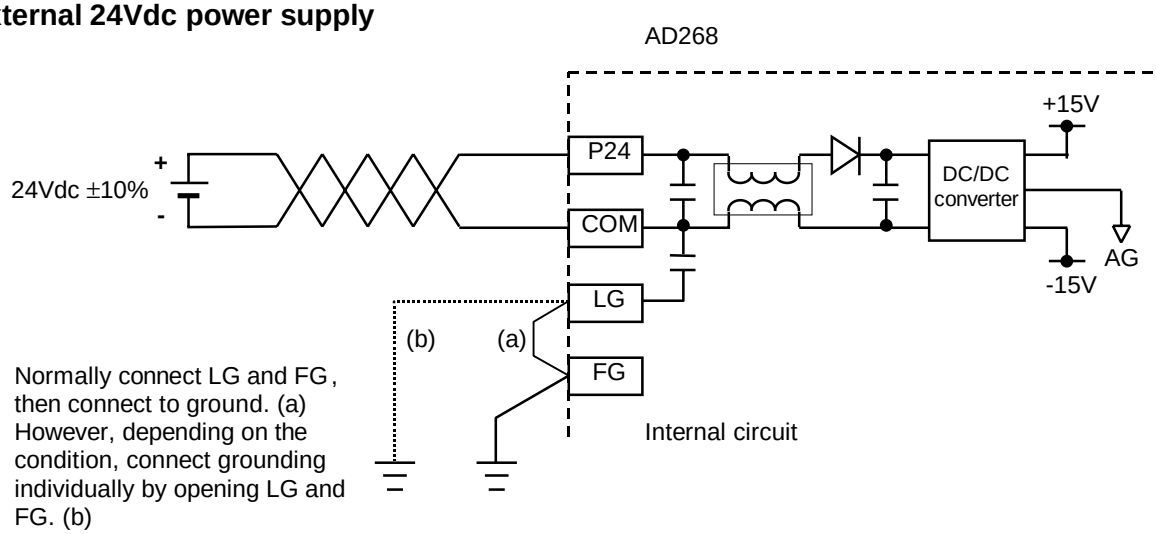
Voltage input



Current input

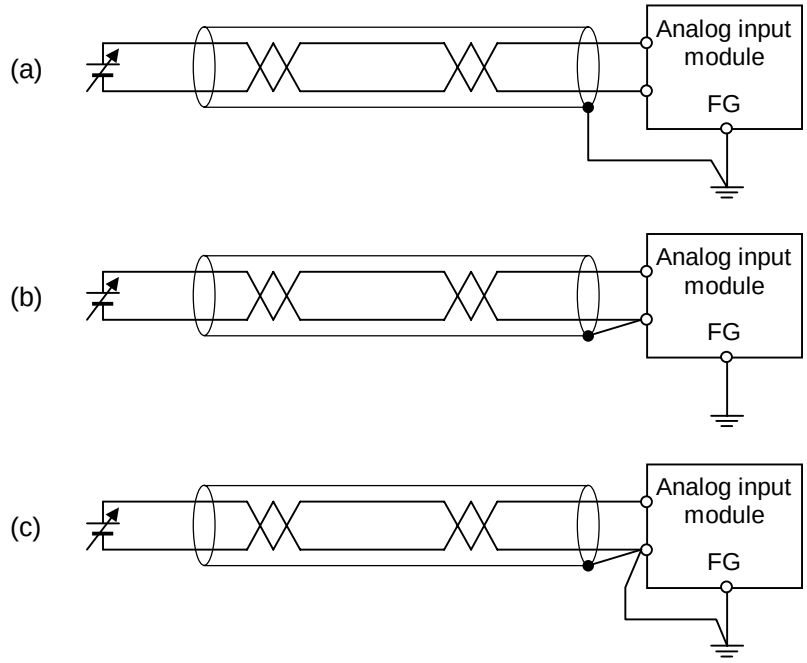


External 24Vdc power supply



4.3 Wiring precautions

(1) Use shielded twisted-pair cables for analog input signal lines and wire them in shortest distance. Connect the cable shield to ground in shortest distance for EMC conformity. Normally the grounding method (a) is recommended. However, depending on the condition, method (b) or (c) may be useful for stable operation.



(2) Separate the analog signal cable from other cables to prevent noise interference. (200mm or more)

(3) This module requires 24Vdc power. Apply the 24Vdc power before (or at the same time) applying T2's main power. Otherwise, this module detects the external 24Vdc error.

(4) If the external 24Vdc power for this module is not stable, the converted data will not be stable. In this case, use a dedicated 24Vdc power supply for this module.

(5) It is recommended to short the unused channels. Because if it is open for voltage input, meaningless A/D conversion data will appear.

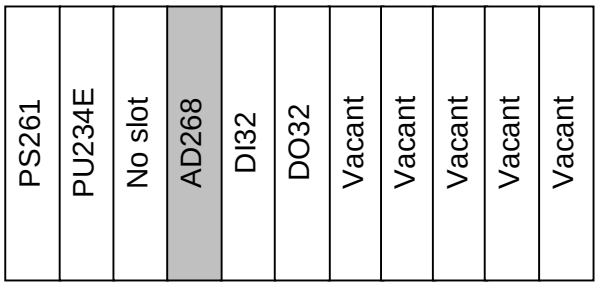
(6) If the converted data is not stable owing to electrical noise, it is recommended to use the input averaging function to reduce the noise interference. For the averaging function, refer to section 6.

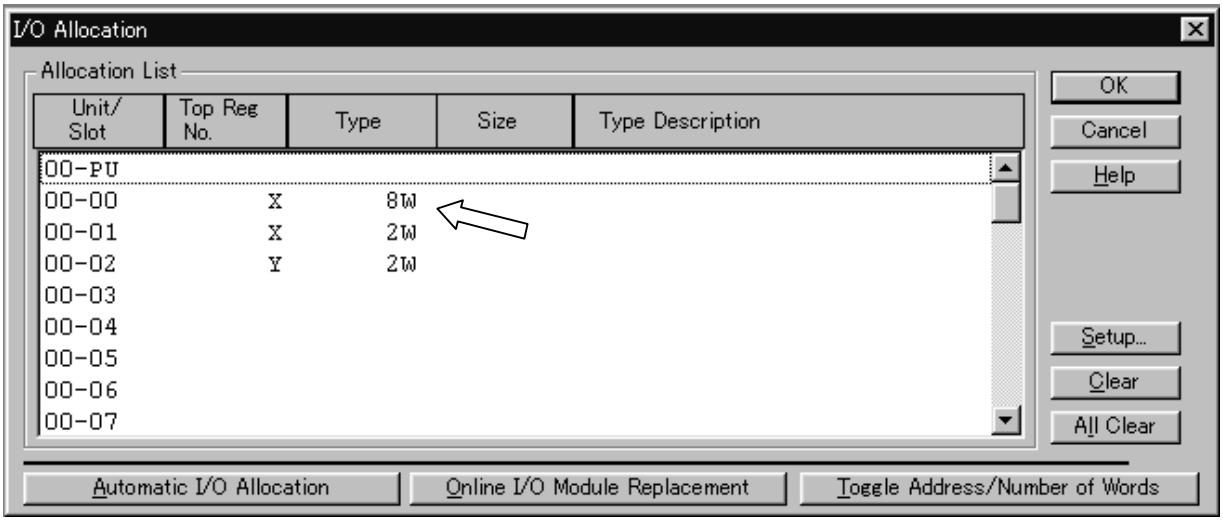
5. I/O Allocation and Programming

5.1 Allocation to the T2 registers

The I/O type of the AD268 is "X 8W".
When the automatic I/O allocation operation is performed with a AD268 mounted on the rack, the AD268 is allocated as "X 8W".
The AD268 occupies the 8 consecutive input (XW) registers of the T2.
In this manual, these assigned I/O registers are expressed as XW(n), XW(n+1), ... XW(n+7).

The following figure shows an example of I/O allocation window of the T-PDS programming software. In this case, the AD268 is mounted in the slot 0 of base unit BU218.





In the above example, the AD268 is allocated on the unit-0, slot-0. And 8 I/O registers, XW000 to XW007 are assigned to the AD268.

5.2 A/D conversion data

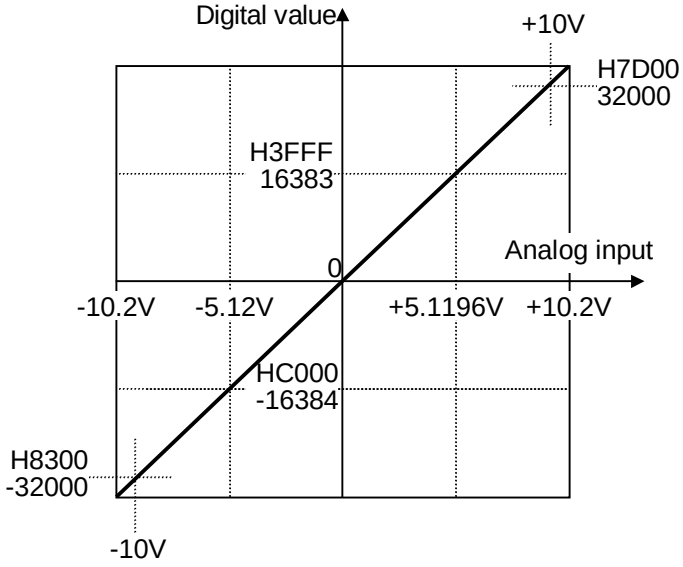
The analog signals received by the AD268 are converted into the digital data in this module. These converted digital data are read by T2 CPU in the batch I/O processing and stored in the assigned input registers as follows.

XW(n) ..... A/D conversion data for channel 1
XW(n+1) .... A/D conversion data for channel 2
XW(n+2) .... A/D conversion data for channel 3
XW(n+3) .... A/D conversion data for channel 4
XW(n+4) .... A/D conversion data for channel 5
XW(n+5) .... A/D conversion data for channel 6
XW(n+6) .... A/D conversion data for channel 7
XW(n+7) .... A/D conversion data for channel 8

The conversion data stored in the XW register is dependent on the input type as follows.

±10V range:

	Input voltage	A/D conversion data		Resolution
		Hexadecimal	Integer	
Upper limit	+10.2 V	H7F80	32640	0.3125 mV / bit
	:	:	:	
Full scale (positive)	+10 V	H7D00	32000	
	:	:	:	
	+0.3125 mV	H0001	1	
0	0 V	H0000	0	
	-0.3125 mV	HFFFF	-1	
	:	:	:	
Full scale (negative)	-10 V	H8300	-32000	
	:	:	:	
Lower limit	-10.2 V	H8080	-32640	

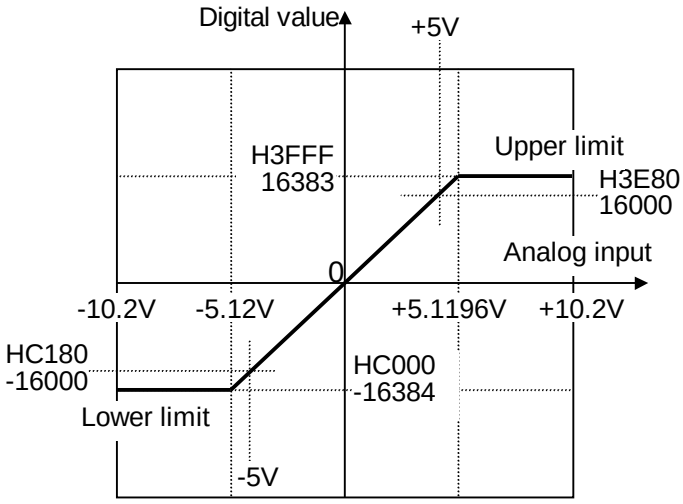


$D = 3200 \times A$

D: Digital data
A: Analog signal (V)

±5V range:

	Input voltage	A/D conversion data		Resolution
		Hexadecimal	Integer	
Upper limit	+5.1196 V	H3FFF	16383	0.3125 mV / bit
	:	:	:	
Full scale (positive)	+5 V	H3E80	16000	
	:	:	:	
	+0.3125 mV	H0001	1	
0	0 V	H0000	0	
	-0.3125 mV	HFFFF	-1	
	:	:	:	
Full scale (negative)	-5 V	HC180	-16000	
	:	:	:	
Lower limit	-5.12 V	HC000	-16384	

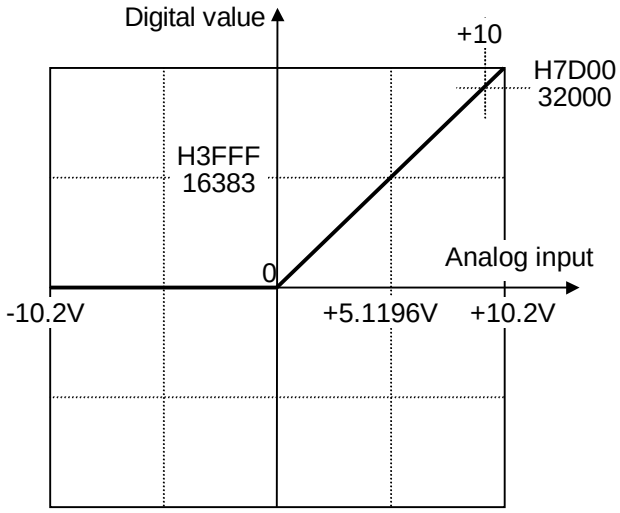


$D = 3200 \times A$

D: Digital data
A: Analog signal (V)

0 to 10V range:

	Input voltage	A/D conversion data		Resolution
		Hexadecimal	Integer	
Upper limit	+10.2 V	H7F80	32640	0.3125 mV / bit
	:	:	:	
Full scale (positive)	+10 V	H7D00	32000	
	:	:	:	
	+0.3125 mV	H0001	1	
0	0 V	H0000	0	

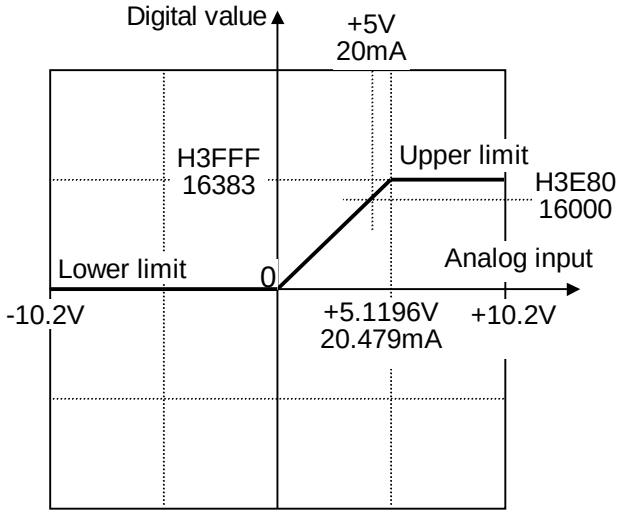


$D = 3200 \times A$

D: Digital data
A: Analog signal (V)

0 to 5V / 0 to 20mA range:

	Input voltage/current		A/D conversion data		Resolution
	0 to 5 V	0 to 20 mA	Hexadecimal	Integer	
Upper limit	+5.1196 V	+20.479 mA	H3FFF	16383	0.3125 mV / bit 1.25 μA / bit
	:	:	:	:	
Full scale (positive)	+5 V	+20 mA	H3E80	16000	
	:	:	:	:	
	+0.3125 mV	+0.00125 mA	H0001	1	
0	0 V	0 mA	H0000	0	



0 to 5V range:

$D = 3200 \times A$

D: Digital data
A: Analog signal (V)

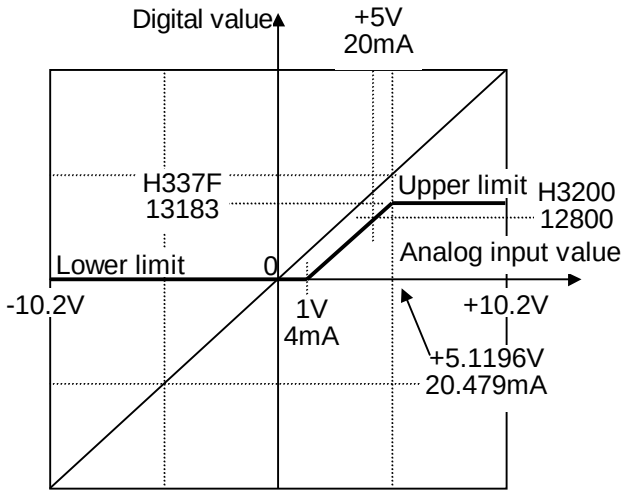
0 to 20mA range:

$D = 800 \times A$

D: Digital data
A: Analog signal (mA)

1 to 5V / 4 to 20mA range:

	Input voltage/current		A/D conversion data		Resolution
	1 to 5 V	4 to 20 mA	Hexadecimal	Integer	
Upper limit	+5.1196 V	+20.479 mA	H337F	13183	0.3125 mV / bit 1.25 μA / bit
	:	:	:	:	
Full scale (positive)	+5 V	+20 mA	H3200	12800	
	:	:	:	:	
	+1.0003125 V	+4.00125 mA	H0001	1	
Lower limit	1 V	4 mA	H0000	0	



1 to 5V range:

$D = 3200 \times A - 3200$

D: Digital data
A: Analog signal (V)

4 to 20mA range:

$D = 800 \times A - 3200$

D: Digital data
A: Analog signal (mA)

5.3 Programming

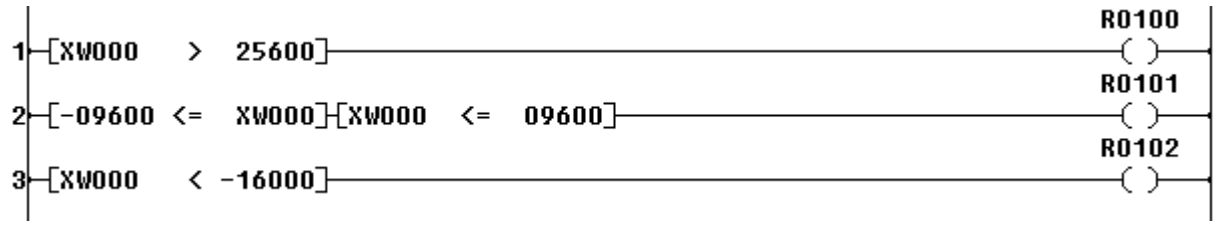
To read the A/D conversion data, there is no need to use special instruction. The A/D conversion data are automatically stored in the assigned input registers (XW registers).

