

# X20AT2222

## 1 General information

The module is equipped with 2 inputs for PT100/PT1000 resistance temperature measurement.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 inputs for resistance temperature measurement
- For PT100 and PT1000
- Configurable sensor type per channel
- Direct resistance measurement
- Configurable 2- or 3- wire connections per module
- Configurable filter time

## 2 Order data

| Model number | Short description  | Figure   |
|--------------|--|--|
|              | <b>Temperature measurement</b>   |  |
| X20AT2222    | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections |  |
|              | <b>Required accessories</b>  |  |
|              | <b>Bus modules</b>   |  |
| X20BM11      | X20 bus module, 24 VDC keyed, internal I/O supply continuous   |  |
| X20BM15      | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous                                  |  |
|              | <b>Terminal blocks</b>   |  |
| X20TB06      | X20 terminal block, 6-pin, 24 VDC keyed  |  |
| X20TB12      | X20 terminal block, 12-pin, 24 VDC keyed   |  |
|              |  |  |

Table 1: X20AT2222 - Order data

### 3 Technical data

| Model number   | X20AT2222  |
|--|--|
| <b>Short description</b>   |  |
| I/O module   | 2 inputs for PT100 or PT1000 resistance temperature measurement  |
| <b>General information</b>                                       |  |
| B&R ID code  | 0x1BA6   |
| Status indicators  | I/O function per channel, operating state, module status   |
| Diagnostics  |  |
| Module run/error   | Yes, using status LED and software   |
| Inputs   | Yes, using status LED and software   |
| Power consumption  |  |
| Bus  | 0.01 W   |
| Internal I/O   | 1.1 W  |
| Additional power dissipation caused by actuators (resistive) [W] | -  |
| Certifications   |  |
| CE   | Yes  |
| KC   | Yes  |
| EAC  | Yes  |
| UL   | cULus E115267<br>Industrial control equipment  |
| HazLoc   | cCSAus 244665<br>Process control equipment<br>for hazardous locations<br>Class I, Division 2, Groups ABCD, T5                            |
| ATEX   | Zone 2, II 3G Ex nA nC IIA T5 Gc<br>IP20, Ta (see X20 user's manual)<br>FTZÜ 09 ATEX 0083X   |
| DNV GL   | Temperature: <b>B</b> (0 - 55°C)<br>Humidity: <b>B</b> (up to 100%)<br>Vibration: <b>B</b> (4 g)<br>EMC: <b>B</b> (bridge and open deck) |
| LR   | ENV1   |
| KR   | Yes  |
| <b>Resistance measurement temperature inputs</b>                 |  |
| Input  | Resistance measurement with constant current supply for 2- or 3-wire connections   |
| Digital converter resolution                                     | 16-bit   |
| Filter time  | Configurable between 1 ms and 66.7 ms  |
| Conversion time  |  |
| 1 channel  | 20 ms with 50 Hz filter  |
| 2 channels   | 80 ms with 50 Hz filter  |
| Conversion procedure   | Sigma Delta  |
| Output format  | INT or UINT for resistance measurement   |
| Sensor   |  |
| Sensor type  | Configurable per channel   |
| PT100  | -200 to 850°C  |
| PT1000   | -200 to 850°C  |
| Resistance measurement range                                     | 0.1 to 4500 Ω / 0.05 to 2250 Ω   |
| Input filter   | 1st-order low pass / cutoff frequency 500 Hz   |
| Sensor standard  | EN 60751   |
| Common-mode range  | >0.7 V   |
| Isolation voltage between channel and bus                        | 500 V <sub>eff</sub>   |
| Linearization method   | Internal   |
| Measurement current  | 250 μA ±1.25%  |
| Reference  | 4530 Ω ±0.1%   |
| Permissible input signal   | Short-term max. ±30 V  |
| Max. error at 25°C   |  |
| Gain   | 0.037% <sup>1)</sup>   |
| Offset   | 0.0015% <sup>2)</sup>  |
| Max. gain drift  | 0.004 %/°C <sup>1)</sup>   |
| Max. offset drift  | 0.00015 %/°C <sup>2)</sup>   |
| Nonlinearity   | <0.001% <sup>2)</sup>  |
| Crosstalk between channels                                       | <-93 dB  |
| Temperature sensor resolution                                    |  |
| PT100  | 1 LSB = 0.1°C  |
| PT1000   | 1 LSB = 0.1°C  |
| Resistance measurement resolution                                |  |
| G = 1  | 0.1 Ω  |
| G = 2  | 0.05 Ω   |
| Common-mode rejection  |  |
| 50 Hz  | >80 dB   |
| DC   | >95 dB   |

