# AC Current RS485 Isolated Transducer

# MODEL TF-6D

INSTRUCTION MANUAL

**Warning** This marking indicates that the erroneous operation of this transducer may result in death or serious injury.

## Precautions

(1) If voltage or current exceeding the input allowable voltage or current is applied to the input terminals, the transducer may be damaged.
(2) Apply power within the applicable range of the transducer. Otherwise fire, electric shock or transducer damage may result.
(3) The contents of this instruction manual are subject to change without prior notice.
(4) This instruction manual is carefully prepared. However, if any mistake or omission is found, contact your nearest Watanabe Electric Industry sales agent or Watanabe Electric Industry directly.
(5) Make this manual available easily anytime.

## Outline

Series TF-6 transducers are RS-485 isolated transducers with the display /analog output function. The TF-6D isolates an AC current input signal and outputs RS-485 data.
Its input, analog output, communication output and power supply are mutually isolated. It has a display unit with 4 digits and a minus sign, all of which can be set to go out. In addition, its analog output is optional.
This transducer uses a socket type screw terminal which enables mounting on DIN rails and also uses a case of 24 mm wide.
When two or more RS-485 communication terminals are connected in a row, they can be easily connected using special short bars attached as standard accessories.
Data output to a sequencer is enabled without using any program if connected with the protocol converter (TF-PC).

## Model No. Configuration

Each code and the standard specifications of this transducer are as follows.First check whether or not your desired specifications are correct by comparing them to the following specifications.

(Example) TF-6D - A 1

TF-6D- □ □

Output code
- 0 : 0 to 5VDC
- 1 : 1 to 5VDC
- 2 : 0 to 10VDC
- A : 4 to 20mADC
- Z : None

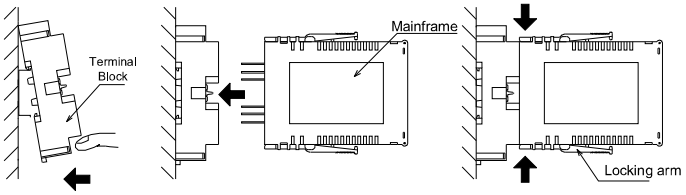
Input code
- A : 0 to 1A AC
- B : 0 to 5A AC

## General specifications

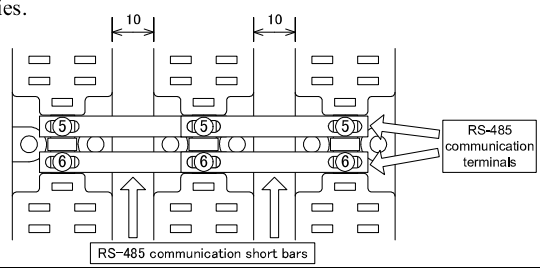
Insulation resistance : Between input and analog output and communication / power supply ; More than 100M Ω at 500 VDC
Dielectric strength : Between input and output and communication / power supply ; For 1 min. at 1500VAC
Power supply voltage : 24VDC ±10 %
Consuming current : Less than 100 mA(At 24VDC)
Operating ambient temperature : -5 to 50ºC
Operating ambient humidity : Less than 90 %RH (No-condensing)
Storage temperature : -10 to 70ºC
Storage humidity : Less than 60%RH (No-condensing)
Case material : ABS (Black)
Weight : Approx. 180 g

## Mounting

Engage the terminal block with the DIN rails as shown in the following Fig., and then insert the mainframe into the terminal block. Lastly, check that each locking arm fixes the mainframe to the terminal block.

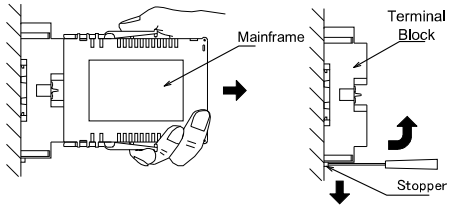



When using two or more series TF-6 transducers in a row on the DIN rails, leave a space of more than 10 mm between each transducer. It is possible to easily connect two or more series TF-6 transducers at intervals of 10 mm by using RS-485 communication short bars attached as accessories.