For example, when the AD268 is allocated to XW000 to XW007, the A/D conversion data of each channel is stored as follows.

XW000 : Channel 1 A/D conversion data
XW001 : Channel 2 A/D conversion data
XW002 : Channel 3 A/D conversion data
XW003 : Channel 4 A/D conversion data
XW004 : Channel 5 A/D conversion data
XW005 : Channel 6 A/D conversion data
XW006 : Channel 7 A/D conversion data
XW007 : Channel 8 A/D conversion data

Therefore, in the user program, you can use these XW registers directly for the analog data processing.

The program shown below is an example of simple comparison with the channel 1 analog data. (±10V setting)



Line 1: When XW000 is greater than 25600 (channel 1 analog input is more than 8V), R0100 is set to ON.

Line 2: When XW000 is in the range of -9600 to 9600 (channel 1 analog input is in the range of -3V to 3V), R0101 is set to ON.

Line 3: When XW000 is less than -16000 (channel 1 analog input is less than -5V), R0102 is set to ON.

6. Parameters

The AD268 has the memory that stores the control parameters, input type designation, module status information, etc. This memory is called the buffer memory. To access (read/write) this memory from the T2 program, READ and WRITE instructions are used.

6.1 Memory map

The contents of the AD268's buffer memory are as follows.

Address	Contents (F … 0)
H8000	Gain calibration value for channel 1
H8001	Gain calibration value for channel 2
H8002	Gain calibration value for channel 3
H8003	Gain calibration value for channel 4
H8004	Gain calibration value for channel 5
H8005	Gain calibration value for channel 6
H8006	Gain calibration value for channel 7
H8007	Gain calibration value for channel 8
H8008	Offset calibration value for channel 1
H8009	Offset calibration value for channel 2
H800A	Offset calibration value for channel 3
H800B	Offset calibration value for channel 4
H800C	Offset calibration value for channel 5
H800D	Offset calibration value for channel 6
H800E	Offset calibration value for channel 7
H800F	Offset calibration value for channel 8
H8010	Averaging times for channel 1
H8011	Averaging times for channel 2
H8012	Averaging times for channel 3
H8013	Averaging times for channel 4
H8014	Averaging times for channel 5
H8015	Averaging times for channel 6
H8016	Averaging times for channel 7
H8017	Averaging times for channel 8
H8018	Input type setting for channel 1
H8019	Input type setting for channel 2
H801A	Input type setting for channel 3
H801B	Input type setting for channel 4
H801C	Input type setting for channel 5
H801D	Input type setting for channel 6
H801E	Input type setting for channel 7
H801F	Input type setting for channel 8
H8020	Command register
H8021	Response register
H8022 : H8027	No use

Use WRITE instruction to write data into these addresses.

Use READ instruction to read data from this address.

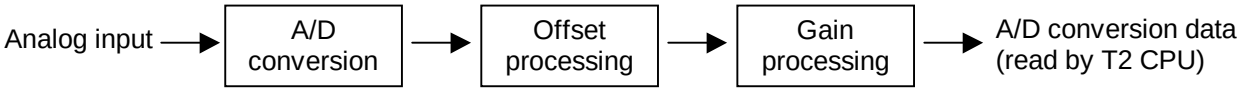
Address	Contents (F … 0)
H8028	Analog input actual value for channel 1
H8029	Analog input actual value for channel 2
H802A	Analog input actual value for channel 3
H802B	Analog input actual value for channel 4
H802C	Analog input actual value for channel 5
H802D	Analog input actual value for channel 6
H802E	Analog input actual value for channel 7
H802F	Analog input actual value for channel 8
H8030	Module status for channel 1
H8031	Module status for channel 2
H8032	Module status for channel 3
H8033	Module status for channel 4
H8034	Module status for channel 5
H8035	Module status for channel 6
H8036	Module status for channel 7
H8037	Module status for channel 8

Use READ instruction to read data from these addresses.

Gain calibration value & Offset calibration value:
(Gain: H8000 to H8007, Offset: H8008 to H800F)

At the factory shipment, the AD268 is calibrated for each input range. Therefore, there is no need for user to calibrate normally.
However, depending on the usage condition, field adjustments are required. For this purpose, the AD268 has the gain and offset calibration function.

In the AD268, the A/D conversion data is calculated as follows.



When the gain calibration value is G and the offset calibration value is O, the conversion calculation is performed in the AD268 as follows.

$X_2 = (X_1 + O) \times G / FS$

X_1: Initial A/D conversion value
X_2: Gain/offset processed value
O: Offset calibration value (buffer memory address H8008 to H800F)
G: Gain calibration value (buffer memory address H8000 to H8007)
FS: Full scale value
- 32000 for ±10V and 0 to 10V ranges
- 16000 for ±5V, 0 to 5V and 0 to 20mA ranges
- 12800 for 1 to 5V and 4 to 20mA ranges

The data setting range of the gain and offset calibration value are as follows.

Input type	Gain calibration value	
±10V 0 to 10V	Upper limit	32000
	Default value	32000
	Lower limit	10000
±5V 0 to 5V 0 to 20mA	Upper limit	16000
	Default value	16000
	Lower limit	5000
1 to 5V 4 to 20mA	Upper limit	12800
	Default value	12800
	Lower limit	4000

Input type	Offset calibration value	
All types	Upper limit	3200
	Default value	0
	Lower limit	-3200

Averaging times:
(H8010 to H8017)

This parameter is for the averaging processing for the analog input data. The moving average is calculated by the given averaging times parameter.
For example, if the averaging times parameter is 10, the average value of latest 10 times conversion is output as the A/D conversion data.
This function is effective to reduce the fluctuation caused by noise.

The available setting range is as follows.

Input type	Averaging times	
All types	Upper limit	127
	Default value	1
	Lower limit	1

Input type setting:
(H8018 to H801F)

This parameter is used to select the input type. This parameter also has a function to skip the A/D conversion for unused channels. By using the channel skip function, the conversion cycle time can be reduced.

The available setting range is as follows.

Input type		Setting value
0 to 5V	0 to 20mA	0
0 to 10V	-	1
1 to 5V	4 to 20mA	2
±5V	-	4
±10V	-	5
Channel skip		128

The default setting value (factory setting) is 5 (±10V).

Command register:
(H8020)

This register is used to issue the following commands to the AD268. To issue the command, write the command value by using WRITE instruction.

Value	Command	Description
0	-	Write 0 after the command processing is completed.
1	Parameter set	When this command is issued, the parameters written into the buffer memory are saved in the AD268 's EEPROM, and the parameters become effective.
2	Reset command	Used to reset the AD268 when some error has occurred. However if the error is caused by hardware or external condition, the reset command may not be effective.

The command register and the response register are used for hand-shaking. Refer to section 6.2 for the parameter setting procedure.

Response register:
(H8021)

This register shows the AD268's response for the command issued. Check the status of this register using READ instruction.

Value	Response	Description
0	-	The requested command is not yet completed.
1	Acknowledge	When the issued command is completed, the response register comes 1.

The command register and the response register are used for hand-shaking. Refer to section 6.2 for the parameter setting procedure.

Analog input actual value:
(H8028 to H802F)

These data show the original A/D conversion data before processing the gain and offset calibration.

Module status:
(H8030 to H8037)

These data show the AD268's operation status.

Bit position →	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
			0								0	0	0			

Bit	Name	Description
0 to 2	Input type	Shows the input type. 000 (0) = 0 to 5V/0 to 20mA 001 (1) = 0 to 10V 010 (2) = 1 to 5V/4 to 20mA 100 (4) = ±5V 101 (5) = ±10V
3 to 5	-	Reserved
6	Channel skip	1 when the channel skip is designated.
7	Input type setting error	1 when the input type designation is invalid.
8	Wire break	1 when wire breakage is detected. (Effective only for 4 to 20mA input)
9	Input limit	1 when the A/D conversion data is limited because of the range over.
A	MPU error	1 when the AD268's processor is not normal.
B	ROM status	1 when the AD268's EEPROM is not normal.
C	DP-RAM status	1 when the AD268's DP-RAM (buffer memory) is not normal.
D	-	Reserved
E	External 24V error	1 when the external 24Vdc is not normal.
F	Initializing	1 during the AD268 is in initialization process.

6.2 Parameter setting procedure

When you change the AD268 parameters, such as input type settings, gain/offset calibrations and averaging times, use the following procedure.

Step (1)

Write the value "0" into the command register of the AD268 buffer memory (address H8020) by WRITE instruction.

H8020	Command register	← Write 0

Step (2)

Write the parameter data into the buffer memory (addresses H8000 to H801F) by WRITE instruction. Be sure to write all the 32 words in batch.

H8000	Gain for channel 1	← Write the parameter data (32 words)
H8001	Gain for channel 2	
:	:	
H801F	Input type for channel 8	

Step (3)

Write the value "1" into the command register (address H8020) by WRITE instruction.

H8020	Command register	← Write 1

Step (4)

Wait until the data of the response register (address H8021) comes "1". Check the data by READ instruction.

H8021	Response register	Check if it comes 1

Step (5)

Write the value "0" into the command register (address H8020) by WRITE instruction.

H8020	Command register	← Write 0

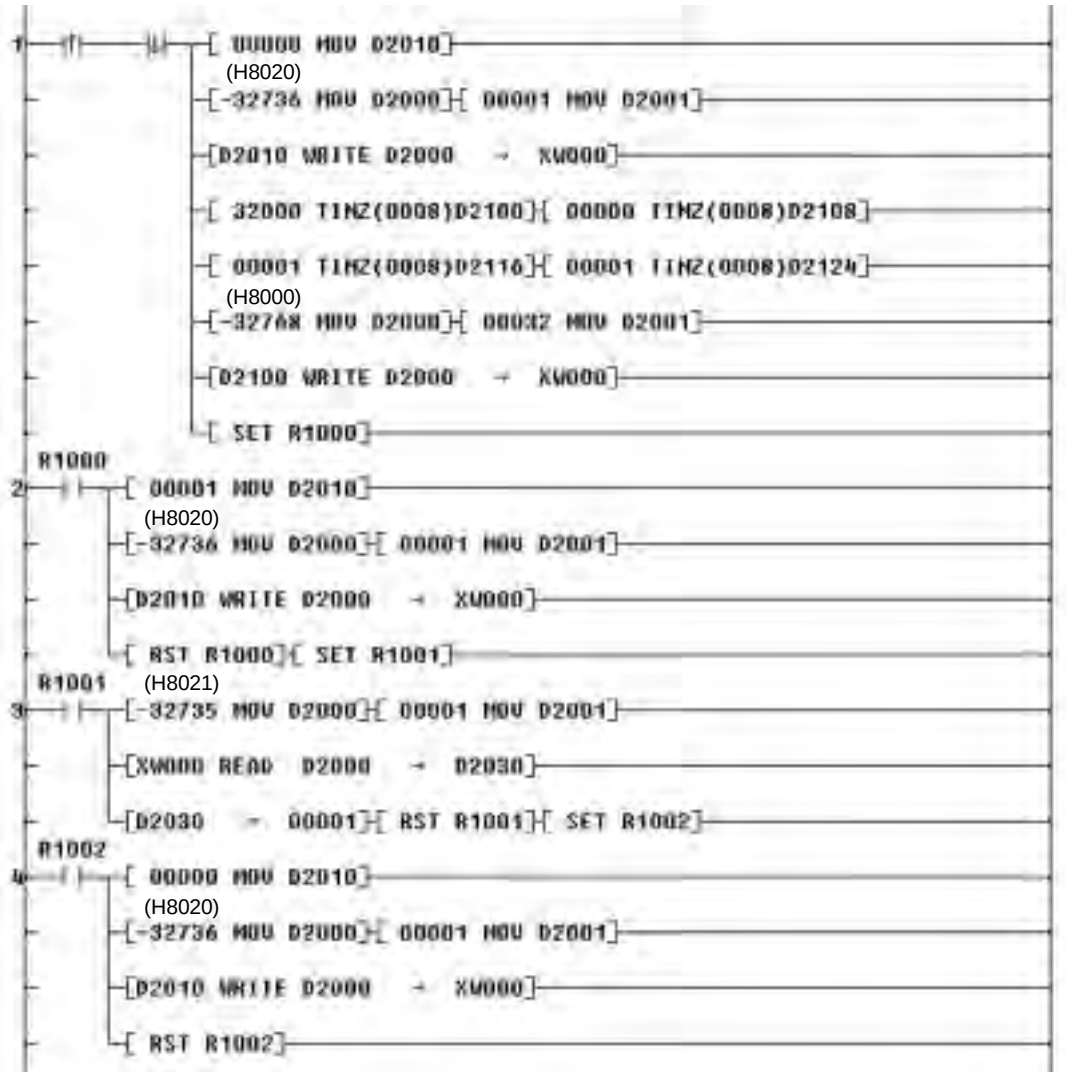
When the above steps are finished and the module status (addresses H8030 to H8037) shows no error, the parameter setting procedure is completed. The parameters are effective and they have been saved in the AD268's EEPROM.

6.3 Sample program for setting the parameters

A sample program to set the parameters is shown below.
This is an example to set the input type as 0 to 10V range (type = 1) for each channel.
In this sample program, it is assumed that he AD268 is allocated to XW000 to XW007.

For details of READ and WRITE instructions, refer to the T-series Instruction Set manual.

(Main program)



In this sample program, the rung 1 is activated at the beginning of RUN mode (at the second scan) automatically. The input type is set to 0 to 10V for all 8 channels.
When the parameter setting process is completed, the flags R1000 to R1002 are returned to OFF.

For reading the parameters from the AD268, there is no special procedure. Simply read the data from the AD268's buffer memory by using READ instruction.

7. Troubleshooting

7.1 RAS information

The RUN LED is provided on the front of the AD268. When the AD268 is operating normally, this LED is lit.
Also the module status information is provided in the AD268's buffer memory (addresses H8030 to H8037). This information is useful for troubleshooting.

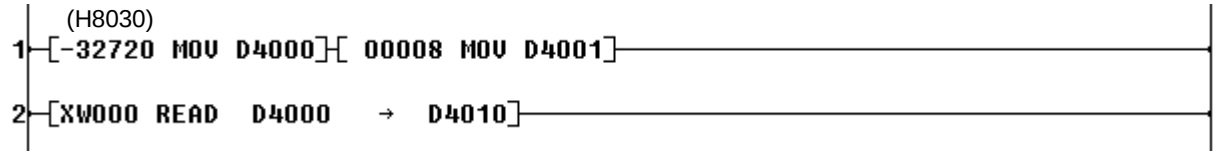
Module status:
(H8030 to H8037)

These data show the AD268's operation status.

