Thermocouple RS485 Isolated Transducer

MODEL TF-6C

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-6C isolates an thermocouple (R, K, E, J, T, S, B,N) 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-6C - K 2

TF-6C- □ □

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

Input code
- R : R   0 to 1700°C
- K : K -50 to 1200°C
- E : E -50 to 900°C
- J : J -50 to 1000°C
- T : T -50 to 350°C
- S : S   0 to 1700°C
- B : B 200 to 1700°C
- N : N -100 to 1200°C

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 50°C
Operating ambient humidity : Less than 90 %RH (No-condensing)
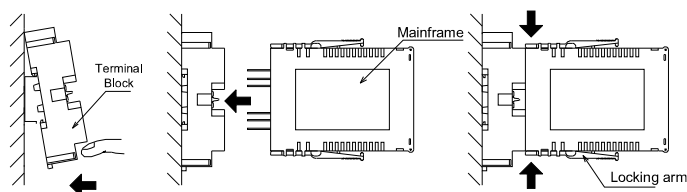Storage temperature : -10 to 70°C
Storage humidity : Less than 60%RH (No-condensing)
Case material : ABS (Black)
Weight : Approx. 180 g

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.
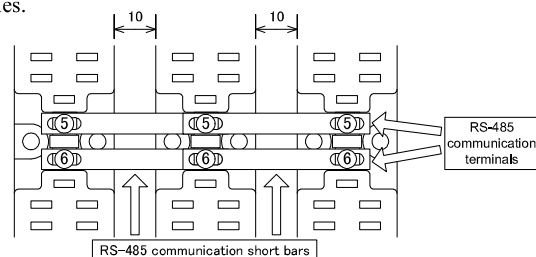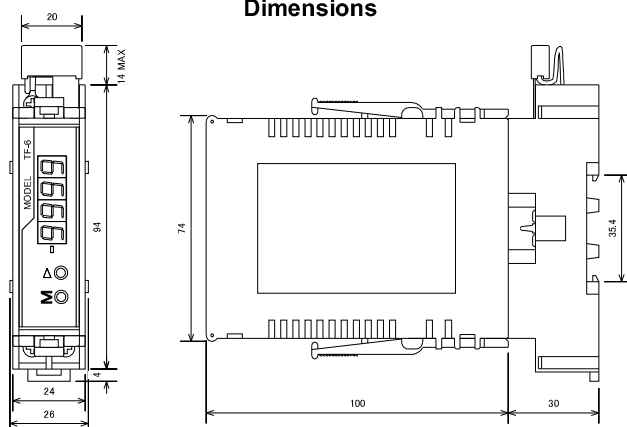

Dismounting

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

WATANABE ELECTRIC INDUSTRY CO., LTD.
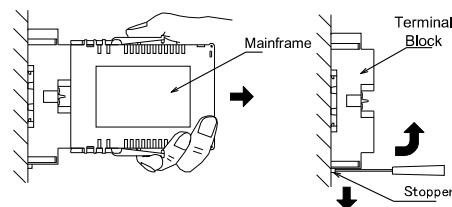
Input Specification

Code No.	Sensor	Input (℃)	Input resistance	Input allowable range	Analog output minimum span (℃)
R	R	0 to 1700	More than 1MΩ	± 2V	400
K	K	-50 to 1200			100
E	E	-50 to 900			100
J	J	-50 to 1000			100
T	T	-50 to 350			100
S	S	0 to 1700			500
B	B	200 to 1700			1000
N	N	-100 to 1200			200

Acuracy of cold junction compensation : ±1℃ (10 to 30℃)

(For thermocouples other than B type thermocouple)

Burnout detection current : 300nA (TYP)

Code No.	Indication	Communication	Acuracy	Temp. characteristic
R	0 to 1700	0. 0 to 1700. 0	±(0.05%F.S+1digit)	±0.01%F.S/℃
K	-50 to 1200	-50. 0 to 1200. 0		
E	-50 to 900	-50. 0 to 900. 0		
J	-50 to 1000	-50. 0 to 1000. 0		
S	0 to 1700	0. 0 to 1700. 0		
T	-50 to 350	-50. 0 to 350. 0	±(0.1%F.S+1digit)	
B	200 to 1700	200. 0 to 1700. 0		
N	-100 to 1200	-100. 0 to 1200. 0	±(0.05%F.S+1digit)	

Sampling rate: Approx. 6 times / second

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 25℃±2℃)

Power supply voltage variation : ±0.06%F.S

Load regulation : ±0.06%F.S

Temperature characteristic: ±0.015%F.S/℃

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.

| c r | R type | c H | K type | c E | E type | c J | J type |
| c t | T type | c S | S type | c b | B type | c n | N type |

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.
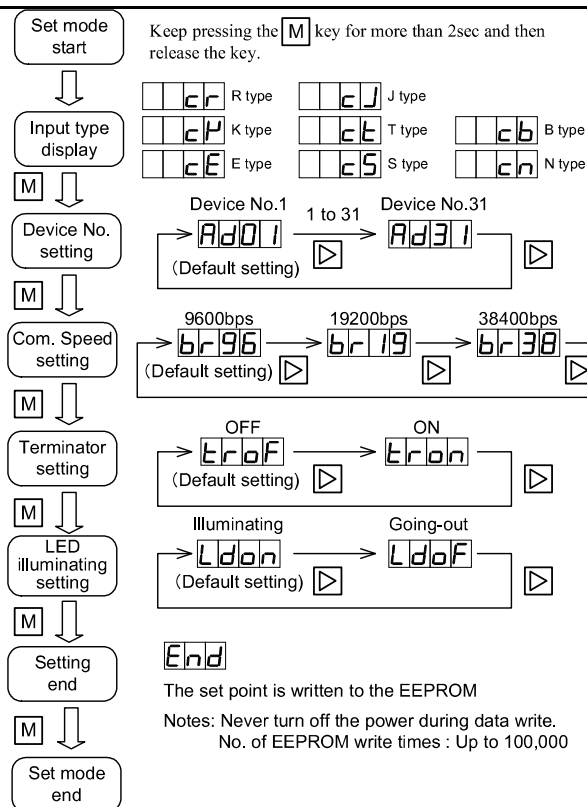
Communication speed

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.