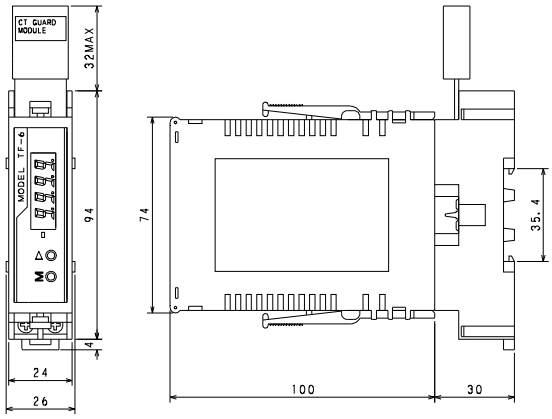



## Dismounting

The mainframe can be disengaged from the terminal block if pulled out toward you while pushing the locking arms in the mainframe.
Remove the terminal block from the DIN rails after moving the stopper in the arrow direction with a screwdriver.




## Dimensions



## Input Specification

| Code No. | Input (A) | Input resistance | Input allowable range |
|---|---|---|---|
| A | 0 to 1A AC | less than 0.1Ω | less than 7.5A AC |
| B | 0 to 5A AC | | |

Input frequency : 40 to 1000Hz

Allowable instantaneous input range : 15A peak/1msec

| Code No. | Indication | Communication | Accuracy | Temp. characteristic | Frequency variation |
|---|---|---|---|---|---|
| A | 0 to 1000 | 0 to 10000 | ±(0.2%F.S+1digit) | ±0.02%F.S/°C | ±0.5%F.S |
| B | 0 to 5000 | 0 to 50000 | | | |

For a range of 0 to 50 mA at standard accuracy : ±0.4%

Frequency variation : Based on 60Hz

Sampling rate: Approx. 12 times / sec.

### CT protection module

If the transducer is disengaged from the terminal block while letting current flow through the input with AC current applied to the transducer through CT, the external CT may be damaged. If the CT protection module is connected to the input terminals together with the input signal wires, the CT can be prevented from its damage.

Note : If the maximum allowable input current is allowed to flow through only the CT protection module for more than 15 minutes, the module may be damaged.

## Analog Output Specification

| Code No. | Output Signal | Output Load Resistance |
|---|---|---|
| 0 | 0 to 5VDC | More than 2kΩ |
| 1 | 1 to 5VDC | |
| 2 | 0 to 10VDC | More than 4kΩ |
| A | 4 to 20mADC | Less than 350Ω |
| Z | None | |

The total analog output error consists of the input error described in the specification and the following errors.

Accuracy : ±0.1%F.S (At 25ºC±2ºC)

Power supply voltage variation : ±0.06%F.S

Load regulation : ±0.06%F.S

Temperature characteristic: ±0.015%F.S/ºC

Response time : Less than 1sec (0 to 90%)

## Set key specifications

The [M] mode and [▷] set keys at the front enable the setting of communication device No. , communication speed, terminator, and LED illuminating or going-out.

It is also possible to check the input type. The setting thus set becomes valid after the set mode terminates.

### Checking the input type

The TF-6 input type can be checked.

dA AC 0 to 1A  db AC 0 to 5A

### Communication device No.

If two or more TF-6 transducers are connected in parallel with RS-485 communication terminals, one host can communicate with 31 devices by assigning communication device Nos. from 1 to 31 to them.

**Note : Always set the communication device No. which is different from that of any other device.**

### Communication speed

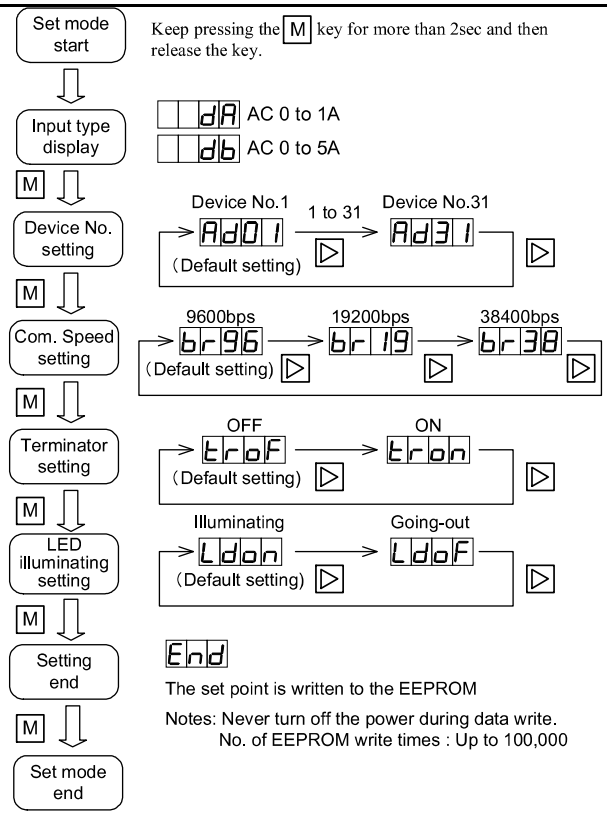
Set any one of the communication speeds of this device (9600/19200/38400bps) so that it matches the communication speed set to the host computer.