Bit position →	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
			0								0	0	0			

Bit	Name	Description
0 to 2	Input type	Shows the input type. 000 (0) = 0 to 5V/0 to 20mA 001 (1) = 0 to 10V 010 (2) = 1 to 5V/4 to 20mA 100 (4) = ±5V 101 (5) = ±10V
3 to 5	-	Reserved
6	Channel skip	1 when the channel skip is designated.
7	Input type setting error	1 when the input type designation is invalid.
8	Wire break	1 when wire breakage is detected. (Effective only for 4 to 20mA input)
9	Input limit	1 when the A/D conversion data is limited because of the range over.
A	MPU error	1 when the AD268's processor is not normal.
B	ROM status	1 when the AD268's EEPROM is not normal.
C	DP-RAM status	1 when the AD268's DP-RAM (buffer memory) is not normal.
D	-	Reserved
E	External 24V error	1 when the external 24Vdc is not normal.
F	Initializing	1 during the AD268 is in initialization process.

A sample program to read the module status information is shown below.



By the above sample program, the module status information for each channel is read from the AD268, and stored in D4010 to D4017.
(In this sample program, it is assumed that the AD268 is allocated to XW000 to XW007)

7.2 Troubleshooting

The table below shows the trouble and its remedy.

Trouble	Module status info	LED	Module operation	Cause	Remedy
Input type setting error	Bit 7 is ON	ON (if the error occurs in all channels, it is OFF)	The error channel stops the conversion. The A/D conversion data is 0.	Invalid input type parameter was set.	Set the correct input type parameter.
Analog signal wire breakage (4-20mA only)	Bit 8 is ON	ON	The A/D conversion data of the channel is 0.	In the 4-20mA input, less than 4mA signal is input.	Check the analog signal wire.
Analog signal limit over	Bit 9 is ON	ON	The A/D conversion data of the channel is limited by the limit value.	Analog input signal is out of the range.	Check the signal source (sensor).
MPU error	Bit A is ON	OFF	The A/D conversion is stopped.	Internal processor operation is not normal.	Execute reset command, or cycle power off and on.
ROM error	Bit B is ON	OFF	The A/D conversion is stopped.	EEPROM data error is detected.	Cycle power off and on.
DP-RAM error	Bit C is ON	OFF	The A/D conversion is stopped.	Buffer memory access error is occurred.	Cycle power off and on.
External 24V error	Bit E is ON	OFF	The A/D conversion is stopped.	Internal ±15V voltage is not normal.	Check the external 24Vdc power supply.

Part 2

4 Channel Analog Output Module DA264

1. Introduction

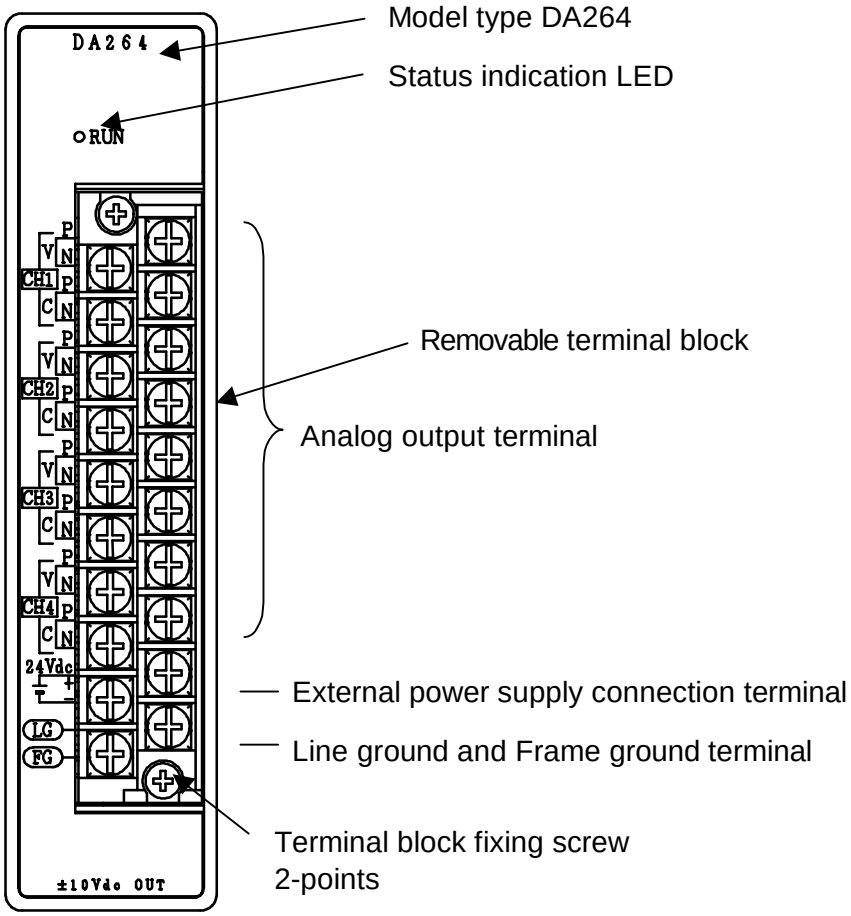
The DA264 is a 4 channel analog output module for the T2 series programmable controllers. The DA264 converts digital values given by the T2 program into the analog signals (voltage or current).

1.1 DA264 Functions

The DA264 has the following functions.

1) 4 channels output per module
2) Selectable output type
   - ±5V
   - ±10V
   - 0 to 5V
   - 0 to 10V
   - 1 to 5V
   - 0 to 20mA
   - 4 to 20mA
3) 16-bit high-resolution D/A conversion
4) High-speed (1ms/channel) conversion cycle
5) Offset calibration function
6) Output hold function

1.2 External features



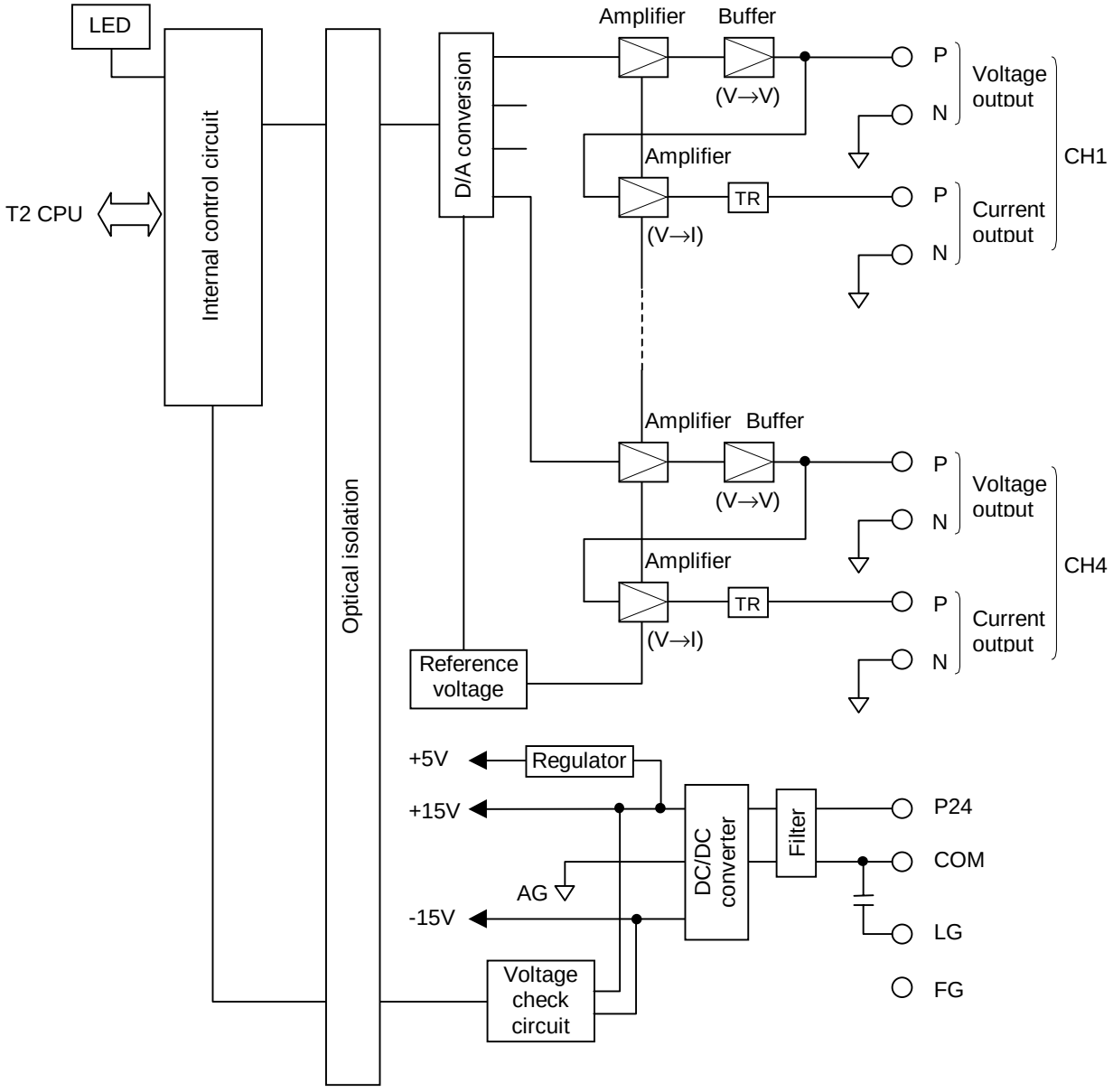
2. Specifications

This section describes the DA264 specifications.
The general specification for the DA264 conforms to the specification for the T2 PLC.

2.1 Specifications

Item		DA264	
Output type		Voltage output	Current output
Output range	Bipolar	-5 to 5V	
		-10 to 10V	
	Unipolar	0 to 5V	0 to 20mA
		0 to 10V	
		1 to 5V	4 to 20mA
Load impedance		1kΩ or more	600Ω or less
Number of output channels		4 channels	
I/O allocation type		Y 4W (4 output registers YW are assigned)	
Resolution		16-bit	
Overall accuracy		±0.2% FS (at 25°C) ±0.5% FS (0 to 55°C) (FS: ±10V)	
Temperature drift		±100ppm/°C or less	
Conversion cycle		Approx. 1ms/channel (Approx. 4ms/4 channels)	
Insulation resistance		10MΩ or more	
Withstand voltage		1500Vac - 1 minute (between logic and analog circuits) 500Vac - 1 minute (between analog circuit and external 24V) 1500Vac - 1 minute (between analog circuit and FG/LG)	
Status indication		1 green LED (On when normal)	
Special function		Offset calibration function Output hold function External 24Vdc power voltage drop detection	
External power supply		24Vdc ±10% - 240mA	
Internal 5Vdc current consumption		230mA or less	
External connection		20-pin removable terminal block	
Weight		Approx. 300g	

2.2 Internal block diagram



The DA264 performs the following operations.
The digital data for D/A conversion generated by the T2 program are written into the DA264. The written digital data are transferred to the D/A converter through optical isolator. Then the D/A converter converts the digital values to the analog signals.
The generated analog signals are output to each channel (CH1 to CH4) via amplifier. Each channel has both the voltage output and the current output. However either voltage or current output can be used.

3. Output Type Setting

The DA264 supports multiple output ranges, ±5V, ±10V, 0 to 5V, 0 to 10V, 1 to 5V, 0 to 20mA, or 4 to 20mA. The output range is selected by writing the parameter into the DA264 by the T2 program. The voltage or current output is selected by the DA264's output terminals.

The general flow for setting the output type is as follows.

(1) Mount the DA264 onto the T2 rack.
(2) Turn on power to the T2 system.
(3) Execute I/O allocation.
(4) Program the "output type setting program". (see below)
(5) Turn the T2 to RUN mode.

3.1 Parameter setting by software

The output range of the DA264 is specified by writing the following parameter data into the DA264's buffer memory. To write the parameter into the buffer memory, T2 user program (WRITE instruction) is used.
These parameter data are not maintained in the DA264. Therefore, program the output type setting routine and execute it at each time of the beginning of the operation.

Output type parameter data:

Parameter data	Output type	
	Voltage output	Current output
0	0 to 5V	0 to 20mA
1	0 to 10V	
2	1 to 5V	4 to 20mA
4	±5V	
5	±10V	

DA264 buffer memory address:

H8004	Output type for channel 1
H8005	Output type for channel 2
H8006	Output type for channel 3
H8007	Output type for channel 4

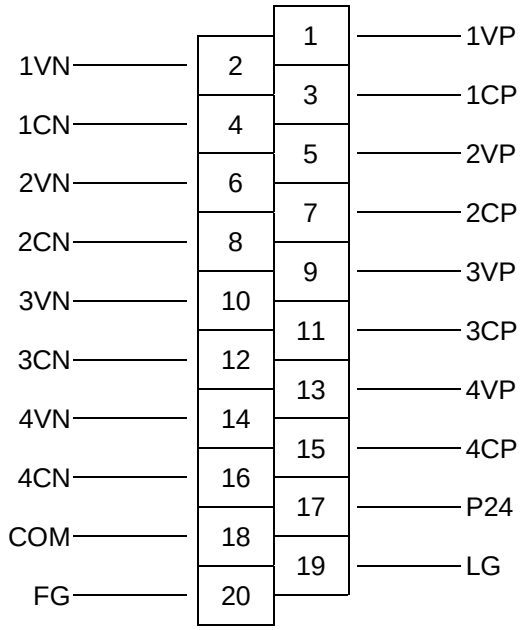
The factory setting is 0 to 5V / 0 to 20mA range.

Refer to section 6 for the sample program to set the output type.

4. Wiring

4.1 Terminal arrangement

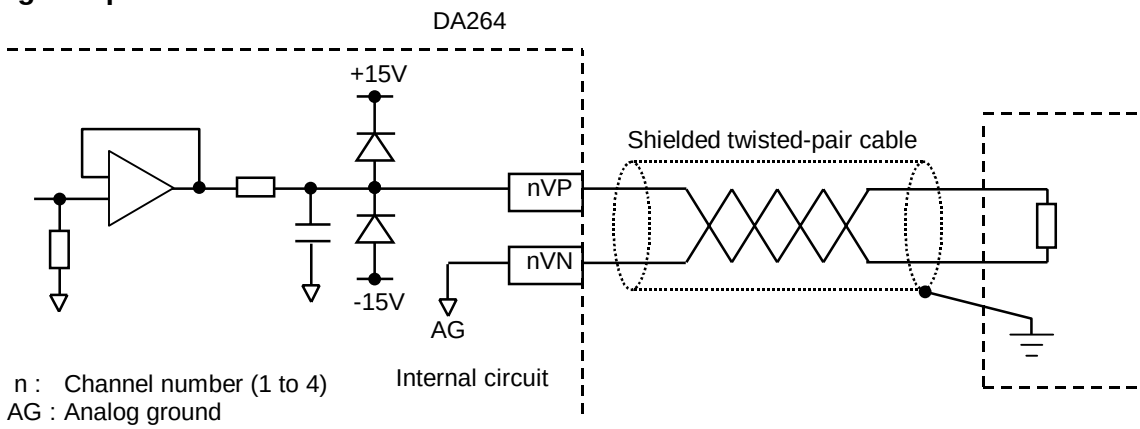
DA264 terminal block



Terminal No.	Signal name	Function
1	1VP	Channel 1 Voltage output
2	1VN	
3	1CP	Channel 1 Current output
4	1CN	
5	2VP	Channel 2 Voltage output
6	2VN	
7	2CP	Channel 2 Current output
8	2CN	
9	3VP	Channel 3 Voltage output
10	3VN	
11	3CP	Channel 3 Current output
12	3CN	
13	4VP	Channel 4 Voltage output
14	4VN	
15	4CP	Channel 4 Current output
16	4CN	
17	P24	External 24Vdc power (+)
18	COM	External 24Vdc power (-)
19	LG	Line filter ground
20	FG	Frame ground