Table 2: X20AT2222 - Technical data

| Model number  | X20AT2222   |
|---|---|
| Standardized range of values for resistance measurement |   |
| G = 1   | 0.1 to 4500 $\Omega$  |
| G = 2   | 0.05 to 2250 $\Omega$   |
| Temperature sensor normalization                        |   |
| PT100   | -200.0 to 850.0°C   |
| PT1000  | -200.0 to 850.0°C   |
| Temperature measurement monitoring                      |   |
| Range undershoot  | 0x8001  |
| Range overshoot   | 0x7FFF  |
| Open circuit  | 0x7FFF  |
| General fault   | 0x8000  |
| Open inputs   | 0x7FFF  |
| Resistance measurement monitoring                       |   |
| Range overshoot   | 0xFFFF  |
| Open circuit  | 0xFFFF  |
| General fault   | 0xFFFF  |
| Open inputs   | 0xFFFF  |
| <b>Electrical properties</b>                            |   |
| Electrical isolation                                    | Channel isolated from bus<br>Channel not isolated from channel                                  |
| <b>Operating conditions</b>                             |   |
| Mounting orientation                                    |   |
| Horizontal  | Yes   |
| Vertical  | Yes   |
| Installation elevation above sea level                  |   |
| 0 to 2000 m   | No limitations  |
| >2000 m   | Reduction of ambient temperature by 0.5°C per 100 m   |
| Degree of protection per EN 60529                       | IP20  |
| <b>Ambient conditions</b>                               |   |
| Temperature   |   |
| Operation   |   |
| Horizontal mounting orientation                         | -25 to 60°C   |
| Vertical mounting orientation                           | -25 to 50°C   |
| Derating  | -   |
| Storage   | -40 to 85°C   |
| Transport   | -40 to 85°C   |
| Relative humidity                                       |   |
| Operation   | 5 to 95%, non-condensing  |
| Storage   | 5 to 95%, non-condensing  |
| Transport   | 5 to 95%, non-condensing  |
| <b>Mechanical properties</b>                            |   |
| Note  | Order 1x X20TB06 or X20TB12 terminal block separately<br>Order 1x X20BM11 bus module separately |
| Spacing   | 12.5 <sup>+0.2</sup> mm   |

Table 2: X20AT2222 - Technical data

- 1) Based on the current resistance value.
- 2) Based on the entire resistance measurement range.

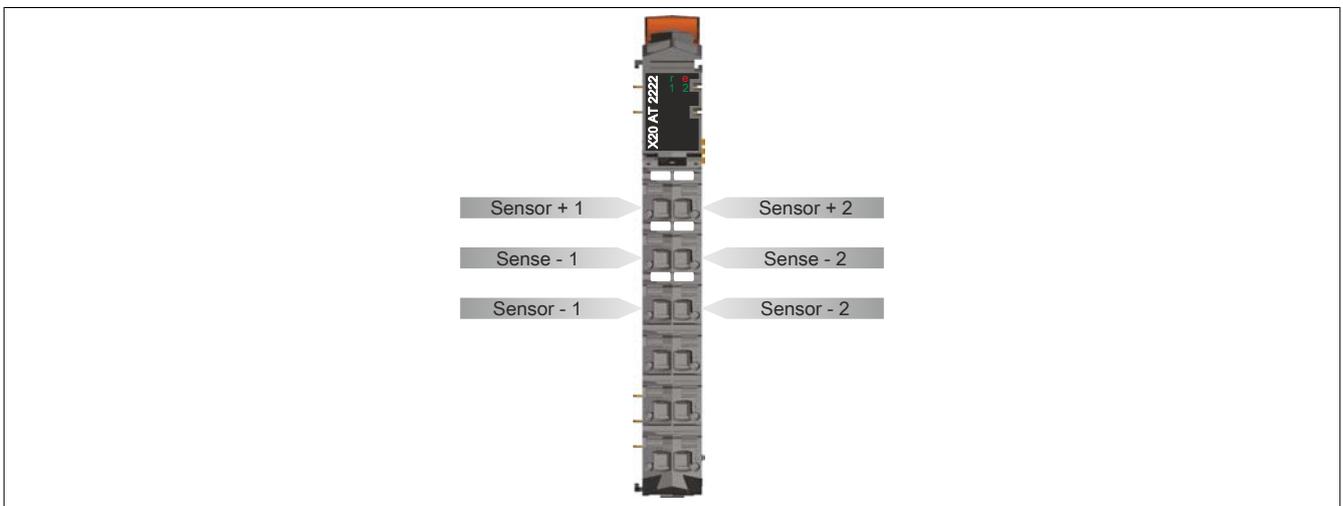
## 4 LED status indicators

For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" of the X20 system user's manual.

