

## 21 TI4 (TEMPERATURE INPUT UNIT)

### TI4W3 D201159

### TI4W4 D201171

### 21.1 USE

The TI4 units are four-channel temperature measurement units suited for the PT100 sensor.

The TI4W3 unit is used in 3-wire measurements and the TI4W4 unit in 4-wire measurements. The TI4W3 unit internally corrects the error generated in the 3-wire connection due to the resistance of the measurement wires. The error correction is based on the assumption that all three measurement wires are identical. A formula for compensating for the error resulting from measurement wire resistance difference is presented in chapter 21.3.1 "TI4W3". The TI4W4 unit automatically compensates for measurement wire tolerance. In 4-wire measurement the measurement wire resistance does not influence to the measurement result.

The TI4W3 and TI4W4 temperature input units carry out an accurate linearization in their measuring range of  $-70\text{ }^{\circ}\text{C} \dots +430\text{ }^{\circ}\text{C}$ . The actual rated measurement range is  $-50\text{ }^{\circ}\text{C} \dots +400\text{ }^{\circ}\text{C}$ . The range above and below the rated range is used for monitoring the fault that results from going above or below the measuring range.



## 21.2 TECHNICAL SPECIFICATIONS

### 21.2.1 Structure

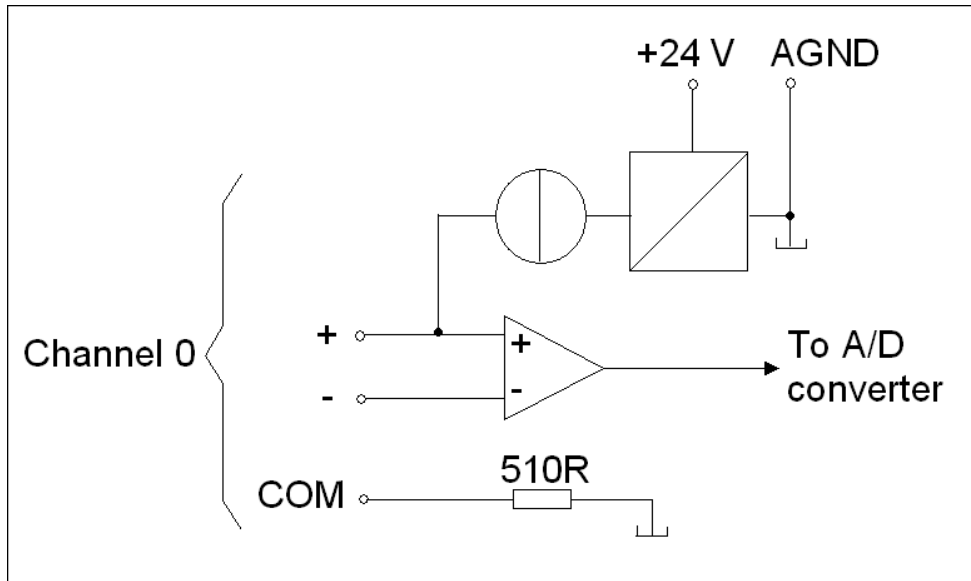
- the size of the casing: 95 mm x 24 mm x 95 mm [H x W x D]
- weight: 90 g

### 21.2.2 Field interfaces

Inputs	TI4W3 D201159	TI4W4 D201171
Number of channels	4	
Measurement method	3-wire	4-wire
Wire asymmetry compensated	Yes	No
Linearization	PT100, IEC 60751	
Rated measuring range	-50 °C...400 °C (80.31 Ω...247.09 Ω)	
Total measuring range	-70 °C...430 °C (72.33 Ω...257.38 Ω)	
Measuring range low alarm limit	n. -57 °C (77.48 Ω)	
Measuring range high alarm limit	n. +408 °C (249.92 Ω)	
Break fault limit	ca. > 1 kΩ	
Short-circuit fault limit	ca. < 77.4 Ω	
Accuracy relative to the measuring range	0.02 % @ 25 °C + 0.02 %/10 °C	
Measuring current (revision 05 or earlier)	5 mA	
Measuring current (revision 06 or later)	1 mA	
Circuit maximum resistance	500 Ω	
Input resistance	≥ 5 MΩ	
AD resolution	16 bit, LSB = 0.015 °C	
Filtering	-3 dB, 1 Hz (2nd order)	
CMRR	76 dB, max. 3.4 V	
NMRR	70 dB, f ≥ 50 Hz	
Parameterizable filtering by software	35 ms...81 s	
Measuring interval	4.4 ms	
Field circuit current supply	Operation voltage	