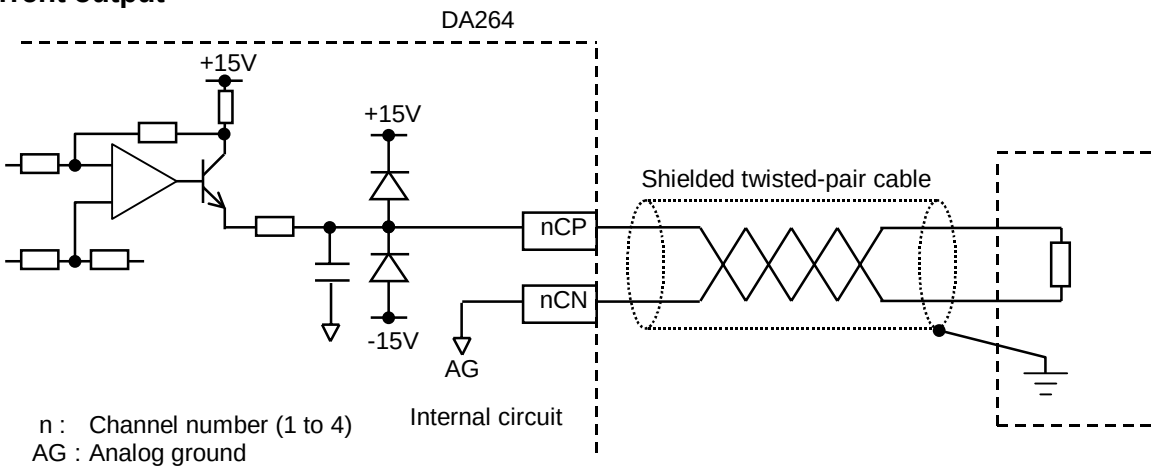
4.2 Signal wiring

Voltage output



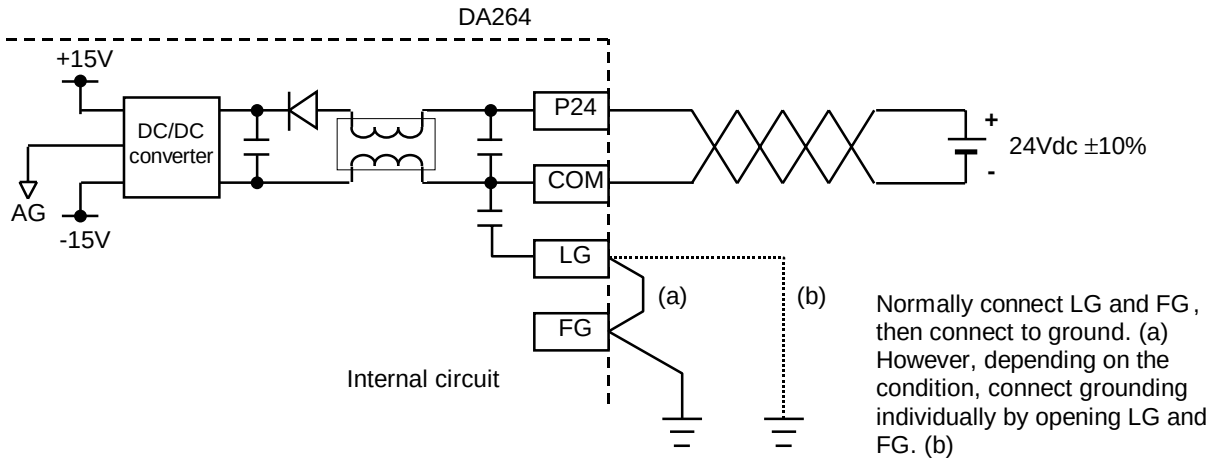
n : Channel number (1 to 4)
AG : Analog ground

Current output



n : Channel number (1 to 4)
AG : Analog ground

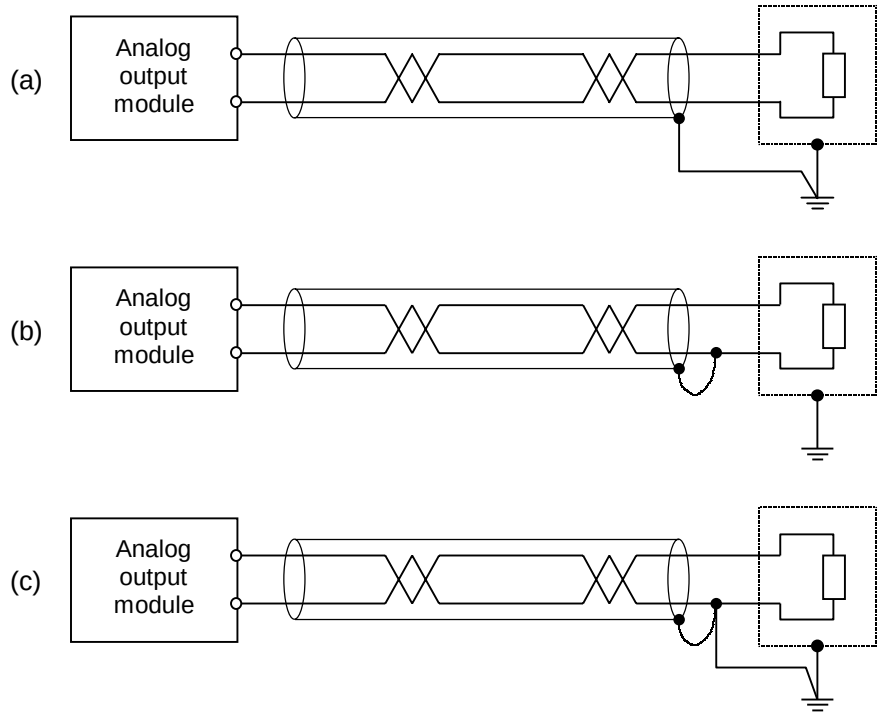
External 24Vdc power supply



Normally connect LG and FG, then connect to ground. (a) However, depending on the condition, connect grounding individually by opening LG and FG. (b)

4.3 Wiring precautions

(1) Use shielded twisted-pair cables for analog output signal lines and wire them in shortest distance. Connect the cable shield to ground in shortest distance for EMC conformity. Normally the grounding method (a) is recommended. However, depending on the condition, method (b) or (c) may be useful for stable operation.



(2) Separate the analog signal cable from other cables to prevent noise interference. (200mm or more)

(3) This module requires 24Vdc power. Apply the 24Vdc power before (or at the same time) applying T2's main power. Otherwise, this module detects the external 24Vdc error.

(4) If the external 24Vdc power for this module is not stable, the converted data will not be stable. In this case, use a dedicated 24Vdc power supply for this module.

(5) When the external 24Vdc power is applied, about 0.7V voltage will output for few ms (milliseconds). Therefore the power-up sequence should be as follows.

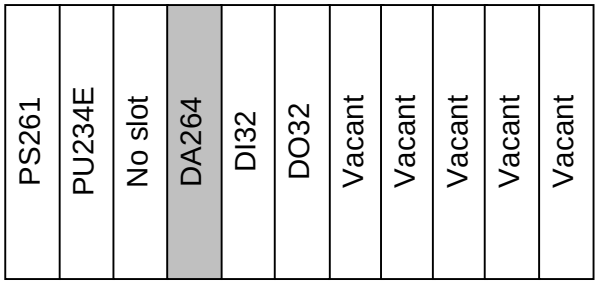
External 24Vdc $\rightarrow$ T2 main power $\rightarrow$ Power for output load

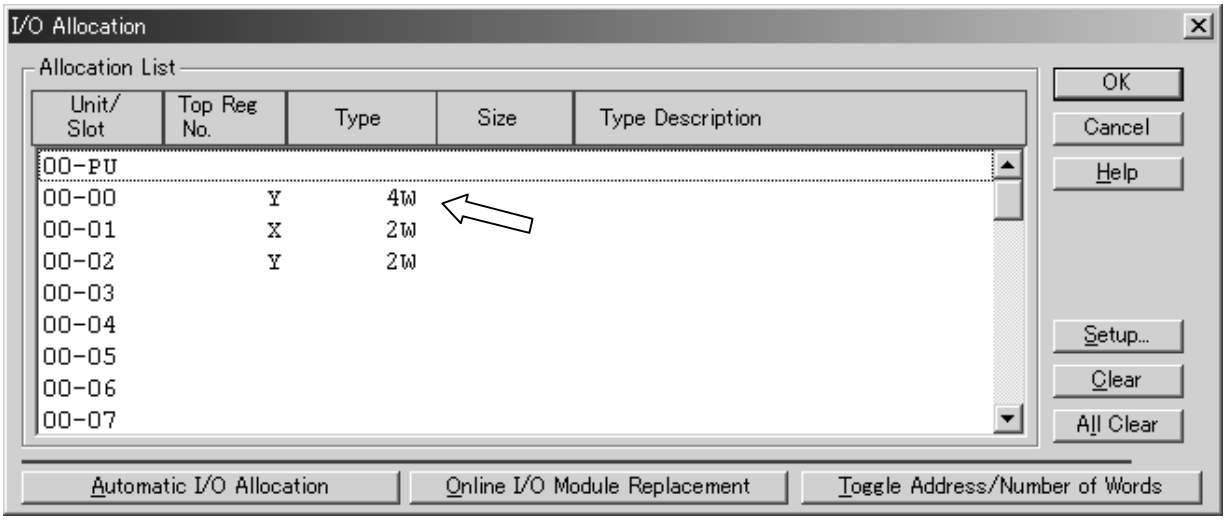
5. I/O Allocation and Programming

5.1 Allocation to the T2 registers

The I/O type of the DA264 is "Y 4W".
When the automatic I/O allocation operation is performed with a DA264 mounted on the rack, the DA264 is allocated as "Y 4W".
The DA264 occupies the 4 consecutive output (YW) registers of the T2.
In this manual, these assigned I/O registers are expressed as YW(n), YW(n+1), YW(n+2) and YW(n+3).

The following figure shows an example of I/O allocation window of the T-PDS programming software. In this case, the DA264 is mounted in the slot 0 of base unit BU218.





In the above example, the DA264 is allocated on the unit-0, slot-0. And 4 I/O registers, YW000 to YW003 are assigned to the DA264.

5.2 D/A conversion data

To output the desired analog signals from the DA264, simply write the appropriate data into the assigned I/O registers YW(n) to YW(n+3) for the DA264.

The data of YW(n) to YW(n+3) are transferred to the DA264 at the T2's batch I/O processing. Then in the DA264, these D/A conversion data are converted into the analog signals and output from the DA264.

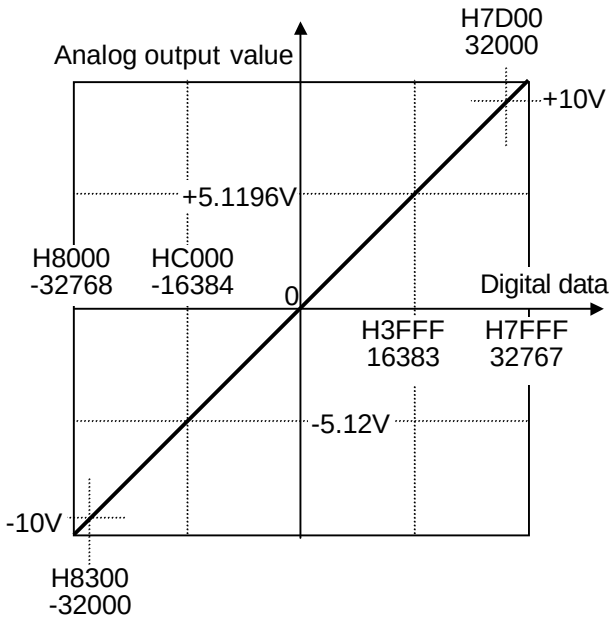
The I/O register assignment is as follows.

YW(n) ..... D/A conversion data for channel 1
YW(n+1) .... D/A conversion data for channel 2
YW(n+2) .... D/A conversion data for channel 3
YW(n+3) .... D/A conversion data for channel 4

The conversion data to be written into the YW register is dependent on the output type as follows.

±10V range:

	D/A conversion data		Output voltage	Resolution
	Hexadecimal	Integer		
Upper limit	H7F80	32640	+10.2V	0.3125 mV / bit
	:	:	:	
Full scale (positive)	H7D00	32000	+10V	
	:	:	:	
	H0001	1	+0.3125 mV	
0	H0000	0	0V	
	HFFFF	-1	-0.3125 mV	
	:	:	:	
Full scale (negative)	H8300	-32000	-10V	
	:	:	:	
Lower limit	H8080	-32640	-10.2V	

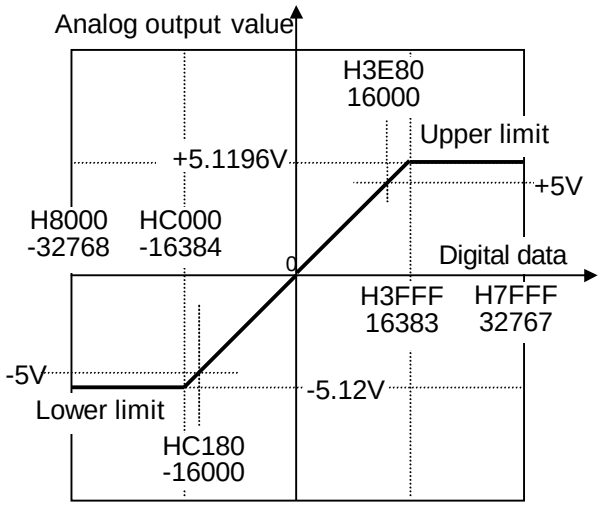


$A = 0.3125 \times D$

D: Digital data
A: Analog signal (mV)

±5V range:

	D/A conversion data		Output voltage	Resolution
	Hexadecimal	Integer		
Upper limit	H3FFF	16383	+5.1196 V	0.3125 mV / bit
	:	:	:	
Full scale (positive)	H3E80	16000	+5 V	
	:	:	:	
	H0001	1	+0.3125 mV	
0	H0000	0	0 V	
	HFFFF	-1	-0.3125 mV	
	:	:	:	
Full scale (negative)	HC180	-16000	-5 V	
	:	:	:	
Lower limit	HC000	-16384	-5.12 V	

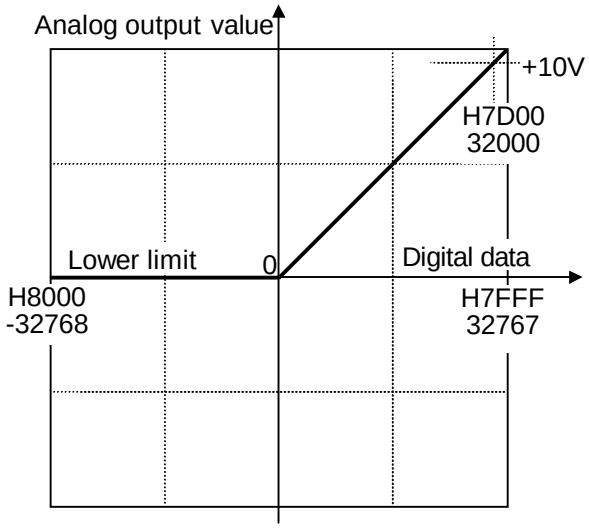


$A = 0.3125 \times D$

D: Digital data
A: Analog signal (mV)

0 to 10V range:

	D/A conversion data		Output voltage	Resolution
	Hexadecimal	Integer		
Upper limit	H7F80	32640	+10.2 V	0.3125 mV / bit
	:	:	:	
Full scale (positive)	H7D00	32000	+10 V	
	:	:	:	
	H0001	1	+0.3125 mV	
0	H0000	0	0 V	

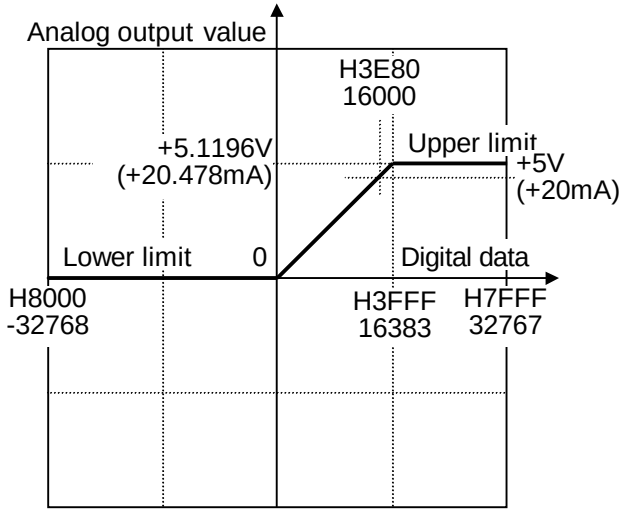


$A = 0.3125 \times D$

D: Digital data
A: Analog signal (mV)