### Terminator

Devices connected to both ends of the transmission line need to be terminated in order to prevent signal reflection. When connecting this transducer to the end of the transmission line, terminate it with the terminator turned on. When connecting the transducer to the middle of the transmission line, turn off the terminator.

### Setting LED illuminating or going-out

It is possible to set the LED at the front to the illuminating or going-out state.




## Display specification

Value obtained by rounding off the measured-value response to 4 digits is displayed.

Display : 7-segment LED display (red) (character height : 8 mm)

Polarity indication : Automatically indicated when the calculated result is negative.

Over-range alarm : -oL. Approx. less than -5%

oL. Approx. more than 105%

Zero indication : Leading zero suppression

Decimal point : Settable to any digit position

## RS-485 communication specification

It is possible to set any parameters necessary for measured-data capture and measurement operation by connecting the RS-485 interface of this transducer to external devices such as personal computers, etc.

(Compatible with EIA RS-485)

Synchronization : Start-stop

Communication method : Two-wire half-duplex (polling/selecting)

Transmission rate : 9600, 19200, 38400bps

Number of start bits : 1bit  Number of stop bits : 2bit

Data length : 7bits

Error detection : Even parity, BCC checksum

Character code : ASCII code

Transmission control procedure : Non-procedural

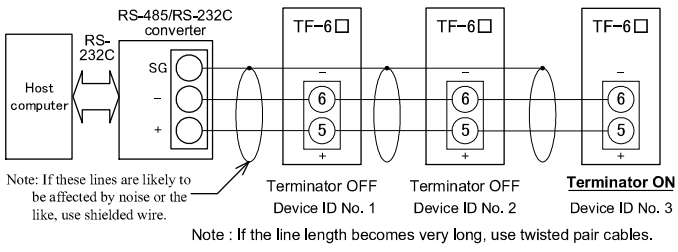
Signal name used : Non-inverting (+), inverting (-)

Number of units that can be connected : 31 for transducers

Transmission line length : 500m max. (overrall length)

Delimiter : CR+LF

## Example of RS-485 Connection



## Procedure for RS-485 communication

Change the communication speed, device No. or terminator setting to that meeting the communication environment. For details of the setting procedure, see the set key specifications.

## Establishing and Releasing the Communication Link

1) Establishment of communication link

In order to enable communication with this transducer, first it is necessary to establish communication with that device by sending the desired device No. (01 to 31) from the host side. Specify the desired device ID in 2 digits. (00 : Invalid) If the Device ID is different, no response is issued.

| Communication comand | | | | | Response data | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| ENQ | 0 | 1 | CR | LF | ACK | 0 | 1 | CR | LF |

(Normal response)

Note : The response time is 200msec maximum.

2) Releasing the communication link

Before communicating with any devices other than the devices now in communication, open the communication as follows and then establish the communication with the next device in accordance with the procedure described above. (Communication is also possible if established by any other device No. without opening it.)

| Communication command | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| EOT | CR | LF | | |

(No response is made for release.)

## BCC Checksum

As error detection, the BCC (Block Check Character) Checksum is used for the RS-485 communication of this transducer. Since the command and data to be sent are totalized as a binary number in the ASCII codes and the lower 8-bit BCC checksum is added to both send and receive data for checking, always conduct the communication with the BCC checksum added.

Note : No BCC checksum is added to ACK, EOT and ENQ.