## 21.3 INPUT CIRCUIT

### 21.3.1 TI4W3



The flat cable connectors on the MB2 and MB8 mounting bases are connected according to the following table:

C = COM, CH = channel

CH	0	0	1	1	2	2	3	3
Pin	2	4	6	8	10	12	14	16
		-		-		-		-
Pin	1	3	5	7	9	11	13	15
	+	C	+	C	+	C	+	C

The connecting order for the cable connector signals of CXS, CXW and CXR cross connection boards is as follows:

CH	3	3	3	3	2	2	2	2	1	1	1	1	0	0	0	0
TI4W3	-	C		+	-	C		+	-	C		+	-	C		+
CXx	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

There are two versions of the connection units for the MB2 and MB8 mounting bases. With the FCx units, FCS S446105 and FCR S446106, the connection order is as listed in the table below:

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
13	Ch3 +	14	Ch3 NC	15	Ch3 COM	16	Ch3 -
9	Ch2 +	10	Ch2 NC	11	Ch2 COM	12	Ch2 -
5	Ch1 +	6	Ch1 NC	7	Ch1 COM	8	Ch1 -
1	Ch0 +	2	Ch0 NC	3	Ch0 COM	4	Ch0 -

NC = not connected

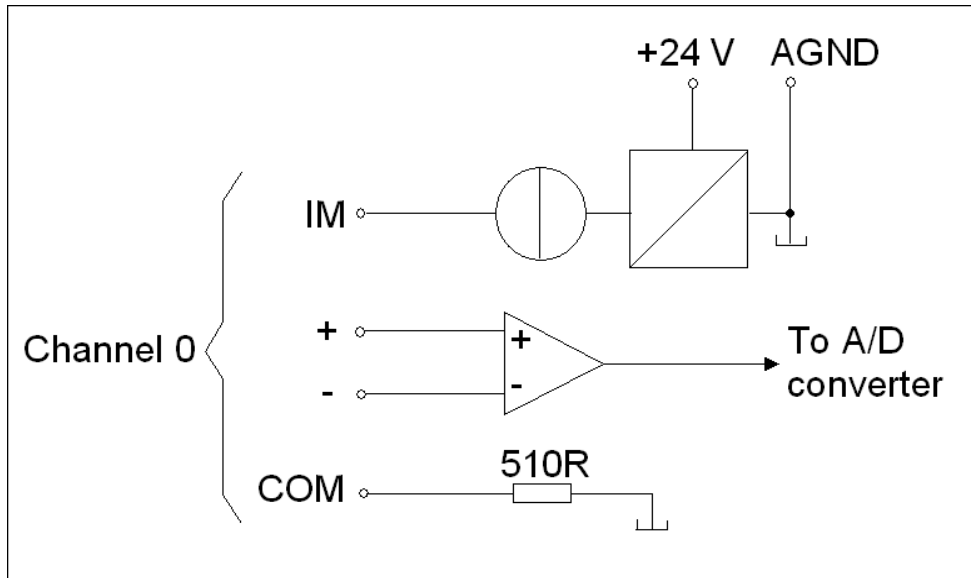
**NOTE!**

If there is a difference in the resistance of the + and COM measurement wires in the field cable, the extent of the resulting error in centigrade ( $^{\circ}\text{C}$ ) can be calculated using the formula:

$$(R_{COM} - R_{+}) * 2.64 = Error[^{\circ}\text{C}].$$

In the formula,  $R_{+}$  stands for the resistance of the + wire in the field cable and  $R_{COM}$  for the resistance of the COM wire. The error, including the sign, is added to the measured result to achieve the corrected measurement result.

