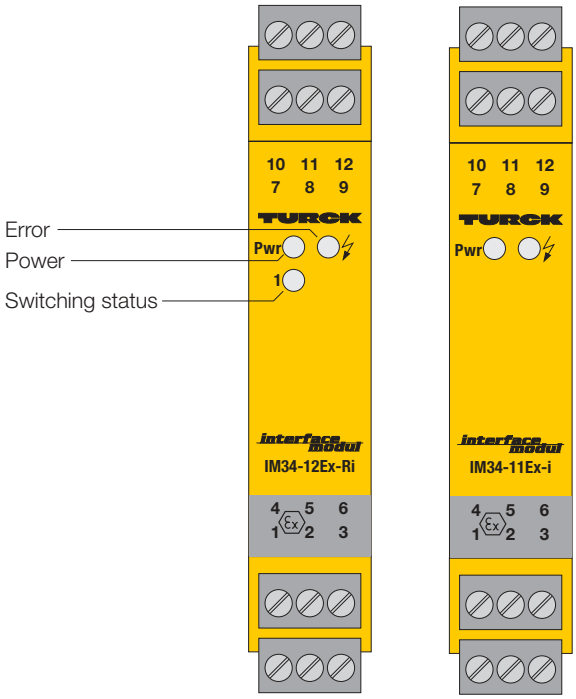



# Temperature Measuring Amplifier IM34-11Ex-i IM34-12Ex-Ri 1-channel

3

- **1-channel temperature measuring amplifier with removable terminal blocks**
- **Intrinsically safe input circuit EEx ia with wire-break monitoring function**
- **Area of application according to ATEX: II (1) GD**
- **Input for Ni100/Pt100 resistance temperature detectors, thermoelements and millivolt signals**
- **Lower and upper measuring range value adjustable via coded rotary switches**
- **Current output 0/4…20 mA**
- **Limit value relay (IM34-12Ex-Ri only)**
- **Complete galvanic isolation**
- **Adjustable analogue output performance in case of errors in the input circuit**
- **Universal supply voltage (20...250 VAC/20...125 VDC)**

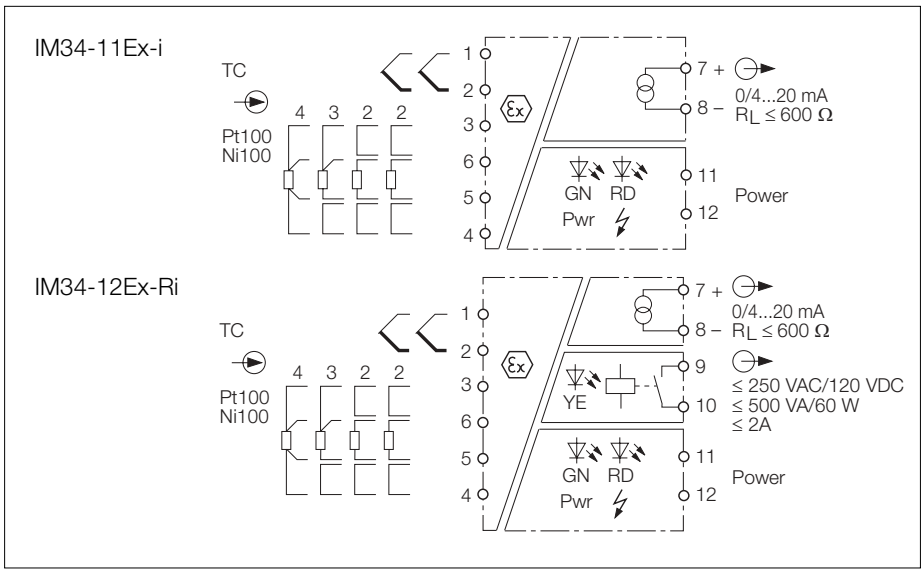
The single-channel temperature measuring amplifier IM34-1.Ex-... is designed to evaluate the temperature-dependent variations of Ni100/Pt100 resistance temperature detectors, thermoelement types B, E, J, K, L, N, R, S and T or low voltages in a range of -160...+160 mV and to reproduce these values as temperature-linear current signals of 0/4…20 mA. The IM34-12Ex-Ri is equipped with an additional relay output to monitor a limit value for under- and overrrange conditions.
The input circuit of the measuring amplifier is also suited for connection of 2, 3 or 4-wire Ni100/Pt100 resistors. The Ni100/Pt100 input may be used for external cold junction compensation for the thermoelements (2-wire types) or as an independent measuring input.