**Example of BCC Checksum for Transmission (DSP command send)**

| | | | | | | BCC L | BCC H | | |
|---|---|---|---|---|---|---|---|---|---|
| Character | STX | D | S | P | ETX | A | E | CR | LF |
| Hexadecimal | 02H | 44H | 53H | 50H | 03H | 41H | 45H | 0DH | 0AH |
| | | [1] | [2] | [3] | [4] | | | | |

BCC L= Lower-order 4 bits among the lower-order 8 bits of the sum of the hexadecimal values numbered from [1] to [4]

44H+53H+50H+03H=E**A**H

BCC H= Higher-order 4 bits among the lower-order 8 bits of the sum of the hexadecimal values numbered from [1] to [4]

44H+53H+50H+03H=**E**AH

**Example of BCC Checksum for Reception (DSP command response)**

| | | | | | | | | | | | | BCC L | BCC H | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Character | STX | | | 5 | 0 | 0 | 0 | . | 0 | ETX | 6 | A | CR | LF |
| Hexadecimal | 02H | 20H | 20H | 20H | 35H | 30H | 30H | 30H | 2EH | 30H | 20H | 03H | 36H | 41H | 0DH | 0AH |
| | | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | | | | |

BCC L= Lower-order 4 bits among the lower-order 8 bits of the sum of the hexadecimal values numbered from [1] to [11]

20H+20H+20H+35H+30H+30H+30H+2EH+30H+20H+03H=1A**6**H

BCC H= Higher-order 4 bits among the lower-order 8 bits of the sum of the hexadecimal values numbered from [1] to [11]

20H+20H+20H+35H+30H+30H+30H+2EH+30H+20H+03H=1**A**6H

## Usable control and ASCII codes

| Higher / Lower | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 0 | NUL | DLE | SPACE | 0 | @ | P | ` | p |
| 1 | SOH | DC1 | ! | 1 | A | Q | a | q |
| 2 | STX | DC2 | " | 2 | B | R | b | r |
| 3 | ETX | DC3 | # | 3 | C | S | c | s |
| 4 | EOT | DC4 | $ | 4 | D | T | d | t |
| 5 | ENQ | NAK | % | 5 | E | U | e | u |
| 6 | ACK | SYN | & | 6 | F | V | f | w |
| 7 | BEL | ETB | ' | 7 | G | W | g | x |
| 8 | BS | CAN | ( | 8 | H | X | h | y |
| 9 | HT | EM | ) | 9 | I | Y | I | z |
| A | LF | SUB | * | : | J | Z | j | { |
| B | VT | ESC | + | ; | K | [ | k | } |
| C | FF | FS | , | < | L | ¥ | l | \| |
| D | CR | GS | − | = | M | ] | m | } |
| E | SO | RS | . | > | N | ^ | n | ~ |
| F | SI | US | / | ? | O | _ | o | DEL |

Note : No lower-case characters can be used for the RS-485 program.

| Control Code | Hexadecimal | Name | Description |
|---|---|---|---|
| STX | 02H | Start of Text | Marks the starting point of text. |
| ETX | 03H | End of Text | Marks the ending poing of text. |
| EOT | 04H | End of Transmission | Marks the end of transmission. |
| ENQ | 05H | Enquiry | Denotes an enquiry. |
| ACK | 06H | Acknowledge | Denotes an affirmative reply. |

## Communication Commands

It is possible to collect, set and change measured data by communicating with this transducer using the following commands.

### 1) Measured-data response

If It is necessary to read measured data of this transducer via RS-485 communication, use the 2 types of commands : DSP and MES

Use the DSP command when the digit position is not desired to be changed. Or, use the MES command when each digit is desired to be left-justified.