0 to 5V / 0 to 20mA range:

	D/A conversion data		Output voltage/current		Resolution
	Hexadecimal	Integer	0 to 5 V	0 to 20 mA	
Upper limit	H3FFF	16383	+5.1196 V	+20.479 mA	0.3125 mV / bit 1.25 μA / bit
	:	:	:	:	
Full scale (positive)	H3E80	16000	+5 V	+20 mA	
	:	:	:	:	
	H0001	1	+0.3125 mV	+0.00125 mA	
0	H0000	0	0 V	0 mA	



0 to 5V range:

$A = 0.3125 \times D$

D: Digital data
A: Analog signal (mV)

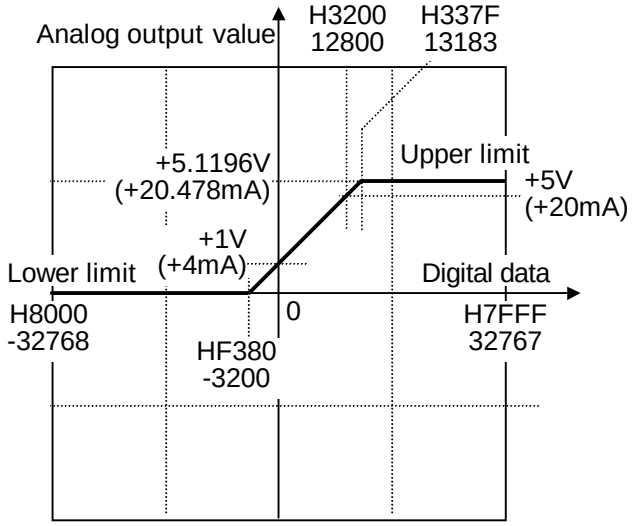
0 to 20mA range:

$A = 1.25 \times D$

D: Digital data
A: Analog signal (μA)

1 to 5V / 4 to 20mA range:

	D/A conversion data		Output voltage/current		Resolution
	Hexadecimal	Integer	1 to 5 V	4 to 20 mA	
Upper limit	H337F	13183	+5.1196 V	+20.479 mA	0.3125 mV / bit 1.25 μA / bit
	:	:	:	:	
Full scale (positive)	H3200	12800	+5 V	+20 mA	
	:	:	:	:	
	H0001	1	+1.0003125 V	+4.00125 mA	
0	H0000	0	1 V	4 mA	
	:	:	:	:	
Lower limit	HF380	-3200	0 V	0 mA	



1 to 5V range:

$A = 0.3125 \times D + 1000$

D: Digital data
A: Analog signal (mV)

4 to 20mA range:

$A = 1.25 \times D + 4000$

D: Digital data
A: Analog signal (μA)

5.3 Programming

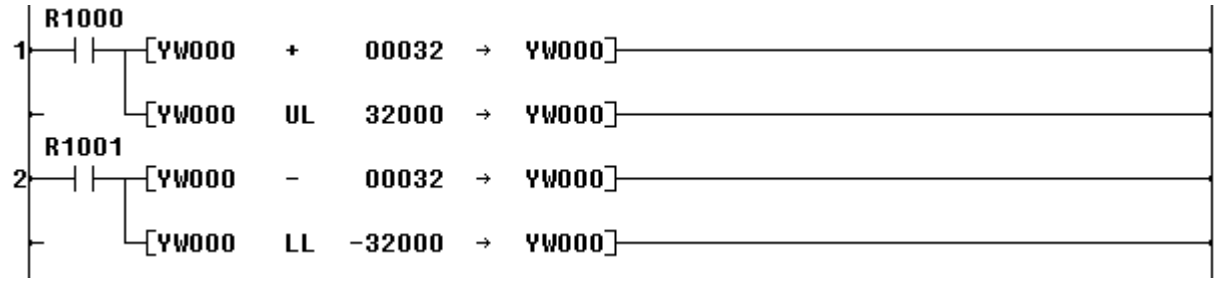
To output the desired analog signal from the DA264, there is no need to use any special instruction. When the D/A conversion data is written in the assigned output register (YW register), it is transferred to the DA264 and converted to the corresponding analog signal.

For example, when the DA264 is allocated to YW000 to YW003, the D/A conversion data of each channel is assigned as follows.

YW000 : Channel 1 D/A conversion data
YW001 : Channel 2 D/A conversion data
YW002 : Channel 3 D/A conversion data
YW003 : Channel 4 D/A conversion data

Therefore, in the user program, you can use any instructions to write data in these YW registers for the analog data processing.

The program shown below is an example of simple increasing/decreasing of the channel 1 analog data. (±10V setting)



Rung 1: During R1000 is ON, YW000 data is increased by 32 (channel 1 analog output is increased by 0.01V) every scan. It is upper-limited by 32000 (10V).

Rung 2: During R1001 is ON, YW000 data is decreased by 32 (channel 1 analog output is decreased by 0.01V) every scan. It is lower-limited by -32000 (-10V).

6. Parameters

The DA264 has the memory that stores the control parameters, output type designation, module status information, etc. This memory is called the buffer memory. To access (read/write) this memory from the T2 program, READ and WRITE instructions are used.

These parameter data are not maintained in the DA264. Therefore, you should write the necessary parameter data at each time of the beginning of the operation.

6.1 Memory map

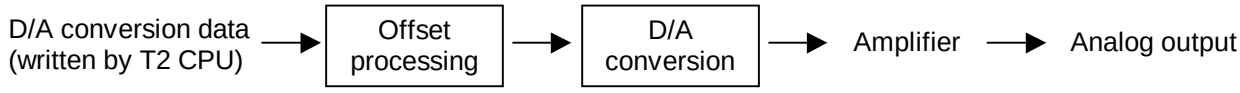
The contents of the DA264's buffer memory are as follows.

Address	Contents (F … 0)	
H8000	Offset calibration value for channel 1	Use WRITE instruction to write data into these addresses.
H8001	Offset calibration value for channel 2	
H8002	Offset calibration value for channel 3	
H8003	Offset calibration value for channel 4	
H8004	Output type setting for channel 1	
H8005	Output type setting for channel 2	
H8006	Output type setting for channel 3	
H8007	Output type setting for channel 4	
H8008	Analog output read-back value for channel 1	Use READ instruction to read data from these addresses.
H8009	Analog output read-back value for channel 2	
H800A	Analog output read-back value for channel 3	
H800B	Analog output read-back value for channel 4	
H800C	Module status for channel 1	
H800D	Module status for channel 2	
H800E	Module status for channel 3	
H800F	Module status for channel 4	

Offset calibration value:
(H8000 to H8003)

At the factory shipment, the DA264 is calibrated for each output range. Therefore, there is no need for user to calibrate normally.
However, depending on the usage condition, field adjustments are required. For this purpose, the DA264 has the offset calibration function.

In the DA264, the D/A conversion is performed as follows.



When the offset calibration value is set, this value is added to the original D/A conversion data. Then D/A conversion is performed in the DA264.

The data setting range of the offset calibration value are as follows.

Offset calibration value		Output calibration range	
		Voltage	Current
Upper limit	127	+39.69 mV	+158.75 μA
Default value	0	0	0
Lower limit	-127	-39.69 mV	-158.75 μA

Output type setting:
(H8004 to H8007)

This parameter is used to select the output type.
This parameter also has a function to select either clear or hold the analog output signal in case of the T2 operation stop (Halt or Error).

The available setting range is as follows.

Output type		Setting value	
		Clear mode	Hold mode
0 to 5V	0 to 20mA	0	160
0 to 10V	-	1	161
1 to 5V	4 to 20mA	2	162
±5V	-	4	164
±10V	-	5	165

The default setting value (factory setting) is 0 (0 to 5V/0 to 20mA).

Between the clear mode and the hold mode, there is no difference in operation when the controller (T2) is operating normally. However, when the T2 stops the operation by Halt mode or Error mode, the DA264's output status is different between these modes. Refer to the table below.

Mode	Condition	Output type	Analog output status
Clear mode	T2 is in normal operation	Any	Normal output
	T2 is in Halt or Error mode	1 to 5V / 4 to 20mA	1V / 4mA
		Other than above	0V / 0mA
	T2's main power is off	Any	0V / 0mA
	DA264's external 24Vdc power is off	Any	0V / 0mA
Hold mode	T2 is in normal operation	Any	Normal output
	T2 is in Halt or Error mode	Any	Holds the previous output status
	T2's main power is off	Any	0V / 0mA
	DA264's external 24Vdc power is off	Any	0V / 0mA

Analog output read-back value:
(H8008 to H800B)

These data show the D/A conversion data after processing the offset calibration.

Module status:
(H800C to H800F)

These data show the DA264's operation status.

Bit position →	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
	0			0	0	0	0					0	0			

Bit	Name	Description
0 to 2	Output type	Shows the output type. 000 (0) = 0 to 5V/0 to 20mA 001 (1) = 0 to 10V 010 (2) = 1 to 5V/4 to 20mA 100 (4) = ±5V 101 (5) = ±10V
3 to 4	-	Reserved
5 to 7	Hold mode	Shows the output mode, clear mode (normal) or hold mode. 101 = Hold mode Other than above = Clear mode
8	Output type setting error	1 when the output type designation is invalid.
9 to C	-	Reserved
D	Output limit	1 when the D/A conversion data is limited because of the range over.
E	External 24V error	1 when the external 24Vdc is not normal.
F	-	Reserved

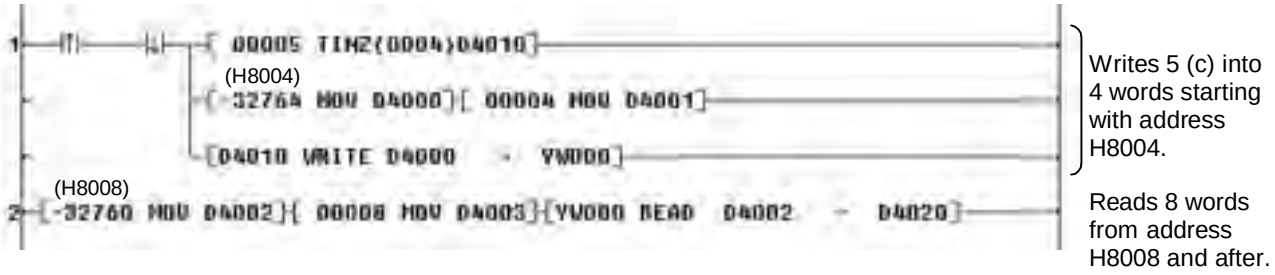
6.2 Sample program to access the parameters

To write the parameters into the DA264's buffer memory, use the WRITE instruction. No special procedure is required.
To read the parameters from the DA264's buffer memory, use the READ instruction.

A sample program to write/read the parameters is shown below.
This is an example to set the output type as ±10V range (type = 5) for each channel.
In this sample program, it is assumed that he DA264 is allocated to YW000 to YW003.

For details of READ and WRITE instructions, refer to the T-series Instruction Set manual.

(Main program)



In this sample program, the rung 1 is activated at the beginning of RUN mode (at the second scan) automatically. The output type is set to ±10V for all 4 channels.
The rung 2 is to read the analog output read-back values and the module status. These data are read from the DA264 and stored in D4020 to D4027.

7. Troubleshooting

7.1 RAS information

The RUN LED is provided on the front of the DA264. When the DA264 is operating normally, this LED is lit.
Also the module status information is provided in the DA264's buffer memory (addresses H800C to H800F). This information is useful for troubleshooting.
Refer to section 6 for the module status information and how to read it.

7.2 Troubleshooting

The table below shows the trouble and its remedy.

Trouble	Module status info	LED	Module operation	Cause	Remedy
Output type setting error	Bit 8 is ON	ON (if the error occurs in all channels, it is OFF)	The D/A conversion continues based on the previous setting.	Invalid output type parameter was set.	Set the correct output type parameter.
D/A conversion data limit over	Bit D is ON	ON	The D/A conversion data of the channel is limited by the limit value.	The written D/A conversion data is out of the range.	Check the output rage and write the correct data.
External 24V error	Bit E is ON	OFF	The D/A conversion is stopped. Output signal is 0V/0mA.	Internal ±15V voltage is not normal.	Check the external 24Vdc power supply.

Part 3

8 Channel Thermocouple Input Module TC218

1. Introduction

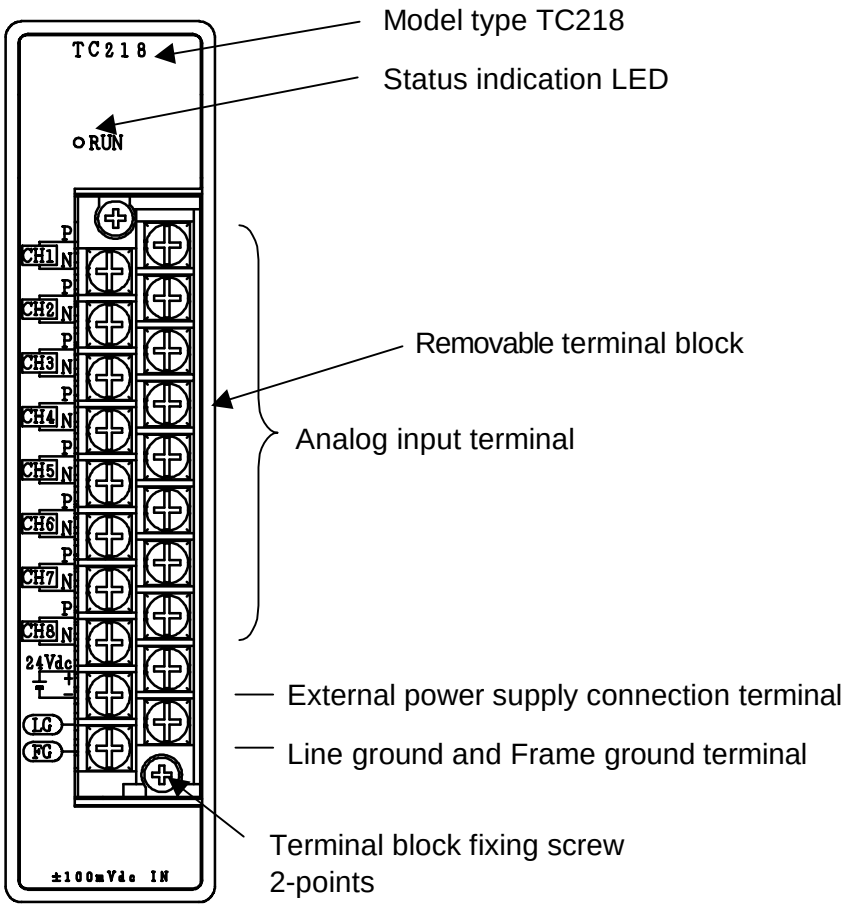
The TC218 is a thermocouple input module for the T2 series programmable controllers.
The TC218 is used to measure the temperature using thermocouples. Thermocouples type K, J, or E can be used.
The TC218 can be used for ±100mV input also.
When the TC218 is used for the thermocouple input, it has 7 channels of thermocouple input. The remaining 1 channel is used to measure the ambient temperature for cold junction compensation. For this purpose, a thermistor is attached with the TC218.
On the other hand, when the TC218 is used for ±100mV input, it has 8 channels of input.

1.1 TC218 Functions

The TC218 has the following functions.

1) 7 channels input per module for thermocouple input
   8 channels input per module for ±100mV input
2) Selectable input type
   - Thermocouple type K (-200 to +1200 °C)
   - Thermocouple type J (-200 to +800 °C)
   - Thermocouple type E (-200 to +600 °C)
   - ±100mV
3) 16-bit high-resolution A/D conversion
4) Built-in linearize function
5) Cold junction compensation function
6) Burnout detection function
7) Input data averaging function
8) Gain and offset calibration function (±100mV input only)

1.2 External features



For thermocouple input, CH2 to CH8 are used to connect the thermocouple input wires. The CH1 is used to connect the thermistor to measure the ambient temperature for cold junction compensation.
For ±100mV input, all 8 channels CH1 to CH8 are used.