The measuring range and the device functions are set via coded rotary switches or slide switches (on the right side of the device).

Version IM34-12Ex-Ri enables adjustment of a limt value via the coded rotary switch.

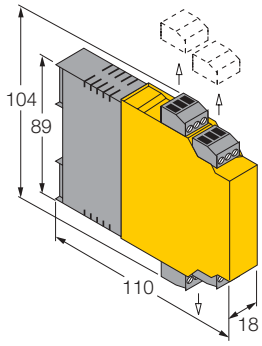
The following parameters may be set:
- type of measuring device
- connection of the Ni100/Pt100 resistance temperature detector in 2, 3 and 4-wire technology
- lower measuring range value -100...- 1°C in increments of 1 K 0...990 °C in increments of 10 K
- upper measuring range value 0...1990 °C in increments of 10 K
- limit value (IM34-12Ex-Ri only)
- input circuit monitoring for wire-break
- current output performance in case of errors in the input circuit: 0 or > 22 mA
- internal or external cold junction compensation

The signals are transformed according to ITS90 IEC 584 for thermoelements and IEC 751 for PT100 RTDs and provided as temperature-linear signals at the current output.



# Temperature Measuring Amplifier IM34-11Ex-i/IM34-12Ex-Ri

| **Type** | IM34-11Ex-i | IM34-12Ex-Ri |
|---|---|---|
| Ident.-no. | 7506630 | 7506631 |
| **Supply voltage** $U_B$ | 20...250 VAC/20...125 VDC | |
| Line frequency (AC) | 40...70 Hz | |
| Power consumption | ≤ 3 W | |
| Galvanic isolation | between input and output circuit and supply voltage for 250 $V_{rms}$, test voltage 2.5 $kV_{rms}$ | |
| **Input circuit** | intrinsically safe according to EN 50020<br>version Ni100 and Pt100 (IEC 751), 2, 3 and 4-wire technology<br>measuring range -200...800 K (Pt100), -60...250 K (Ni100)<br>thermoelements B, E, J, K, N, R, S, T (ITS 90/IEC 584), L (DIN 43710)<br>extra-low voltages with a measuring span of -160 mV...+160 mV | |
| Resistor current Pt100/Ni100 | approx. 200 µA | |
| **Output circuits** | | |
| Current output | 0/4…20 mA (load ≤ 600 Ω) | 0/4…20 mA (load ≤ 600 Ω) |
| Relay output | – | 1 normally open contact |
| – Switching voltage | – | ≤ 250 VAC/120 VDC |
| – Switching current | – | ≤ 2 A |
| – Switching capacity | – | ≤ 500 VA/60 W |
| – Switching frequency | – | ≤ 10 Hz |
| – Switching hysteresis | – | ≤ 5 K |
| – Contact materials: | – | Ag alloy + 3 µm Au |
| **Ex-approvals acc. to certificate of conformity** | TÜV 02 ATEX 1898 | TÜV 02 ATEX 1898 |
| Input circuit | | |
| – Max. values | | |
| No-load voltage $U_0$ | 5 V | 5 V |
| Short-circuit current $I_0$ | 2 mA | 2 mA |
| Power $P_0$ | 2.6 mW | 2.6 mW |
| Internal inductances/capacitances $L_i/C_i$ | 0.2 mH/– | 0.2 mH/– |
| Max. external inductances/capacitances $L_0/C_0$ | | |
| – [EEx ia] IIC | 1000 mH/100 µF | 1000 mH/100 µF |
| – [EEx ia] IIB | 1000 mH/1000 µF | 1000 mH/1000 µF |
| Marking of the Device | II (1) GD [EEx ia] IIC | II (1) GD [EEx ia] IIC |
| **Transfer characteristics** | | |
| Accuracy | see page 3 – 39 | |
| Total error | see from pages 3 – 40 on | |
| Rise time (10 %…90 %) | < 1 s | |
| Release time (90 %…10 %) | < 1 s | |
| Response time | < 1 s | |
| **LED indications** | | |
| – Power | green | green |
| – Error | red | red |
| – Switching status | – | yellow |
| **Housing** | 12 poles, 18 mm wide, Polycarbonatet/ABS, flammability class V-0 per UL94 | |
| Mounting | snap-on hat rail (DIN 50022)<br>or panel screw mounting | |
| Connection | removable terminal blocks, polarity protected<br>screw connection, self-lifting | |
| Connection profile | ≤ 1 x 2.5 mm², 2 x 1.5 mm² or 2 x 1.0 mm²<br>with wire sleeves | |
| Degree of protection (IEC 60529/EN 60529) | IP20 | |
| Operating temperature | -25…+70 °C | |