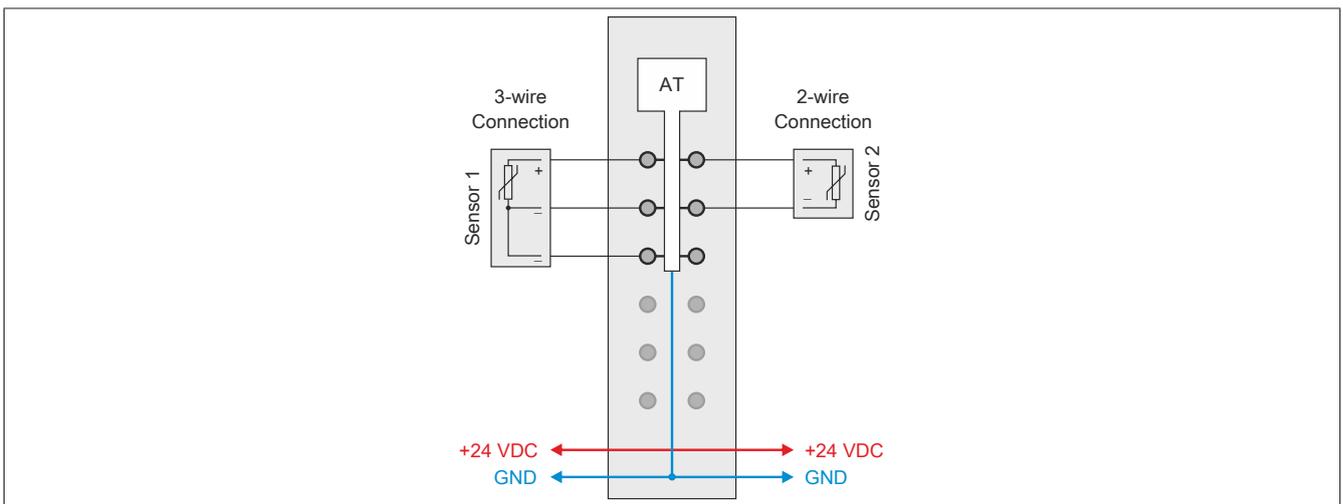
| Figure  | LED   | Color                       | Status           | Description  |
|---|-------|-----------------------------|------------------|--|
|  | r     | Green                       | Off              | No power to module   |
|   |       |                             | Single flash     | RESET mode   |
|   |       |                             | Blinking         | PREOPERATIONAL mode  |
|   | e     | Red                         | On               | RUN mode   |
|   |       |                             | Off              | No power to module or everything OK  |
|   |       |                             | Single flash     | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
|   | e + r | Red on / Green single flash | Invalid firmware |  |
|   | 1 - 2 | Green                       | Off              | The input is switched off  |
|   |       |                             | Blinking         | Overflow, underflow or open line   |
|   |       |                             | On               | Analog/digital converter running, value OK                                   |

## 5 Pinout

Channels that are not being used should be disabled.