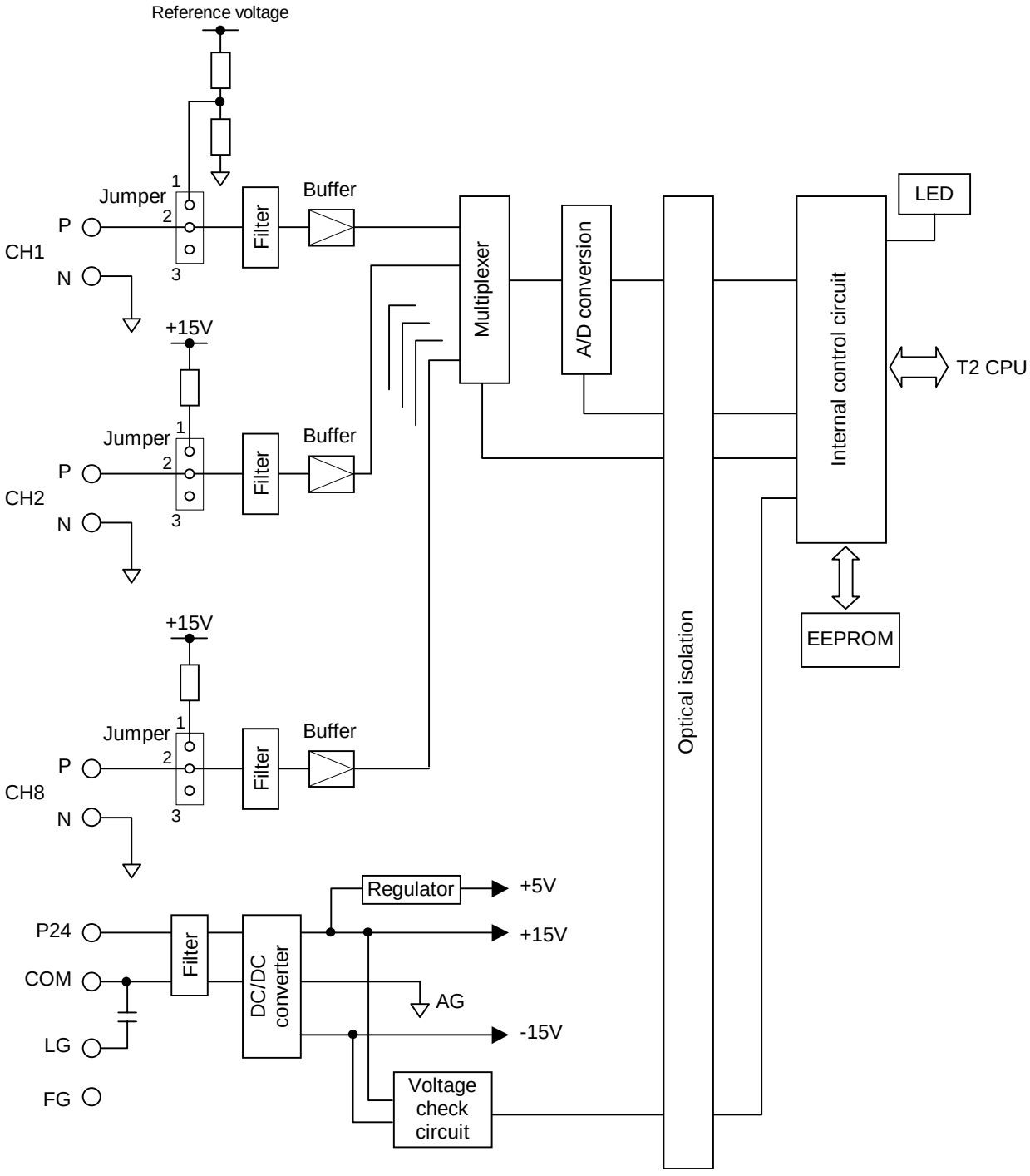
2. Specifications

This section describes the TC218 specifications.
The general specification for the TC218 conforms to the specification for the T2 PLC.

2.1 Specifications

Item	TC218			
Input type	Voltage input	Thermocouple input		
Input range	mV input	Type K	Type J	Type E
	-100 to +100 mV	-200 to +1200 °C	-200 to +800 °C	-200 to +600 °C
Number of input channels	8 channels	7 channels	7 channels	7 channels
Input impedance	1MΩ or more			
I/O allocation type	X 8W (8 input registers XW are assigned)			
Resolution	16-bit			
Overall accuracy	±0.2% FS (at 25°C) ±0.5% FS (0 to 55°C) (FS: ±100mV (mV input) or 1400°C (type K))			
Temperature drift	±100ppm/°C or less			
Conversion cycle	Approx. 1ms/channel (Approx. 8ms/8 channels)			
Insulation resistance	10MΩ or more			
Withstand voltage	1500Vac - 1 minute (between logic and analog circuits) 500Vac - 1 minute (between analog circuit and external 24V) 1500Vac - 1 minute (between analog circuit and FG/LG)			
Status indication	1 green LED (On when normal)			
Special function	Gain and offset calibration function (mV input only) Linearize function (thermocouple input) Cold junction compensation function (thermocouple input) Burnout detection function (thermocouple input) Input data averaging function External 24Vdc power voltage drop detection			
External power supply	24Vdc ±10% - 120mA			
Internal 5Vdc current consumption	300mA or less			
External connection	20-pin removable terminal block			
Weight	Approx. 300g			

2.2 Internal block diagram



The TC218 performs the following operations.
The external analog signals come to the buffer amplifier through the filter. The multiplexer sequentially selects CH1 to CH8 to convert the input analog signals into digital data via the A/D converter. The converted digital data reaches to the internal control circuit through optical isolator. Every time when the T2 CPU requests to read the converted data, the internal control circuit sends the data to the T2 CPU. The TC218's parameters are stored in the EEPROM.

3. Input Type Setting

The TC218 supports multiple input types, type K, type J, type E, or ±100mV. The input type is selected by jumper plug setting and the parameter writing by the T2 program.

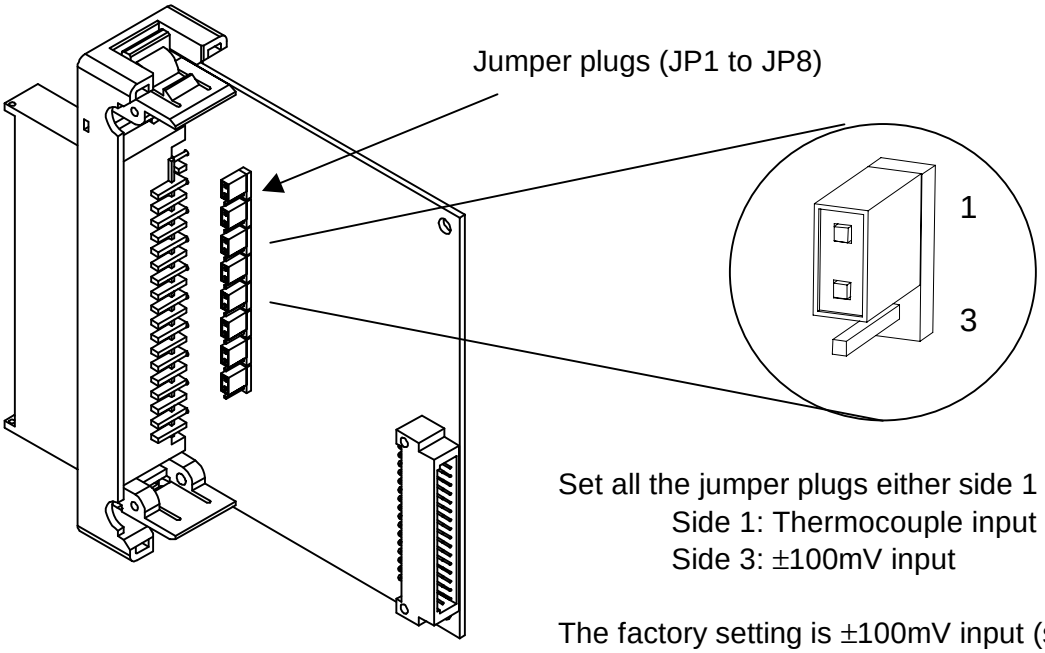
Note that the input type can be selected either one, type K, type J, type E, or ±100mV, for all channels. Any mixture settings among the channels are not allowed.

The general flow for setting the input type is as follows.

(1) Set the jumper plugs to select thermocouple input or mV input.
(2) Mount the TC218 onto the T2 rack.
(3) Turn on power to the T2 system.
(4) Execute I/O allocation.
(5) Program the "input type setting program". (see the next page)
(6) Turn the T2 to RUN mode.
(7) Cycle power off/on

3.1 Jumper plug setting

8 jumper plugs are provided on the TC218 board.
The jumper plug setting is for selecting either thermocouple input or mV input.



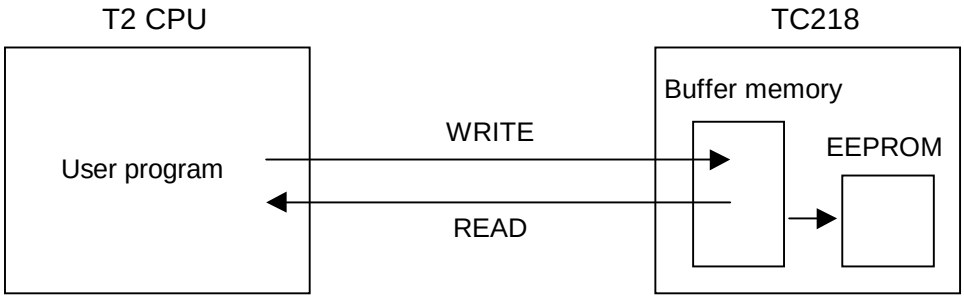
Set all the jumper plugs either side 1 or 3.
Side 1: Thermocouple input
Side 3: ±100mV input

The factory setting is ±100mV input (side 3).

- Use a pair of tweezers to set the jumper plug.
- Pay attention not to touch the components on the board other than the jumper plug.

3.2 Parameter setting by software

The input type of the TC218 is specified by writing the following parameter data into the TC218's buffer memory. To access the buffer memory, T2 user program (READ and WRITE instructions) is required.
When the parameter is set to the TC218, it is saved in the TC218's built-in EEPROM. Therefore, once the input type parameter is set, there is no need to execute the input type setting operation.



Input type parameter data:

Parameter data	Input type
0	Type K thermocouple
1	Type J thermocouple
2	Type E thermocouple
5	±100mV

TC218 buffer memory address:

H8018	Input type for channel 1
H8019	Input type for channel 2
H801A	Input type for channel 3
H801B	Input type for channel 4
H801C	Input type for channel 5
H801D	Input type for channel 6
H801E	Input type for channel 7
H801F	Input type for channel 8

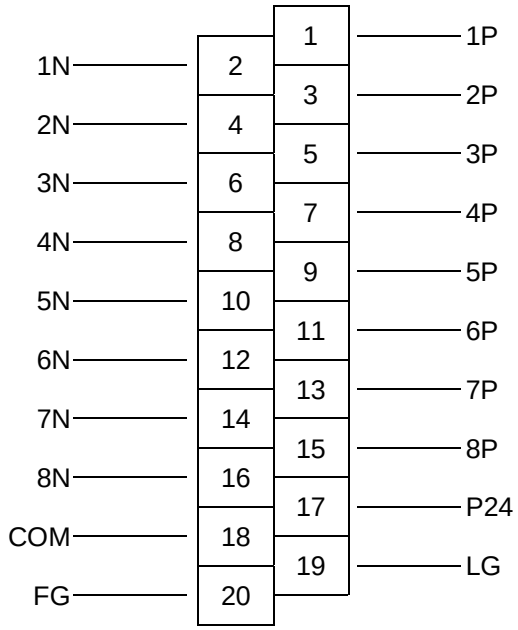
Set the same parameter data for all 8 channels.
The factory setting is ±100mV range.

For details of the procedure to set the input type parameter, refer to section 6.

4. Wiring

4.1 Terminal arrangement

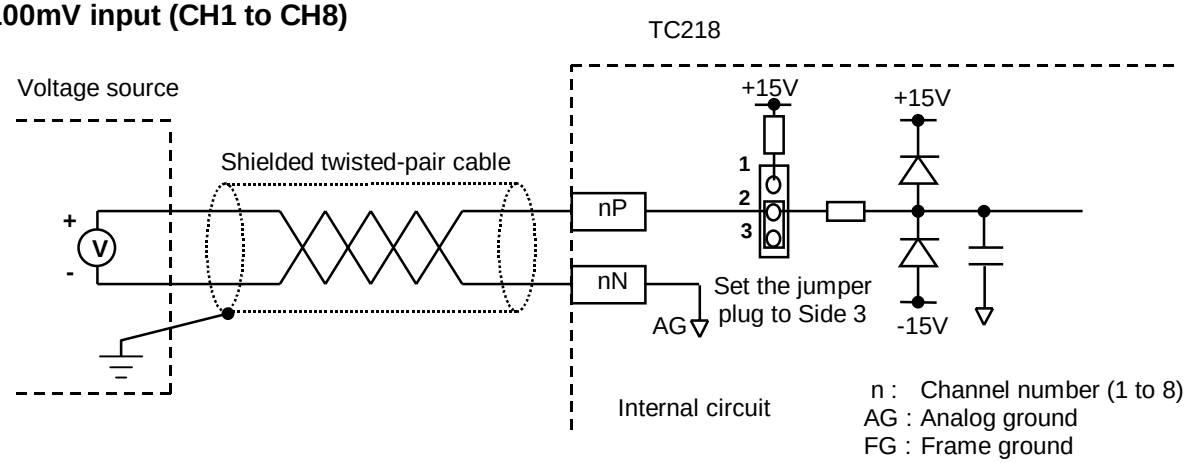
TC218 terminal block



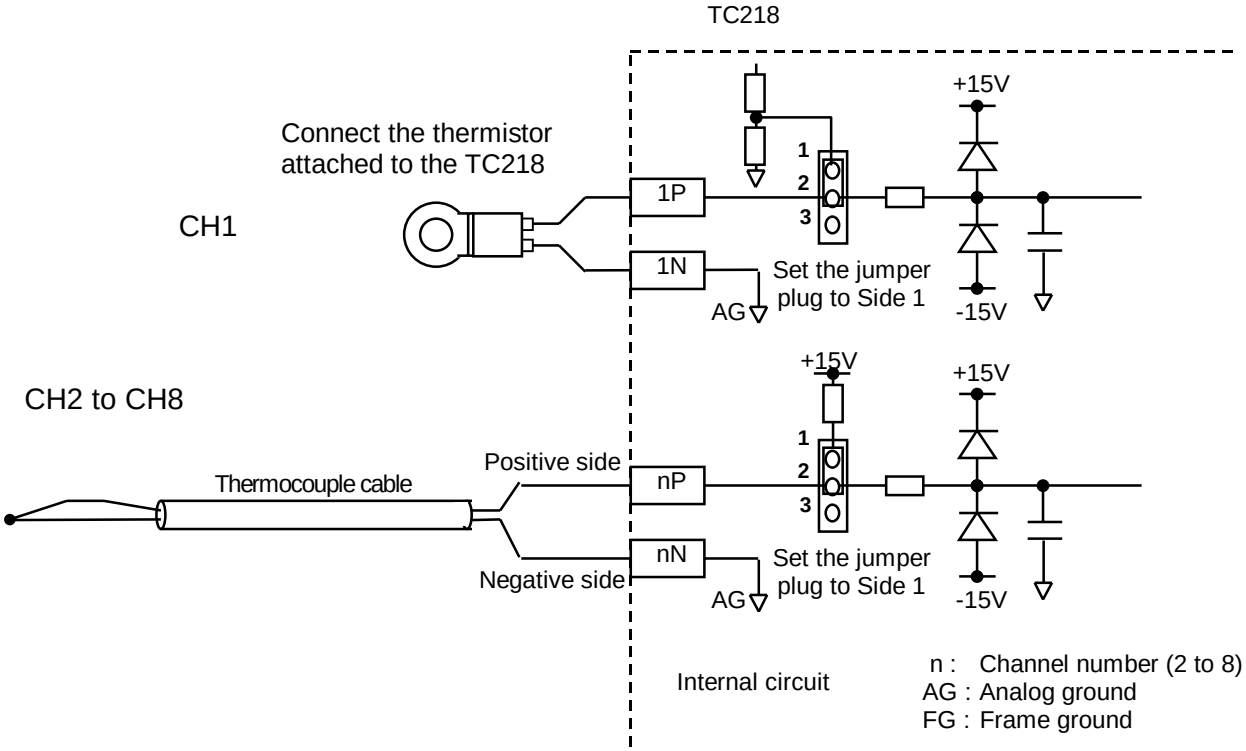
Terminal No.	Signal name	Function
1	1P	Channel 1 input
2	1N	
3	2P	Channel 2 input
4	2N	
5	3P	Channel 3 input
6	3N	
7	4P	Channel 4 input
8	4N	
9	5P	Channel 5 input
10	5N	
11	6P	Channel 6 input
12	6N	
13	7P	Channel 7 input
14	7N	
15	8P	Channel 8 input
16	8N	
17	P24	External 24Vdc power (+)
18	COM	External 24Vdc power (-)
19	LG	Line filter ground
20	FG	Frame ground