# Accuracy Ratings

### Accuracy – extra-low voltage input

Basic accuracy:
$\alpha$ = 10 µV =>
31.25 ppm of measuring span/K (320 mV)

Temperature coefficient:
$\beta$ = 1 µV/K =>
3.13 ppm of measuring span (320 mV)

Long-term stability
$\chi$ = 1 µV/p. a. =>
3.13 ppm of measuring span (320 mV)

$\Delta_{mV} = \pm (\alpha + \beta \cdot |T_U - 25\ °C| + \chi \cdot age)$

**For example:** Assumption: $T_U$ = 50 °C, age = 5 years

$\Delta_{mV} = \pm (10\ \mu V + 1\ \mu V/K \cdot |50\ °C - 25\ °C| + 1\ \mu V/years \cdot 5\ years = \pm 40\ \mu V$

### Accuracy – RTD input

Basic accuracy:
$\alpha$ = 50 mΩ =>
25 ppm of measuring span (2000 Ω)

Temperature coefficient:
$\beta$ = 0.75 mΩ/K
0.38 ppm of measuring span (2000 Ω)

Long-term stability
=> $\chi$ = 1 mΩ/p. a. =>
0.5 ppm of measuring span (2000 Ω)

$\Delta_{RTD} = \pm (\alpha + \beta \cdot |T_U - 25\ °C| + \chi \cdot age)$

**For example:** Assumption: $T_U$ = 35 °C, age = 1 year

$\Delta_{RTD} = \pm (50\ m\Omega + 0{,}75\ m\Omega/K \cdot |35\ °C - 25\ °C| + 1\ m\Omega/year \cdot 1\ year = \pm 58.5\ m\Omega$

### Accuracy – thermoelement input with internal cold junction compensation

$\Delta_{KSI} = \pm\ 1.5\ K$

### Accuracy – current output

Basic accuracy:
$\alpha$ = 5 µA =>
250 ppm of measuring span (20 mA)

Temperature coefficient:
$\beta$ = 0.5 µA/K =>
25 ppm of final value (20 mA)

Long-term stability
$\chi$ = 1 µA/p. a. =>
50 ppm of final value (20 mA)

$\Delta_I = \pm (\alpha + \beta \cdot |T_U - 25\ °C| + \chi \cdot age)$

**For example:** Assumption: $T_U$ = 25 °C, age = 1 year

$\Delta_I = \pm (5\ \mu A + 0.5\ \mu A/K \cdot |25\ °C - 25\ °C| + 1\ \mu A/year \cdot 1\ year = \pm 6\ \mu A$

# Temperature measuring amplifier IM34-11-Ex-i/IM34-12-Ex-Ri

## Total Error – Extra-low Voltage Input and RTD Input

**Total error – extra-low voltage input**

Output: 0...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{20\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{mV}| \right)$$