DSP

| Communication command | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| STX | D | S | P | ETX | A | E | CR | LF |

| Response data (Ex.) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| + | STX | | | | | 1 | 0 | 0 | . | 0 | | ETX | 2 | 9 | CR | LF |
| − | STX | | | − | | | | 5 | . | 0 | | ETX | 8 | 3 | CR | LF |
| + OVER | STX | < | = | | 1 | 5 | 0 | 0 | . | 0 | | ETX | 0 | E | CR | LF |
| − OVER | STX | < | = | − | | 9 | 0 | 0 | . | 0 | | ETX | 0 | E | CR | LF |

MES

| Communication command | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| STX | M | E | S | ETX | 8 | E | CR | LF |

| Response data (Ex.) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| + | | | | | 1 | 0 | 0 | . | 0 | | | | | ETX | 2 | D | CR | LF |
| − | | | | − | 5 | . | 0 | | | | | | | ETX | C | 3 | CR | LF |
| + OVER | STX | < | = | | 1 | 5 | 0 | 0 | . | 0 | | | | ETX | 0 | 2 | CR | LF |
| − OVER | STX | < | = | − | 9 | 0 | 0 | . | 0 | | | | | ETX | 0 | 2 | CR | LF |

### 2) Setting scaling data

It is possible to change the display, measured-data response and analog output to any values (-99999 to 99999) specified by the customer by the communication command.

◎ Set items

FIN : Fullscale input value

FSC : Scaling value at fullscale input value

OIN : Offset input value

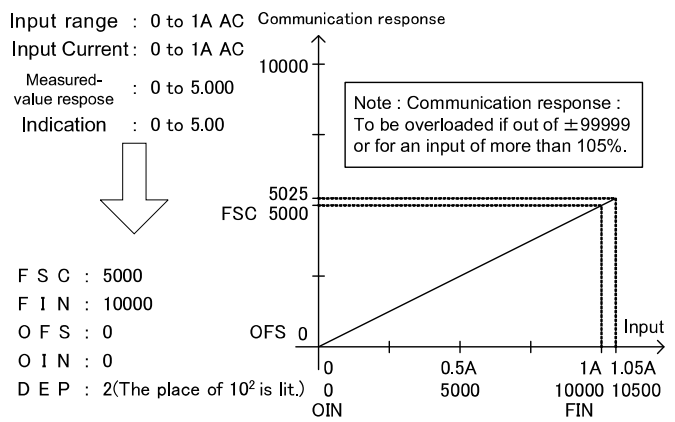
OFS : Scaling value at offset input value

AOHI : Fullscale analog output value corresponding to value after scaling

AOLO : Offset analog output value corresponding to value after scaling

DEP : Number from 0 to 4 to be set to decide the position of a decimal point

If set to 4, no decimal point is displayed. if set to 0, the decimal point is displayed to the right of the $10^0$ digit. If set to 1, the decimal point is displayed between the $10^1$ and $10^0$ digits. If set to 3, the decimal point is displayed between the $10^3$ and $10^2$ digits.



### Analog output

It is possible to output an analog signal corresponding to any input range specified by the customer by setting AOHI and AOLO to any values based on a measured-data response after scaling.

The analog output range corresponds to -5 to 105% of the range obtained by AOHI and AOLO. For any range out of the above range, a value of 5% (fixed) is output when below -5% and 105% (fixed) when above 105%, respectively.

For any range out of a measured-data response of ±99999 or any input value widely exceeding the input range, a value of 120% (fixed) is output.

◎ Command

The scaling set is changed by the three types (MET, N and R) of commands.

MET

The FSC value is displayed by changing the mode from the normal measurement mode to the scaling set mode.

| Send command | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| STX | M | E | T | ETX | 9 | E | CR | LF |

N

This command can be used only in the scaling set mode. Each set item is changed as in the following order every time the command is sent once to display it as shown in the following table.

FSC → FIN → OFS → OIN → AOHI → AOLO → FSC → To be repeated

| Send command | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| STX | N | ETX | 1 | 5 | CR | LF |

Note: When there is no analog output, do not change the AOHI and AOLO setpoints.

| Response (Ex.) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| STX | F | S | C | | | | | 9 | 0 | 0 | 0 | ETX | 8 | 2 | CR | LF |
| STX | F | I | N | | | | 1 | 0 | 0 | 0 | 0 | ETX | 1 | 3 | CR | LF |
| STX | O | F | S | | | - | 9 | 9 | 9 | 9 | 9 | ETX | 5 | 7 | CR | LF |
| STX | O | I | N | | | | | | | | 0 | ETX | 9 | F | CR | LF |
| STX | A | O | H | I | | | | 9 | 0 | 0 | 0 | ETX | D | 4 | CR | LF |
| STX | A | O | L | O | | | | | | | 0 | ETX | E | 1 | CR | LF |
| STX | D | E | P | | | 4 | ETX | 0 | 5 | CR | LF | | | | | |