21.3.2 TI4W4



The flat cable connectors on the MB2 and MB8 mounting bases are connected according to the following table:

C = COM, CH = channel

CH	0	0	1	1	2	2	3	3
Pin	2	4	6	8	10	12	14	16
	IM	-	IM	-	IM	-	IM	-
Pin	1	3	5	7	9	11	13	15
	+	C	+	C	+	C	+	C

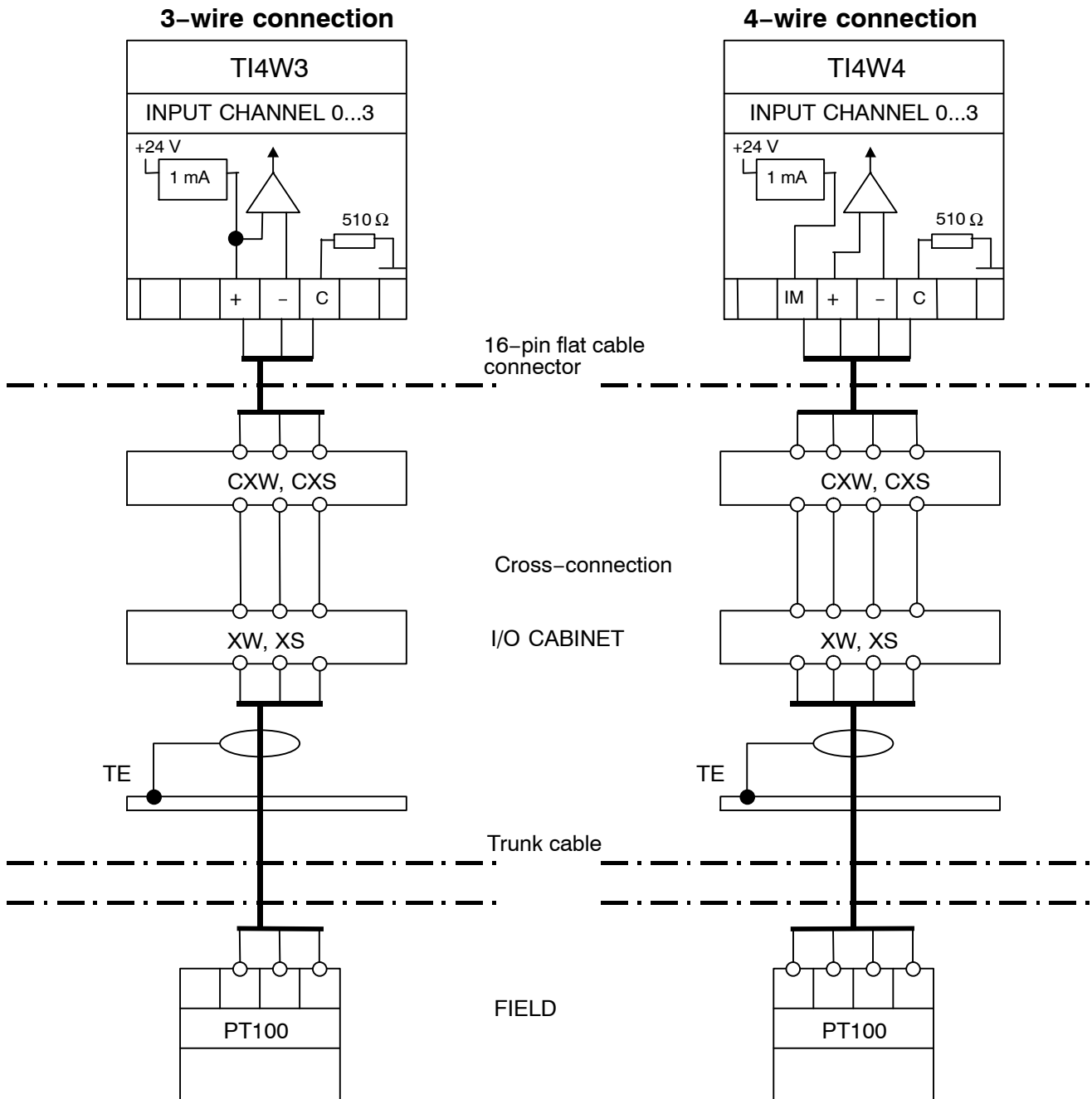
The connecting order for the cable connector signals of CXS, CXW and CXR cross connection boards is as follows:

CH	3	3	3	3	2	2	2	2	1	1	1	1	0	0	0	0
TI4W4	-	C	IM	+	-	C	IM	+	-	C	IM	+	-	C	IM	+
CXx	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

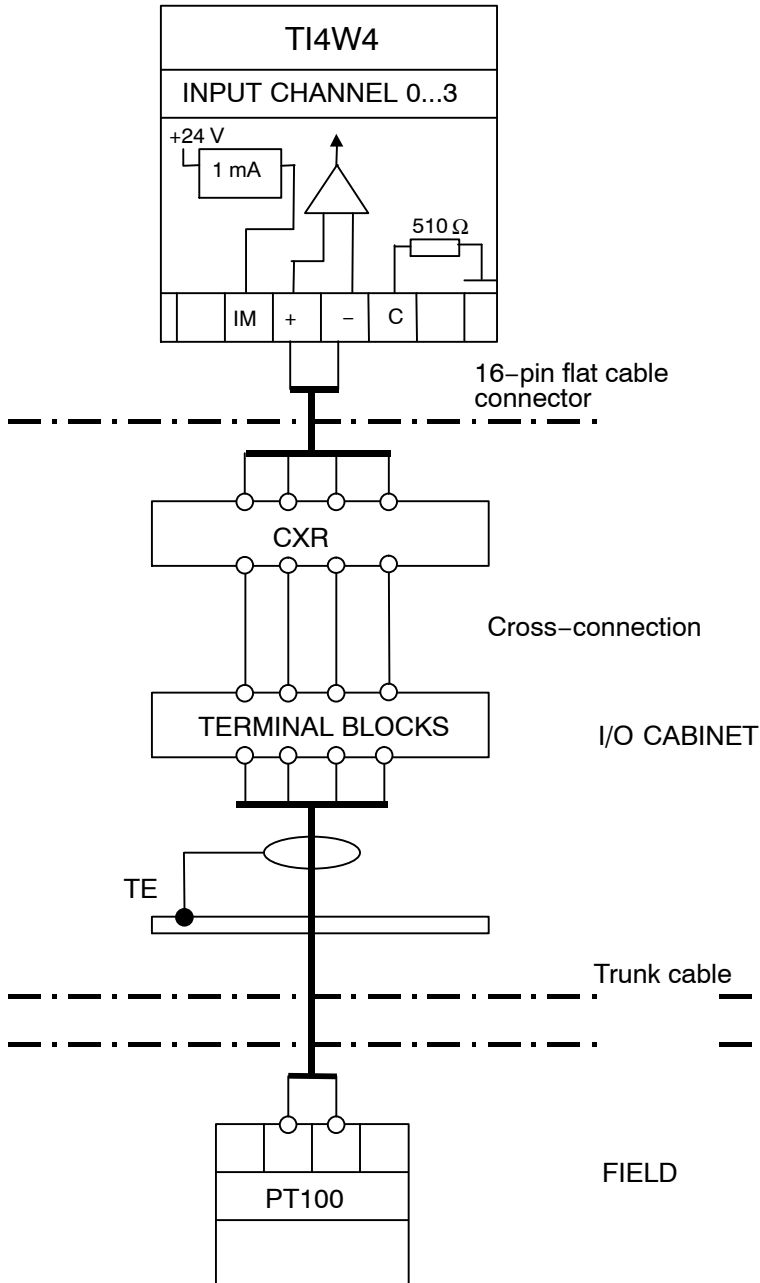
There are two versions of the connection units for the MB2 and MB8 mounting bases. With the FCx units, FCS S446105 and FCR S446106, the connection order is as listed in the table below:

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
13	Ch3 +	14	Ch3 IM	15	Ch3 COM	16	Ch3 -
9	Ch2 +	10	Ch2 IM	11	Ch2 COM	12	Ch2 -
5	Ch1 +	6	Ch1 IM	7	Ch1 COM	8	Ch1 -
1	Ch0 +	2	Ch0 IM	3	Ch0 COM	4	Ch0 -