Output: 4...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{16\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{mV}| \right)$$

**For example:** Assumption: $T_U$ = 40 °C, age = 2 years, output: 4...20 mA, MBA = 0 mV, MBE = 100 mV

1) Accuracy calculation - extra-low voltage input (s. page 3 – 39) => $\Delta_{mV}$ = ± 27 µV

2) Accuracy calculation - current output (s. page 3 – 39) => $\Delta_I$ = ± 14.5 µA

3) Total error calculation - extra-low voltage input

$$\Delta_G = \pm \left( \frac{|14.5\ \mu\text{A}|}{\frac{16\ \text{mA}}{|0 - 100\ \text{mV}|}} + |27\ \mu\text{V}| \right) = \pm\ 117\ \mu\text{V}$$

---

**Total error – RTD input (4-wire operation)**

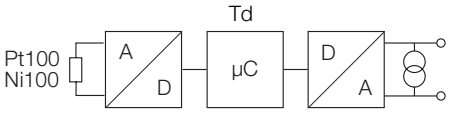
Output: 0...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{20\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{Td}| \right)$$

Output: 4...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{16\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{Td}| \right)$$

Digital temperature Td:
The digital temperature is the digitised value of the analogue sensor value of the Pt100/Ni100. The block diagram illustrates the measuring operation:




| $\Delta_{Td} \leq \Delta_{RTD} / \alpha_T$ | | |
|---|---|---|
| | Sensitivity $\alpha_{Tmin}$ (see note) | For example: $\Delta_{RTD}$ = ± 50 mΩ |
| Type | $\alpha_{Tmin}$ | $\Delta_{Tdmax}$ |
| Pt100 | 300 mΩ/K | ± 0.16 K |
| Ni100 | 470 mΩ/K | ± 0.1 K |

**Please note:**
The sensitivity rating $\boldsymbol{\alpha}_{Tmin}$ is a „worst-case“ assessment and is generally better. The maximum digital temperature Td of a faulty Pt100/Ni100 RTD can be calculated as follows:

**For example:** Assumption: Probe: Pt100, $T_U$ = 40 °C, MBA = 0 °C, MBE = 100 °C, age = 10 years, output: 0...20 mA

1) Accuracy calculation - RTD input (s. page 3 – 39) => $\Delta_{RTD}$ = ± 71.25 mΩ

2) Accuracy calculation - current output (s. page 3 – 39) => $\Delta_I$ = ± 22.5 µA

3) Total error calculation – RTD input

$$\Delta_G = \pm \left( \frac{|22.5\ \mu\text{A}|}{\frac{20\ \text{mA}}{|0 - 100\ °\text{C}|}} + |0.24\text{K}| \right) = \pm\ 0.35\ \text{K}$$

MBA = lower measuring range value
MBE = upper measuring range value

# Total Error – Thermoelement Input with External Cold Junction Compensation

**Total error – thermoelement input**

Output: 0...20 mA

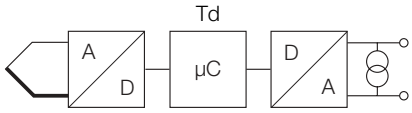
$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{20\ \text{mA}}{|\text{MBA} - \text{MBE}|}} + |\Delta_{Td}| \right)$$

Output: 4...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{16\ \text{mA}}{|\text{MBA} - \text{MBE}|}} + |\Delta_{Td}| \right)$$

**Please note:**
The sensitivity rating $\alpha_{Tmin}$ is a „worst-case“ assessment and is generally better. The maximum digital temperature Td of a faulty thermovoltage can be calculated as follows: when using, e.g., type B, the sensitivity rises from 4 µV/K at 400 °C up to 12 µV/K at 1600 °C. At 50 µV and 400 °C the error is 12.5 K and at 1600 °C it drops to 4 K. Thus it becomes clear that type B is better suited for higher temperatures.