4.2 Signal wiring

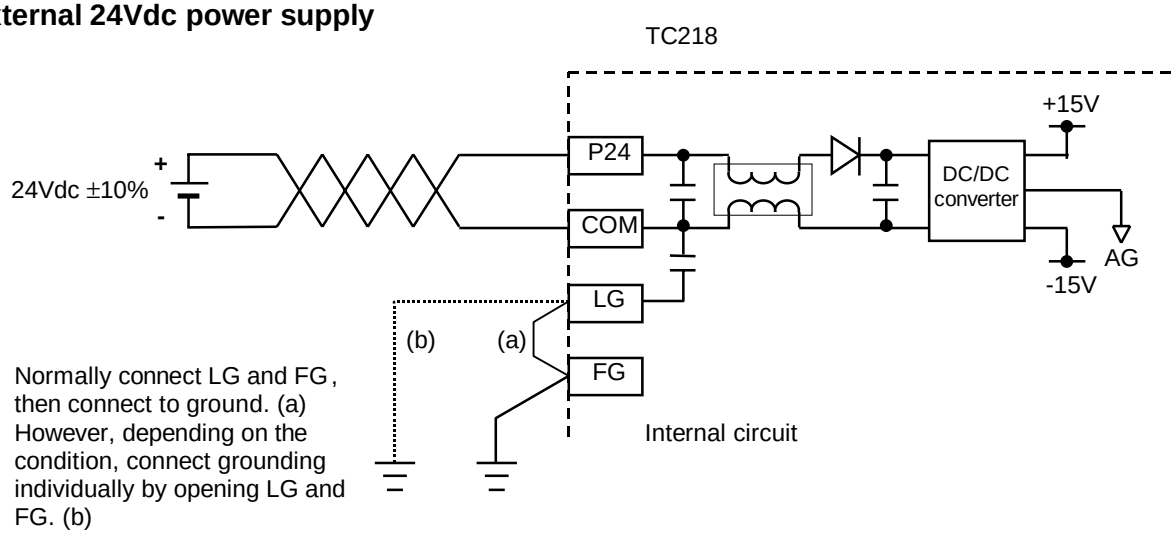
±100mV input (CH1 to CH8)



Thermocouple input



External 24Vdc power supply



4.3 Wiring precautions

(1) The thermocouple signal is weak voltage. Pay attention to prevent noise interference.
- Shortest cable distance
- Cable shield and grounding
- Separation from other cables

(2) This module requires 24Vdc power. Apply the 24Vdc power before (or at the same time) applying T2's main power. Otherwise, this module detects the external 24Vdc error.

(3) If the external 24Vdc power for this module is not stable, the converted data will not be stable. In this case, use a dedicated 24Vdc power supply for this module.

(4) It is recommended to short the unused channels. Because if it is open, meaningless A/D conversion data will appear.

(5) If the converted data is not stable owing to electrical noise, it is recommended to use the input averaging function to reduce the noise interference. For the averaging function, refer to section 6.

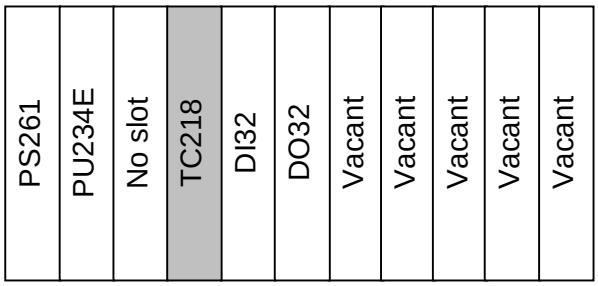
(6) When this module is used for thermocouple input, connect the thermistor to channel 1 (CH1). The thermistor is attached with this module.

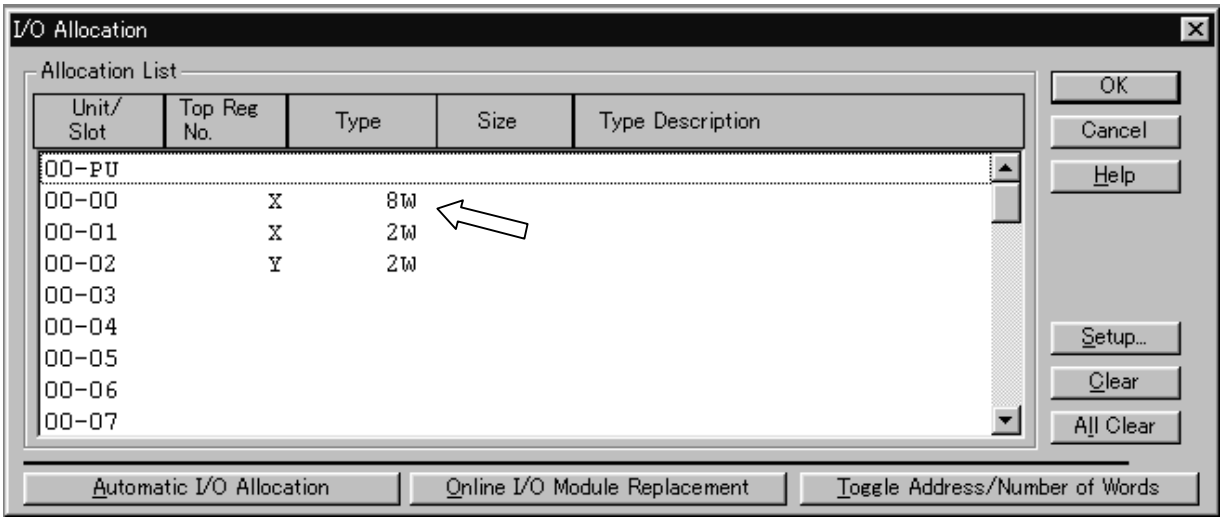
5. I/O Allocation and Programming

5.1 Allocation to the T2 registers

The I/O type of the TC218 is "X 8W".
When the automatic I/O allocation operation is performed with a TC218 mounted on the rack, the TC218 is allocated as "X 8W".
The TC218 occupies the 8 consecutive input (XW) registers of the T2.
In this manual, these assigned I/O registers are expressed as XW(n), XW(n+1), ... XW(n+7).

The following figure shows an example of I/O allocation window of the T-PDS programming software. In this case, the TC218 is mounted in the slot 0 of base unit BU218.





In the above example, the TC218 is allocated on the unit-0, slot-0. And 8 I/O registers, XW000 to XW007 are assigned to the TC218.

5.2 A/D conversion data

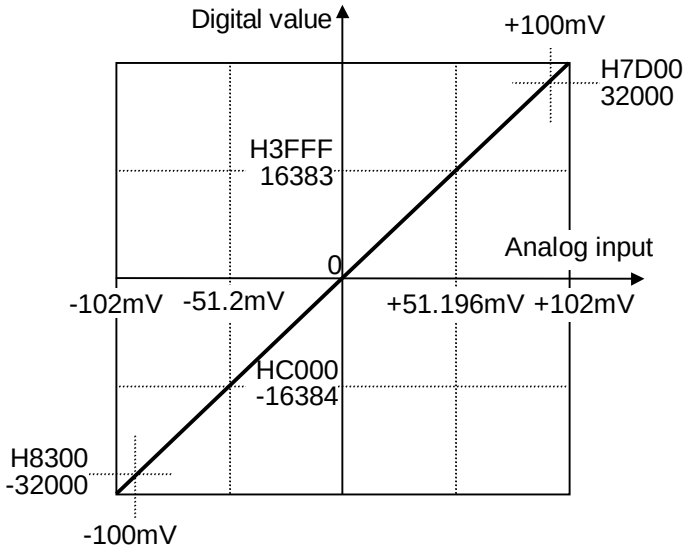
The analog signals received by the TC218 are converted into the digital data in this module. These converted digital data are read by T2 CPU in the batch I/O processing and stored in the assigned input registers as follows.

XW(n) ..... A/D conversion data for channel 1
XW(n+1) .... A/D conversion data for channel 2
XW(n+2) .... A/D conversion data for channel 3
XW(n+3) .... A/D conversion data for channel 4
XW(n+4) .... A/D conversion data for channel 5
XW(n+5) .... A/D conversion data for channel 6
XW(n+6) .... A/D conversion data for channel 7
XW(n+7) .... A/D conversion data for channel 8

The conversion data stored in the XW register is dependent on the input type as follows.

±100mV input:

	Input voltage	A/D conversion data		Resolution
		Hexadecimal	Integer	
Upper limit	+102 mV	H7F80	32640	3.125 μV / bit
	:	:	:	
Full scale (positive)	+100 mV	H7D00	32000	
	:	:	:	
	+3.125 μV	H0001	1	
0	0 V	H0000	0	
	-3.125 μV	HFFFF	-1	
	:	:	:	
Full scale (negative)	-100 mV	H8300	-32000	
	:	:	:	
Lower limit	-102 mV	H8080	-32640	

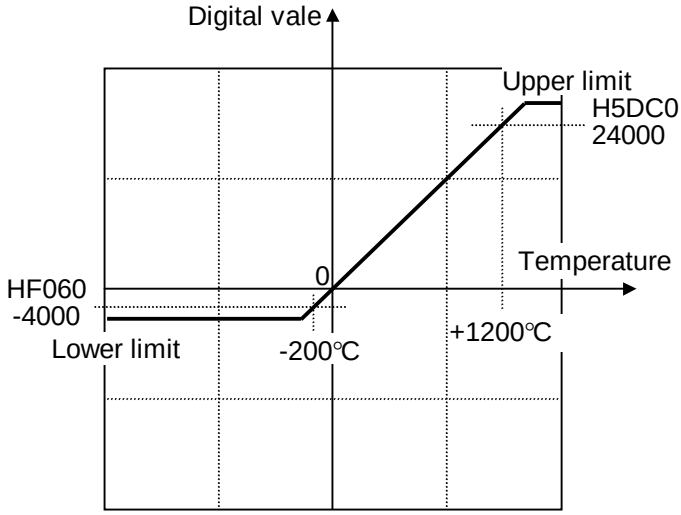


$D = 320 \times A$

D: Digital data
A: Analog signal (mV)

Thermocouple (type K) input:

	Input temperature	A/D conversion data		Resolution
		Hexadecimal	Integer	
Burnout detection	-	H7FFF	32767	0.05 ℃ / bit
Upper limit	+1370 ℃	H6B08	27400	
	:	:	:	
Full scale (positive)	+1200 ℃	H5DC0	24000	
	:	:	:	
	+0.05 ℃	H0001	1	
0	0 V	H0000	0	
	-0.05 ℃	HFFFF	-1	
	:	:	:	
Full scale (negative)	-200 ℃	HF060	-4000	
	:	:	:	
Lower limit	-270 ℃	HEAE8	-5400	

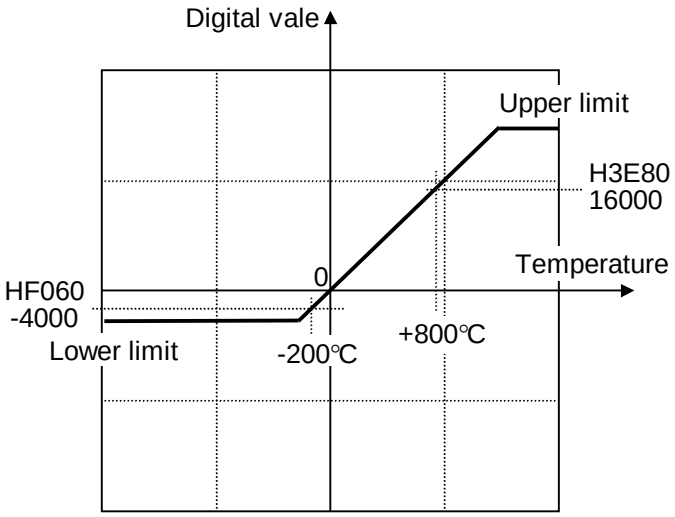


$D = 20 \times A$

D: Digital data
A: Temperature (℃)

Thermocouple (type J) input:

	Input temperature	A/D conversion data		Resolution
		Hexadecimal	Integer	
Burnout detection	-	H7FFF	32767	0.05 ℃ / bit
Upper limit	+1200 ℃	H5DC0	24000	
	:	:	:	
Full scale (positive)	+800 ℃	H3E80	16000	
	:	:	:	
	+0.05 ℃	H0001	1	
0	0 V	H0000	0	
	-0.05 ℃	HFFFF	-1	
	:	:	:	
Full scale (negative)	-200 ℃	HF060	-4000	
	:	:	:	
Lower limit	-210 ℃	HEF98	-4200	

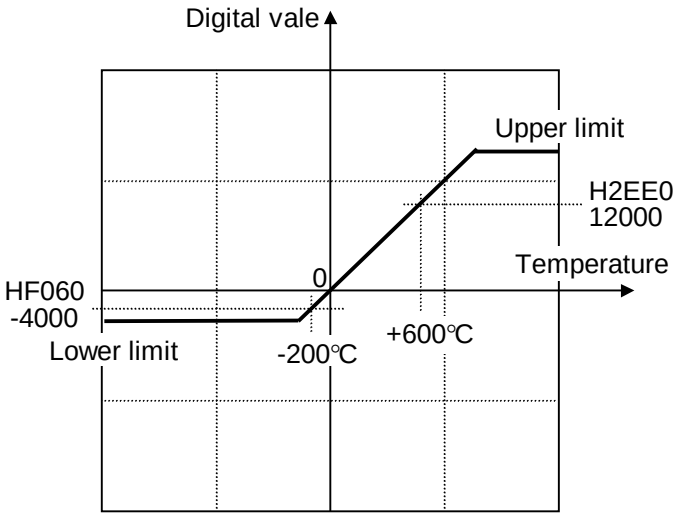


$D = 20 \times A$

D: Digital data
A: Temperature (℃)

Thermocouple (type E) input:

	Input temperature	A/D conversion data		Resolution
		Hexadecimal	Integer	
Burnout detection	-	H7FFF	32767	0.05 ℃ / bit
Upper limit	+1000 ℃	H4E20	20000	
	:	:	:	
Full scale (positive)	+600 ℃	H2EE0	12000	
	:	:	:	
	+0.05 ℃	H0001	1	
0	0 V	H0000	0	
	-0.05 ℃	HFFFF	-1	
	:	:	:	
Full scale (negative)	-200 ℃	HF060	-4000	
	:	:	:	
Lower limit	-270 ℃	HEAE8	-5400	



$D = 20 \times A$

D: Digital data
A: Temperature (℃)

5.3 Programming

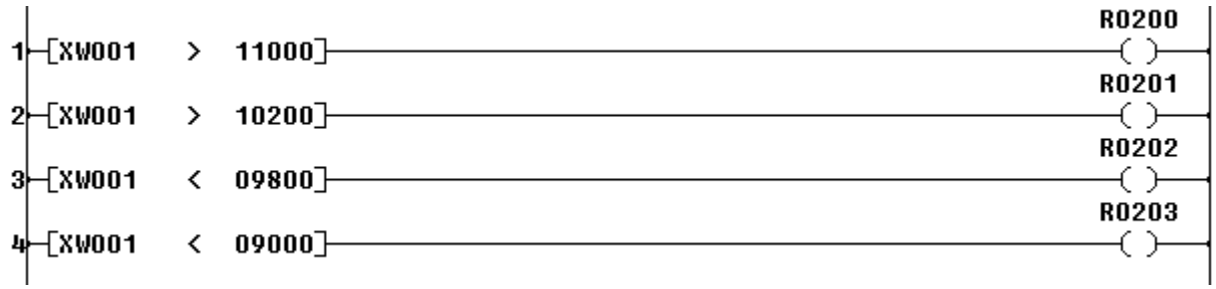
To read the A/D conversion data, there is no need to use special instruction. The A/D conversion data are automatically stored in the assigned input registers (XW registers).

For example, when the TC218 is allocated to XW000 to XW007, the A/D conversion data of each channel is stored as follows.