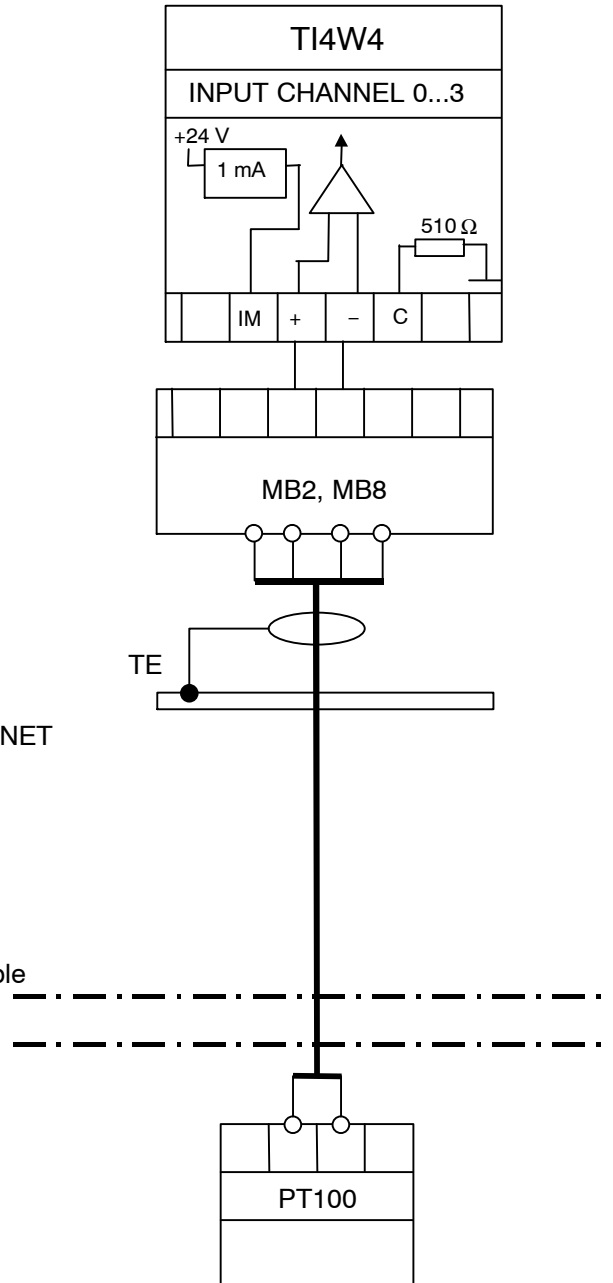
### 21.3.3 Example connections



**Terminal block cross-connection**



**Without cross-connection**



## 21.4 SIGNAL LIGHTS

There are four red and four yellow signal lights on the unit, marked 0...3.

If one of the signal lights OF0...OF3 (yellow) is continuously lit, the low or high alarm limit of the channel's measurement range has been exceeded. If one of the signal lights LO0...LO3 (red) is continuously lit, there is a break in the field circuit. A break fault can be detected in a TI4W3 unit only from a break in wires + or C and in a TI4W4 unit only from a IM or C wire break. Only a below or an above measuring range fault is caused with delay from a Sense line break.

The operation of the signal light OF can be affected using the configuration parameter "Line fault control" (lfcntrl).



## 21.5 FAULT BITS

When a resistance sensor supply circuit is broken, the newest measurement read from the I/O unit is not approved, the measurement freezes and fault bits 'EXT' and 'OLD' are added to it.

In a situation when a measurement value is above or below the channel nominal measurement range, measurement processing and the operation of the 'EXT' and 'OLD' fault bits can be controlled by using the "Behavior if "EXT" is on" (extcntrl) and "Line fault control" (lfcntrl) parameters.

In fault situations in which the process control server is not able to read a new measurement from the I/O unit, the default action is that the measurement freezes and the fault bit 'OLD' is added to it. Measurement processing and the operation of the 'OLD' fault bit can be controlled by using the "Input fault control" (infcntrl) parameter of the configuration symbol.