Digital temperature Td:
The digital temperature is the digitised value of the analogue sensor value of the thermoelement. The block diagram illustrates the measuring operation:




| **External cold junction point compensation: $\Delta_{Td} = \Delta_{mV} / \alpha_{Tmin} + \Delta_{TdCJC}$ [1]<br>Internal cold junction point compensation: $\Delta_{Td} = \Delta_{mV} / \alpha_{Tmin} + \Delta_{KSI}$ ($\Delta_{KSI} = \pm 1.5$ K)** | | |
|---|---|---|
| | Sensitivity $\alpha_{Tmin}$ (see note) | Example: $\Delta_{mV} = \pm 10$ µV |
| Type | $\alpha_{Tmin}$ | $\Delta_{TdThermo}$ |
| J | 41 µV/K | ± 0.24 K |
| B | 4.0 µV/K | ± 2.50 K |
| E | 45 µV/K | ± 0.22 K |
| K | 30 µV/K | ± 0.33 K |
| L | 39 µV/K | ± 0.25 K |
| N | 21 µV/K | ± 0.47 K |
| R | 3.7 µV/K | ± 2.70 K |
| S | 3.9 µV/K | ± 2.56 K |
| T | 28 µV/K | ± 0.36 K |

**Example for external cold junction compensation CJC:** Assumption:
Thermoelement type T, external cold junction compensation via Ni100 (2-wire operation), MBA = 500 °C, MBE = 1000 °C, $T_U$ = 60 °C, age = 3 years, output: 0...20 mA

1) Accuracy calculation - extra-low voltage input (s. page 3 – 39) => $\Delta_{mV} = \pm 48$ µV

2) Accuracy calculation - RTD input (s. page 3 – 39) => $\Delta_{RTD} = \pm 79$ mΩ
(in case of 2-wire operation multiply by 2 => $\Delta_{RTD} = \pm 158.5$ mΩ

3) $\Delta_{TdCJC}$ = 158.5 mΩ/300 mΩ/K = 0.52 K

4) $\Delta_{TdThermo}$ = 48 µV/28 µV/K = 1.7 K

5) $\Delta_{Td} = \Delta_{TdCJC} + \Delta_{TdThermo}$ = 2.23 K

6) Accuracy calculation - current output (s. page 3 – 39) => $\Delta_I = \pm 25.5$ µA

7) Total error calculation – thermoelement input

$$\Delta_G = \pm \left( \frac{|25.5\ \mu\text{A}|}{\frac{20\ \text{mA}}{|550\ °\text{C} - 1000\ °\text{C}|}} + |2.23\ \text{K}| \right) = \pm 2.87\ \text{K}$$

[1] In case of external cold junction compensation via RTD the digital t emperature also has to be considered.

3

# Temperature Measuring Amplifier IM34-11-Ex-i/IM34-12-Ex-Ri

## Total Error – Thermoelement Input with Internal Cold Junction Compensation

**Total error – thermoelement input**

Output: 0...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{20\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{Td}| \right)$$

Output: 4...20 mA

$$\Delta_G = \pm \left( \frac{|\Delta_I|}{\frac{16\ \text{mA}}{|\text{MBA - MBE}|}} + |\Delta_{Td}| \right)$$

**Example for internal cold junction compensation:**
Assumption: Thermoelement type J, internal cold junction compensation via Ni100, MBA = 400 °C, MBE = 800 °C,
$T_U$ = 40 °C, age = 5 years, output: 4...20 mA

1) Accuracy calculation - extra-low voltage input (s. page 3 – 39) => $\Delta_{mV} = \pm$ 30 µV

2) $\Delta_{Td}$ = 30 µV/41µV/K + 1.5 K = 2.23 K

3) Accuracy calculation - current output (s. page 3 – 39) => $\Delta_I = \pm$ 17.5 µA

4) Total error calculation – thermoelement input

$$\Delta_G = \pm \left( \frac{|17.5\ \mu\text{A}|}{\frac{16\ \text{mA}}{|400\ °\text{C} - 800\ °\text{C}|}} + |2.23\ \text{K}| \right) = \pm 2.66\ \text{K}$$