### Changing the setpoint

Move to the set item which needs to be changed by the N command and then send the left-justified setpoint as shown in the following send commands (Example). As its response, the setpoint set in the same way as the above table is returned. Just when the response is returned, the setpoint becomes active.

| Send command (Ex.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| STX | 0 | ETX | 3 | 3 | CR | LF | | | | | |
| STX | - | 9 | 9 | 9 | 9 | 9 | ETX | D | 4 | CR | LF |

| Response when any value out of the set range is input. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| STX | E | R | R | O | R | | ETX | D | A | CR | LF |

R

This command terminates the scaling set mode to return to the normal measurement mode. In addition, the setpoint is written into the EEPROM.

| Send command | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| STX | R | ETX | 5 | 5 | CR | LF |

| Response | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| STX | Y | E | S | | | ETX | 4 | 3 | CR | LF |

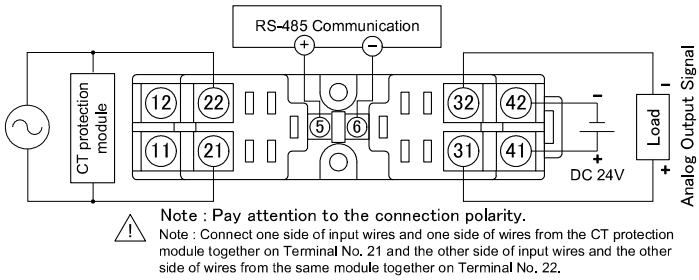
### Communication with sequencer

It becomes possible to send series TF-6 data to a sequencer which enables RS-232C communication without describing any program by using our TF-PC protocol converter. For details, see the brochure for "TF-PC."

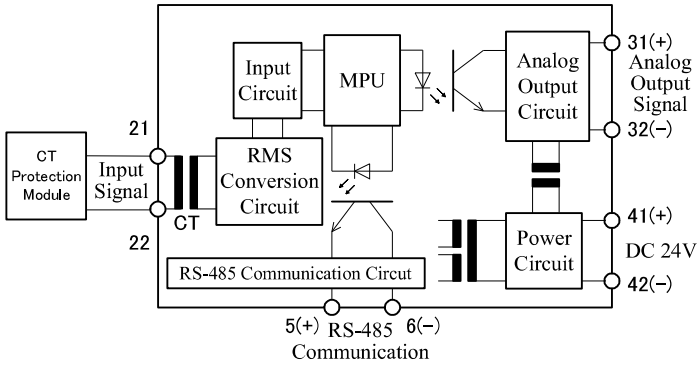
### Screw type terminal block

1. Screw size:M4 × 8
   M2.5 × 2 (RS-485 communication terminal)
2. Quality of material: Screw Iron, nickel plating
   Connection board Screw Iron, nickel plating

### Input/Output connection diagram




### Block diagram




### Accessories

RS-485 communication short bar × 2, CT protection module

### Caution

a) Store the transducer at a storage temperature of -10 to +70ºC and a humidity of less than 60 % RH.

b) Use the transducer at a location where there are no chemicals or gases harmful to electrical parts or there is no dust.

c) Do not apply any vibration or impact to the transducer.

d) In order to lessen the effect of noise, etc., do not bundle the input/output/communication wires with the power supply wires, nor put these wires in the same duct.

### Warranty

This transducer is warranted for a period of one year from date of delivery. Any defect which occurs in this period and is undoubtedly caused by Watanabe Electric Industry faults will be remedied free of charge. This warranty does not apply to the transducer showing abuse or damage which has been altered or repaired by others except as authorized by Watanabe Electric Industry.

### After-sale service

This transducer is delivered after being manufactured, tested and inspected, under strict quality control. However, if any problem does occur, contact your nearest Watanabe Electric Industry sales agent or Watanabe Electric Industry directly giving as much information on problem as possible.


watanabe

WATANABE ELECTRIC INDUSTRY CO., LTD.

6-16-19, Jingumae, Shibuya-ku, Tokyo 150-0001, Japan
Phone: (81)3-3400-6141
Homepage http://www.watanabe-electric.co.jp/en/