XW000 : Channel 1 A/D conversion data
XW001 : Channel 2 A/D conversion data
XW002 : Channel 3 A/D conversion data
XW003 : Channel 4 A/D conversion data
XW004 : Channel 5 A/D conversion data
XW005 : Channel 6 A/D conversion data
XW006 : Channel 7 A/D conversion data
XW007 : Channel 8 A/D conversion data

Therefore, in the user program, you can use these XW registers directly for the analog data processing.

The program shown below is an example of simple comparison with the channel 2 input data. (Thermocouple type K setting)



By the above program, the ON/OFF status of the internal relays R0200 to R0203 are changed as follows.

Temperature	XW001 data	Status of the internal relays			
		R0200	R0201	R0202	R0203
More than 550 °C	11000 < XW001	**ON**	**ON**	OFF	OFF
510 to 550 °C	10200 < XW001 ≤ 11000	OFF	**ON**	OFF	OFF
490 to 510 °C	9800 ≤ XW001 ≤ 10200	OFF	OFF	OFF	OFF
450 to 490 °C	9000 ≤ XW001 < 9800	OFF	OFF	**ON**	OFF
Less than 450 °C	XW001 < 9000	OFF	OFF	**ON**	**ON**

6. Parameters

The TC218 has the memory that stores the control parameters, input type designation, module status information, etc. This memory is called the buffer memory. To access (read/write) this memory from the T2 program, READ and WRITE instructions are used.

6.1 Memory map

The contents of the TC218's buffer memory are as follows.

Address	Contents (F – 0)
H8000	Gain calibration value for channel 1
H8001	Gain calibration value for channel 2
H8002	Gain calibration value for channel 3
H8003	Gain calibration value for channel 4
H8004	Gain calibration value for channel 5
H8005	Gain calibration value for channel 6
H8006	Gain calibration value for channel 7
H8007	Gain calibration value for channel 8
H8008	Offset calibration value for channel 1
H8009	Offset calibration value for channel 2
H800A	Offset calibration value for channel 3
H800B	Offset calibration value for channel 4
H800C	Offset calibration value for channel 5
H800D	Offset calibration value for channel 6
H800E	Offset calibration value for channel 7
H800F	Offset calibration value for channel 8
H8010	Averaging times for channel 1
H8011	Averaging times for channel 2
H8012	Averaging times for channel 3
H8013	Averaging times for channel 4
H8014	Averaging times for channel 5
H8015	Averaging times for channel 6
H8016	Averaging times for channel 7
H8017	Averaging times for channel 8
H8018	Input type setting for channel 1
H8019	Input type setting for channel 2
H801A	Input type setting for channel 3
H801B	Input type setting for channel 4
H801C	Input type setting for channel 5
H801D	Input type setting for channel 6
H801E	Input type setting for channel 7
H801F	Input type setting for channel 8
H8020	Command register
H8021	Response register
H8022 : H8027	No use

Use WRITE instruction to write data into these addresses.

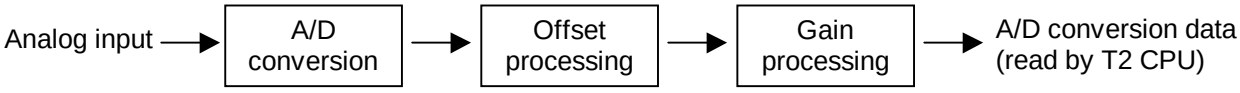
Use READ instruction to read data from this address.

Address	Contents (F … 0)
H8028	Analog input actual value for channel 1
H8029	Analog input actual value for channel 2
H802A	Analog input actual value for channel 3
H802B	Analog input actual value for channel 4
H802C	Analog input actual value for channel 5
H802D	Analog input actual value for channel 6
H802E	Analog input actual value for channel 7
H802F	Analog input actual value for channel 8
H8030	Module status for channel 1
H8031	Module status for channel 2
H8032	Module status for channel 3
H8033	Module status for channel 4
H8034	Module status for channel 5
H8035	Module status for channel 6
H8036	Module status for channel 7
H8037	Module status for channel 8

Use READ instruction to read data from these addresses.

Gain calibration value & Offset calibration value: (±100mV input only)
(Gain: H8000 to H8007, Offset: H8008 to H800F)

For the ±100mV input, the gain and offset calibration is possible.
In the TC218, the A/D conversion data is calculated as follows.



When the gain calibration value is G and the offset calibration value is O, the conversion calculation is performed in the TC218 as follows.

$X_2 = (X_1 + O) \times G / 32000$

X_1: Initial A/D conversion value
X_2: Gain/offset processed value
O: Offset calibration value (buffer memory address H8008 to H800F)
G: Gain calibration value (buffer memory address H8000 to H8007)

The data setting range of the gain and offset calibration value are as follows.

Input type	Gain calibration value	
±100mV	Upper limit	32000
	Default value	32000
	Lower limit	10000
Thermocouple	Not applicable	

Input type	Offset calibration value	
±100mV	Upper limit	3200
	Default value	0
	Lower limit	-3200
Thermocouple	Not applicable	

Averaging times:
(H8010 to H8017)

This parameter is for the averaging processing for the analog input data. The moving average is calculated by the given averaging times parameter.
For example, if the averaging times parameter is 100, the average value of latest 100 times conversion is output as the A/D conversion data.
This function is effective to reduce the fluctuation caused by noise.

The available setting range is as follows.

Input type	Averaging times	
All types	Upper limit	127
	Default value	1
	Lower limit	1

Input type setting:
(H8018 to H801F)

This parameter is used to select the input type. This parameter also has a function to skip the A/D conversion for unused channels. By using the channel skip function, the conversion cycle time can be reduced.

The available setting range is as follows.

Input type	Setting value
Type K thermocouple	0
Type J thermocouple	1
Type E thermocouple	2
±100mV	5

The default setting value (factory setting) is 5 (±100mV).

Command register:
(H8020)

This register is used to issue the following commands to the TC218. To issue the command, write the command value by using WRITE instruction.

Value	Command	Description
0	-	Write 0 after the command processing is completed.
1	Parameter set	When this command is issued, the parameters written into the buffer memory are saved in the TC218 's EEPROM, and the parameters become effective.
2	Reset command	Used to reset the TC218 when some error has occurred. However if the error is caused by hardware or external condition, the reset command may not be effective.

The command register and the response register are used for hand-shaking. Refer to section 6.2 for the parameter setting procedure.

Response register:
(H8021)

This register shows the TC218's response for the command issued. Check the status of this register using READ instruction.

Value	Response	Description
0	-	The requested command is not yet completed.
1	Acknowledge	When the issued command is completed, the response register comes 1.

The command register and the response register are used for hand-shaking. Refer to section 6.2 for the parameter setting procedure.

Analog input actual value:
(H8028 to H802F)

These data show the original A/D conversion data before processing the gain and offset calibration.

Module status:
(H8030 to H8037)

These data show the TC218's operation status.

Bit position →	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
			0							0	0	0	0			

Bit	Name	Description
0 to 2	Input type	Shows the input type. 000 (0) = Type K thermocouple 001 (1) = Type J thermocouple 010 (2) = Type E thermocouple 101 (5) = ±100mV
3 to 6	-	Reserved
7	Input type setting error	1 when the input type designation is invalid.
8	Burnout detection	1 when thermocouple burnout is detected.
9	Input limit	1 when the A/D conversion data is limited because of the range over.
A	MPU error	1 when the TC218's processor is not normal.
B	ROM status	1 when the TC218's EEPROM is not normal.
C	DP-RAM status	1 when the TC218's DP-RAM (buffer memory) is not normal.
D	-	Reserved
E	External 24V error	1 when the external 24Vdc is not normal.
F	Initializing	1 during the TC218 is in initialization process.

6.2 Parameter setting procedure

When you change the TC218 parameters, such as input type settings, gain/offset calibrations and averaging times, use the following procedure.

Step (1)

Write the value "0" into the command register of the TC218 buffer memory (address H8020) by WRITE instruction.

H8020	Command register	← Write 0

Step (2)

Write the parameter data into the buffer memory (addresses H8000 to H801F) by WRITE instruction. Be sure to write all the 32 words in batch.
For thermocouple, write the default value for the gain (32000) and the offset (0).

H8000	Gain for channel 1	← Write the parameter data (32 words)
H8001	Gain for channel 2	
:	:	
H801F	Input type for channel 8	

Step (3)

Write the value "1" into the command register (address H8020) by WRITE instruction.

H8020	Command register	← Write 1

Step (4)

Wait until the data of the response register (address H8021) comes "1". Check the data by READ instruction.

H8021	Response register	Check if it comes 1

Step (5)

Write the value "0" into the command register (address H8020) by WRITE instruction.

H8020	Command register	← Write 0

When the above steps are finished and the module status (addresses H8030 to H8037) shows no error, the parameter setting procedure is completed. The parameters are effective and they have been saved in the TC218's EEPROM.

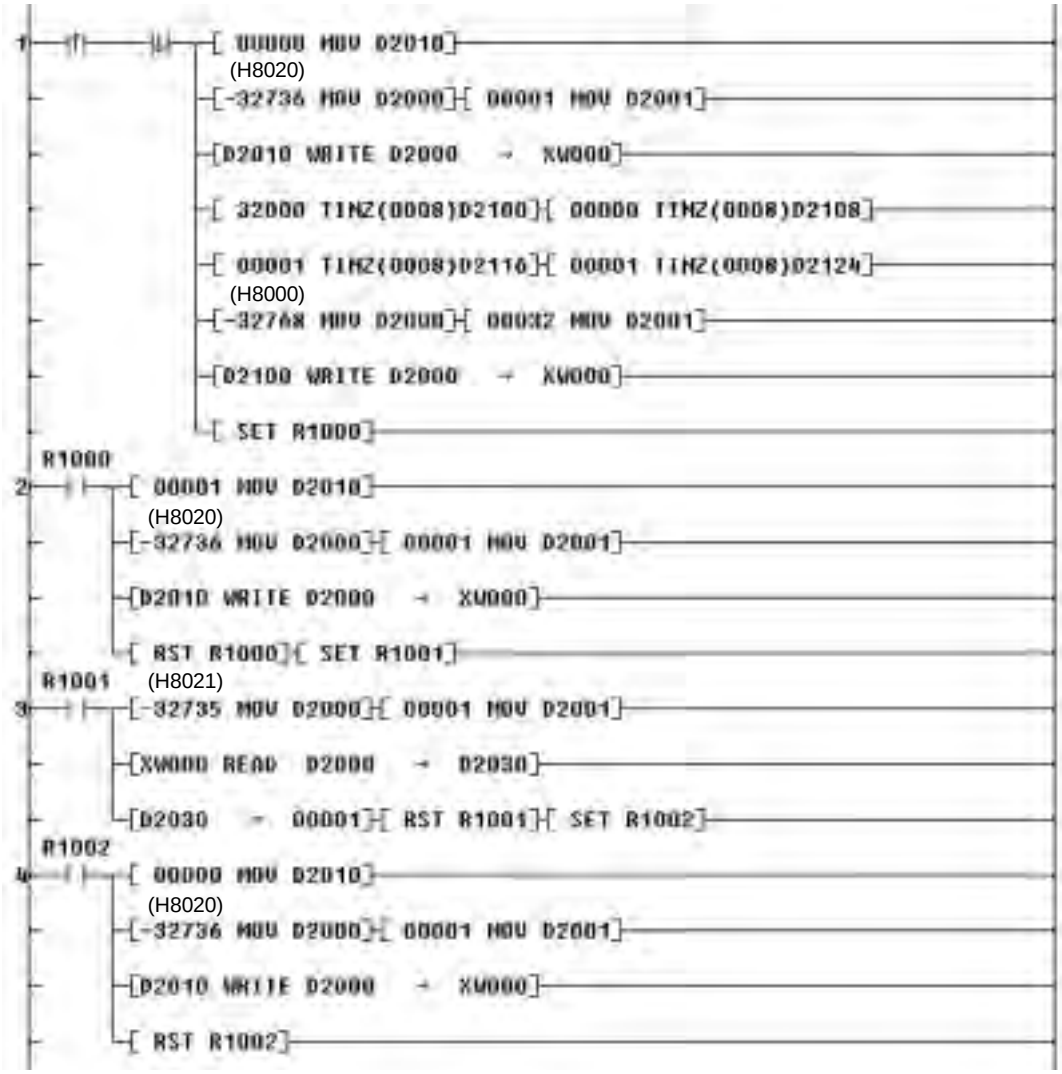
Note) After you write the parameters into the TC218, turn off power and on again.

6.3 Sample program for setting the parameters

A sample program to set the parameters is shown below.
This is an example to set the input type as the type J thermocouple (type = 1) for each channel.
In this sample program, it is assumed that he TC218 is allocated to XW000 to XW007.

For details of READ and WRITE instructions, refer to the T-series Instruction Set manual.

(Main program)



In this sample program, the rung 1 is activated at the beginning of RUN mode (at the second scan) automatically. The input type is set to the type J thermocouple for all 8 channels.
When the parameter setting process is completed, the flags R1000 to R1002 are returned to OFF.

For reading the parameters from the TC218, there is no special procedure. Simply read the data from the TC218's buffer memory by using READ instruction.

7. Troubleshooting

7.1 RAS information

The RUN LED is provided on the front of the TC218. When the TC218 is operating normally, this LED is lit.
Also the module status information is provided in the TC218s buffer memory (addresses H8030 to H8037). This information is useful for troubleshooting.

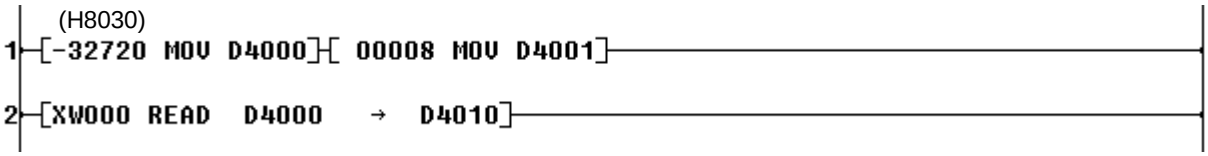
Module status:
(H8030 to H8037)

These data show the TC218's operation status.

Bit position →	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
			0							0	0	0	0			

Bit	Name	Description
0 to 2	Input type	Shows the input type. 000 (0) = Type K thermocouple 001 (1) = Type J thermocouple 010 (2) = Type E thermocouple 101 (5) = ±100mV
3 to 6	-	Reserved
7	Input type setting error	1 when the input type designation is invalid.
8	Burnout detection	1 when thermocouple burnout is detected.
9	Input limit	1 when the A/D conversion data is limited because of the range over.
A	MPU error	1 when the TC218's processor is not normal.
B	ROM status	1 when the TC218's EEPROM is not normal.
C	DP-RAM status	1 when the TC218's DP-RAM (buffer memory) is not normal.
D	-	Reserved
E	External 24V error	1 when the external 24Vdc is not normal.
F	Initializing	1 during the TC218 is in initialization process.

A sample program to read the module status information is shown below.



By the above sample program, the module status information for each channel is read from the TC218, and stored in D4010 to D4017.
(In this sample program, it is assumed that the TC218 is allocated to XW000 to XW007)

7.2 Troubleshooting

The table below shows the trouble and its remedy.

Trouble	Module status info	LED	Module operation	Cause	Remedy
Input type setting error	Bit 7 is ON	ON (if the error occurs in all channels, it is OFF)	The error channel stops the conversion. The A/D conversion data is 0.	Invalid input type parameter was set.	Set the correct input type parameter.
Thermocouple burnout	Bit 8 is ON	ON	The A/D conversion data of the channel is 32767 (H7FFF).	The thermocouple input wire becomes open.	Check the thermocouple.
Analog signal limit over	Bit 9 is ON	ON	The A/D conversion data of the channel is limited by the limit value.	Analog input signal is out of the range.	Check the signal source (sensor).
MPU error	Bit A is ON	OFF	The A/D conversion is stopped.	Internal processor operation is not normal.	Execute reset command, or cycle power off and on.
ROM error	Bit B is ON	OFF	The A/D conversion is stopped.	EEPROM data error is detected.	Cycle power off and on.
DP-RAM error	Bit C is ON	OFF	The A/D conversion is stopped.	Buffer memory access error is occurred.	Cycle power off and on.
External 24V error	Bit E is ON	OFF	The A/D conversion is stopped.	Internal ±15V voltage is not normal.	Check the external 24Vdc power supply.