Keep pressing the [M] key for more than 2sec and then release the key.

c r	R type	c J	J type
c H	K type	c t	T type	c b	B type
c E	E type	c S	S type	c n	N type

Device No.1 (Default setting) Ad01 — 1 to 31 — Device No.31 Ad31

Com. Speed setting: 9600bps br96 (Default setting) — 19200bps br19 — 38400bps br38

Terminator setting: OFF troF (Default setting) — ON tron

LED illuminating setting: Illuminating Ldon (Default setting) — Going-out LdoF

Setting end: End

The set point is written to the EEPROM

Notes: Never turn off the power during data write.
No. of EEPROM write times : Up to 100,000

Display specification

Communication output values whoes digits after one decimal place are rounded off are displayed (in steps of 1℃).

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

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

Over-range alarm : [- o.L.] Approx. less than -5%,
Less than operating ambient temperature

[o.L.] Approx. more than 105%, Burnout, more than operating ambient temperature

Zero indication : Leading zero suppression

Decimal point : Decimal point fixation

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

Note: If these lines are likely to be affected by noise or the like, use shielded wire.

Terminator OFF Device ID No. 1   Terminator OFF Device ID No. 2   **Terminator ON** Device ID No. 3

Note : If the line length becomes very long, use twisted pair cables.
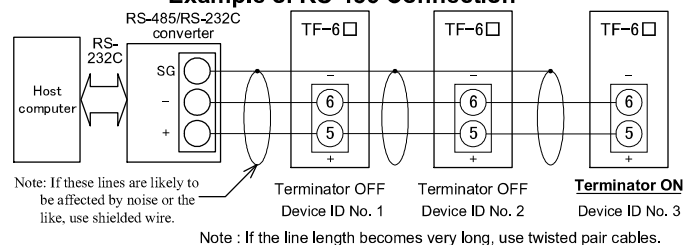
Procedure for RS-485 communication

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)

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)

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	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 the analog output range

When our transducer with analog output is purchased, its analog output range can be set in steps of 1ºC by using the RS-485 communication command.

Note: Do not set any range out of the input range and minimum span.
If so, this is not in our guaranteed operating range. In addition, no reverse output is available.

Analog output zero temp. setting (0℃)

Send command (Ex.)										
1	2	3	4	5	6	7	8	9	10	11
STX	Z	T	P		0	ETX	1	5	CR	LF

There is no response to this command from this transducer.

Analog output span temp. setting (1000℃)

Send command (Ex.)													
1	2	3	4	5	6	7	8	9	10	11	12	13	14
STX	S	T	P		1	0	0	0	ETX	B	D	CR	LF

There is no response to this command from this transducer.

Setpoint write

Send command (EX.)								
1	2	3	4	5	6	7	8	9
STX	S	A	V	ETX	D	E	CR	LF

Response								
1	2	3	4	5	6	7	8	9
STX	Y	E	S	ETX	4	F	CR	LF

Note: If the power is turned off without writing data, the contents changed may be destroyed.

Analog output range : -5 to 105% of range obtained from ZTP and STP

For any analog output ranges other than the above :
-5% (fixed) for a range of less than -5%
105% (fixed) for a range of more than 105%

For input out of -5% to 105% of input range described in the Input code:
An output of 120% (fixed)

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."
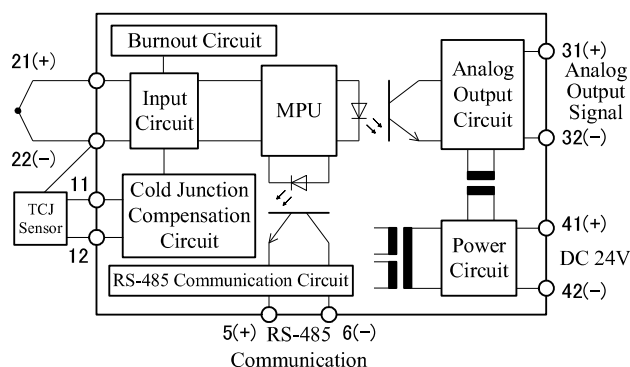
Screw type terminal block

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

Note : Pay attention to the connection polarity.
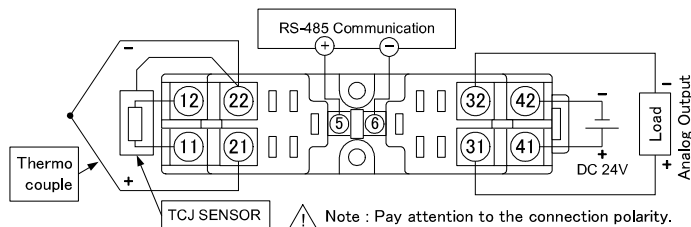
Block diagram

Accessories

RS-485 communication short bar × 2, TCJ sensor

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.