## 21.6 CONFIGURATION

### 21.6.1 Symbols

The symbols can be added in the I/O – MIO M80 menu of the FbCAD tool.

MIO	M80	TI4
pr:TAG_CODE.I		
Address	2 : 0 : 0 : 0	
Measurement		:m <span style="color: green;">■</span>
Scale and unit	-50 - 400 C	

The parameters and default values of the symbol:

Prompt	Value
Input module name	pr:TAG_CODE.I
Card type	TI4
IO cabinet	
FBC slot (2-15)	2
IBC number (0-15)	0
Card place (0-15)	0
Channel number (0-3)	0
Minimum	&mi
Maximum	&ma
Channel measurement mode	0
Filter	7
Additional parameter	""
Input fault control	0
Line fault control	0
Measurement update method	4
Scale and unit	-50 - 400 C
Comment text	
-- Simulation parameters --	
Simulation Group	DefSimGroup
Enable simulation	1
Location	
Document link 1	
Document link 2	
Document link 3	
Document link 4	
Document link 5	
IO-mapping	
Device tag [*]	
Related Tags [*]	
Cycle time for func.gen. [*]	60
Number of decimals [*]	2
Interface type [*]	
Additional info	
Comment	

Show Formulas    Function formula:     Typehelp    ti4

OK    Cancel

### 21.6.2 Parameters connected to run-time operation

#### Input module name

I/O function identifier.

### **Card type**

I/O unit's exact type.

### **IO cabinet**

The identifier of the I/O cabinet where the I/O unit is located.

### **FBC slot (2–15)**

FBC slot number.

### **IBC number (0–15)**

IBC Bus Controller number.

### **Card place (0–15)**

I/O unit's place in I/O group.

### **Channel number (0–3)**

I/O channel number.

### **Minimum (min)**

The unit has a fixed measurement range. Value can only be -50 or &mi.

&mi string means that the value is read from the "Scale and unit" parameter's low limit value.

### **Maximum (max)**

The unit has a fixed measurement range. Value can only be 400 or &ma.

&ma string means that the value is read from the "Scale and unit" parameter's high limit value.

### **Channel measurement mode (mode)**

The channel measurement mode is determined as follows:

0 = PT100 measurement

1 = linear measurement

### **Behavior if "EXT" is on (extcntrl)**

Behavior of measurement if line fault "EXT" is on:

0 = no freezing of measurement

1 = measurement will be frozen at the last known good value

**Filter (filt)**

Software filtering on analog input channel of the I/O (-20 dB/decade); -3 dB cut-off frequency, encoded as follows:

0 = 2.1 Hz (7 ms)	7 = 0.064 Hz (2.5 s)
1 = 2.1 Hz (7 ms)	8 = 0.031 Hz (5.2 s)
2 = 2.1 Hz (7 ms)	9 = 0.016 Hz (10 s)
3 = 1.0 Hz (160 ms)	10 = 0.0078 Hz (21 s)
4 = 0.5 Hz (320 ms)	11 = 0.0039 Hz (41 s)
5 = 0.25 Hz (630 ms)	12 = 0.0020 Hz (81 s)
6 = 0.12 Hz (1.3 s)	

**Additional parameter (a\_param)****Input fault control (infctrl)**

This parameter specifies the measurement value, which is returned to PCS, when there is no connection to IBC or to I/O unit. This parameter is used when the user wants to control the measurement value in the case of power supply failure, when I/O has no backup power supply.

The parameter determines the value returned to process control station and the unnecessary alarms generated by the fault bits can be avoided. The parameter has no effect on the OVF fault bit.