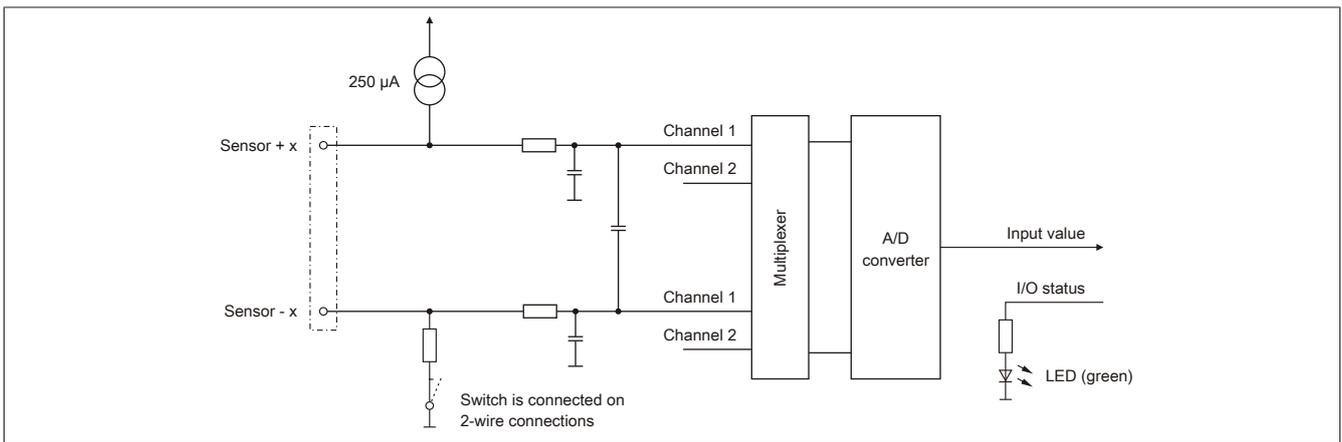


## 6 Connection example

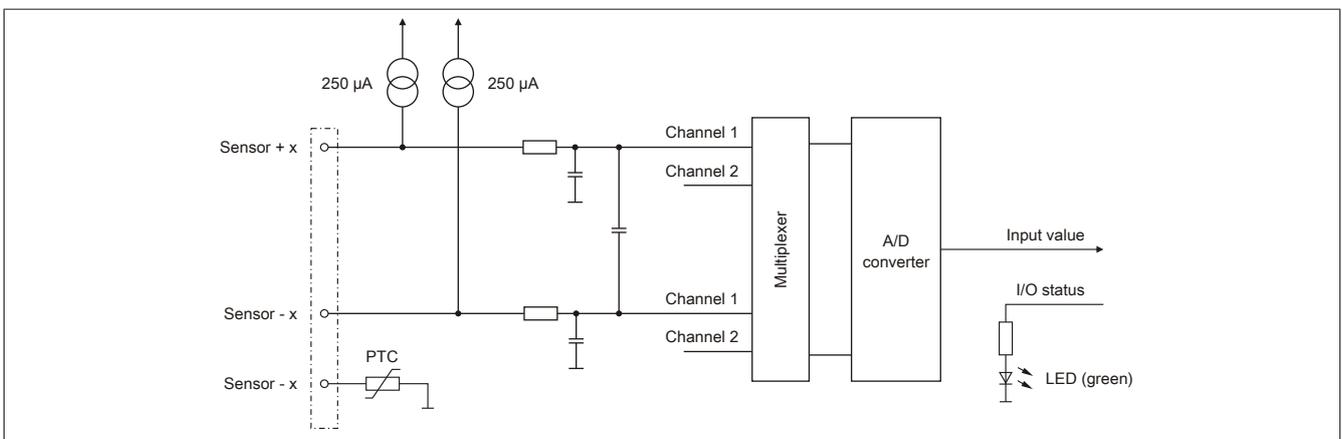


## 7 Input circuit diagram

### 2-wire connections



### 3-wire connections



## 8 Register description

### 8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" of the X20 system user's manual.

### 8.2 Function model 0 - "3-wire connections" and function model 1 - "2-wire connections"

For this module, the connection type is selected using function models 0 and 1.

| Function model | Connection type               |
|----------------|-------------------------------|
| 0              | 3-wire connections (standard) |
| 1              | 2-wire connections            |

The registers used are identical for both function models:

| Register             | Name                                  | Data type | Read   |         | Write  |         |
|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
|                      |                                       |           | Cyclic | Acyclic | Cyclic | Acyclic |
| <b>Configuration</b> |                                       |           |        |         |        |         |
| 16                   | ConfigOutput01 (Input filter)         | USINT     |        |         |        | •       |
| 18                   | ConfigOutput02 (Sensor configuration) | USINT     |        |         |        | •       |
| <b>Communication</b> |                                       |           |        |         |        |         |
| 0                    | Temperature01                         | INT       | •      |         |        |         |
|                      | Resistor01                            | UINT      |        |         |        |         |
| 2                    | Temperature02                         | INT       | •      |         |        |         |
|                      | Resistor02                            | UINT      |        |         |        |         |
| 28                   | IOCycleCounter                        | USINT     | •      |         |        |         |
| 30                   | StatusInput01                         | USINT     | •      |         |        |         |

### 8.3 Function model 254 - Bus controller

| Register             | Offset <sup>1)</sup> | Name                                  | Data type | Read   |         | Write  |         |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
|                      |                      |                                       |           | Cyclic | Acyclic | Cyclic | Acyclic |
| <b>Configuration</b> |                      |                                       |           |        |         |        |         |
| 16                   | -                    | ConfigOutput01 (Input filter)         | USINT     |        |         |        | •       |
| 18                   | -                    | ConfigOutput02 (Sensor configuration) | USINT     |        |         |        | •       |
| <b>Communication</b> |                      |                                       |           |        |         |        |         |
| 0                    | 0                    | Temperature01                         | INT       | •      |         |        |         |
|                      | 0                    | Resistor01                            | UINT      |        |         |        |         |
| 2                    | 2                    | Temperature02                         | INT       | •      |         |        |         |
|                      | 2                    | Resistor02                            | UINT      |        |         |        |         |
| 28                   | -                    | IOCycleCounter                        | USINT     |        | •       |        |         |
| 30                   | -                    | StatusInput01                         | USINT     |        | •       |        |         |

1) The offset specifies the position of the register within the CAN object.