Input fault control parameter is encoded as follows:

- 0 Measurement freezes and OLD fault bit is set.
- 1 If connection to IBC but not to I/O unit, both the measurement value and the fault bits remain as they are. If no connection to IBC, measurement freezes and OLD fault bit is set.
- 2 If connection to IBC but not to I/O unit, measurement value is set to 0%, no change to fault bits. If no connection to IBC, measurement freezes and OLD fault bit is set.
- 3 If connection to IBC but not to I/O unit, measurement value is set to 0%, OLD fault bit is set. If no connection to IBC, measurement freezes and OLD fault bit is set.
- 4 If connection to IBC but not to I/O unit, measurement value is set to 100%, no change to fault bits. If no connection to IBC, measurement freezes and OLD fault bit is set.
- 5 If connection to IBC but not to I/O unit, measurement value is set to 100%, OLD fault bit is set. If no connection to IBC, measurement freezes and OLD fault bit is set.
- 6 If no connection to I/O unit, both the measurement value and the fault bits remain as they are
- 7 If no connection to I/O unit, measurement value is set to 0%, no change to fault bits.
- 8 If no connection to I/O unit, measurement value is set to 0%, OLD fault bit is set.
- 9 If no connection to I/O unit, measurement value is set to 100%, no change to fault bits.
- 10 If no connection to I/O unit, measurement value is set to 100%, OLD fault bit is set.

### Line fault control (lfctrl)

Line fault control on analog input channel of the I/O:

- |    |  |
|----|--|
| 0  | Measurement freezes, EXT and OLD fault bits are set, diagnostic alarm is generated, channel's signal light is lit.         |
| 1  | Measurement freezes, EXT and OLD fault bits are set, diagnostic alarm is not generated, channel's signal light is not lit. |
| 2  | Measurement, EXT fault bit is set, diagnostic alarm is generated, channel's signal light is lit.                           |
| 3  | Measurement, EXT fault bit is set, diagnostic alarm is not generated, channel's signal light is not lit.                   |
| 4  | Measurement, EXT fault bit is not set, diagnostic alarm is generated, channel's signal light is lit.                       |
| 5  | Measurement, EXT fault bit is not set, diagnostic alarm is not generated, channel's signal light is not lit.               |
| 6  | Minimum, EXT fault bit is set, diagnostic alarm is generated, channel's signal light is lit.                               |
| 7  | Minimum, EXT fault bit is set, diagnostic alarm is not generated, channel's signal light is not lit.                       |
| 8  | Minimum, EXT fault bit is not set, diagnostic alarm is generated, channel's signal light is lit.                           |
| 9  | Minimum, EXT fault bit is not set, diagnostic alarm is not generated, channel's signal light is not lit.                   |
| 10 | Maximum, EXT fault bit is set, diagnostic alarm is generated, channel's signal light is lit.                               |
| 11 | Maximum, EXT fault bit is set, diagnostic alarm is not generated, channel's signal light is not lit.                       |
| 12 | Maximum, EXT fault bit is not set, diagnostic alarm is generated, channel's signal light is lit.                           |
| 13 | Maximum, EXT fault bit is not set, diagnostic alarm is not generated, channel's signal light is not lit.                   |

**NOTE!**

In case of current supply overload (>50 mA) the "Line fault control" (lfctrl) parameter value has no effect. Operation is the same as when the "Line fault control" (lfctrl) value is 0.

**NOTE!**

The function of the parameter "Behavior if "EXT" is on" (extctrl) (parameter of IO unit) is independent of the function of the parameter "Line fault control" (lfctrl) (parameter of FBC).

### Measurement update method (upd)

The update method parameter is used to optimize bus transfers to enable fast measurements ( $\leq 20$  ms control cycles).

0 = every cycle

1 = every 20 ms

2 = every 50 ms

3 = every 100 ms

4 = optimized to control task (CT) speed

If  $CT < 200$  ms  $\rightarrow$  upd = 0

If  $CT \geq 200$  ms  $\rightarrow$  upd = 1

If  $CT \geq 500$  ms  $\rightarrow$  upd = 2

If  $CT \geq 1000$  ms  $\rightarrow$  upd = 3

If upd > 0, values from different channels may come from different time points.

### Scale and unit

The signal is scaled to these values.

The unit has a fixed measurement range. Value can only be  $-50 - 400$  C

### Comment text

#### 21.6.3 Example connection



#### 21.7 EC DECLARATION OF CONFORMITY

EC Declaration of Conformity is described in section "EC Declarations of Conformity".