#### 8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use additional registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" of the X20 user's manual (version 3.50 or later).

#### 8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

## 8.4 General information

### 8.4.1 Analog inputs

This module stores converted analog values in the registers. Different resistance or temperature measurements will result in different value ranges and data types.

#### Information:

**Operating channels outside the specification can have an effect on neighboring channels.**

### 8.4.2 Timing

The timing for acquiring measured values is determined by the converter hardware. All switched-on inputs are converted during each conversion cycle and transferred halfway through the X2X Link cycle.

### 8.4.3 Conversion time

The conversion time for the channels depends on their use. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Channel uses                           | Conversion time               |
|--|-------------------------------|
| 1 channel                              | 1 · Filter time               |
| n channels with the same sensor type   | n · (20 ms + Filter time)     |
| n channels with different sensor types | n · (20 ms + 2 · Filter time) |

### 8.4.4 Reduced update time

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily.

The time saved is equal to:

$$\text{Time saved} = 2 \cdot 20 \text{ ms} + \text{Filter time}$$

The filter time is the conversion time for the remaining channels.

#### Examples

Inputs are filtered using a 60 Hz filter.

|                    | Example 1 | Example 2 |
|--------------------|-----------|-----------|
| Switched on inputs | 1         | 1 to 2    |
| Conversion time    | 16.7 ms   | 734 ms    |

## 8.5 Configuration

### 8.5.1 Input filter

Name:

ConfigOutput01

This register can be used to configure the filter time for all analog inputs.

| Data type | Value | Filter                                 | Filter time |
|-----------|-------|--|-------------|
| USINT     | 0     | 15 Hz                                  | 66.7 ms     |
|           | 1     | 25 Hz                                  | 40 ms       |
|           | 2     | 30 Hz                                  | 33.3 ms     |
|           | 3     | 50 Hz (bus controller default setting) | 20 ms       |
|           | 4     | 60 Hz                                  | 16.7 ms     |
|           | 5     | 100 Hz                                 | 10 ms       |
|           | 6     | 500 Hz                                 | 2 ms        |
|           | 7     | 1000 Hz                                | 1 ms        |

### 8.5.2 Sensor configuration

Name:

ConfigOutput02

This register can be used to configure the sensor type for individual channels.

This module is designed for temperature and resistance measurement. The sensor type must be specified because of the different calibration values for temperature and resistance.

The default setting for all channels is ON. To save time, individual channels can be switched off (see "[Reduced update time](#)" on page 7).

| Data type | Values             | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT     | See bit structure. | 34                             |

Bit structure:

| Bit         | Name   | Value       | Information  |             |  |
|-------------|--|-------------|--|-------------|--|
| 0 - 3       | Channel 1                                    | 0000 - 0001 | Reserved   |             |  |
|             |  | 0010        | Sensor type PT100 (bus controller default setting) |             |  |
|             |  | 0011        | PT1000 sensor type                                 |             |  |
|             |  | 0100        | Reserved (channel switched off)                    |             |  |
|             |  | 0101        | Resistance measurement 0.1 to 4500 $\Omega$        |             |  |
|             |  | 0110        | Resistance measurement 0.05 to 2250 $\Omega$       |             |  |
|             |  | 0111        | Channel switched off                               |             |  |
|             |  | 1000 - 1111 | Reserved   |             |  |
|             |  | 4 - 7       | Channel 2  | 0000 - 0001 | Reserved   |
|             |  |             |  | 0010        | Sensor type PT100 (bus controller default setting) |
| 0011        | PT1000 sensor type                           |             |  |             |  |
| 0100        | Reserved (channel switched off)              |             |  |             |  |
| 0101        | Resistance measurement 0.1 to 4500 $\Omega$  |             |  |             |  |
| 0110        | Resistance measurement 0.05 to 2250 $\Omega$ |             |  |             |  |
| 0111        | Channel switched off                         |             |  |             |  |
| 1000 - 1111 | Reserved                                     |             |  |             |  |

## 8.6 Communication

### 8.6.1 Analog input values

Name:

Temperature01 to Temperature02

Resistor01 to Resistor02

This register is used to indicate the analog input values depending on the configured operating mode.

| Data type | Digital value                         | Input signal                          |
|-----------|---------------------------------------|---------------------------------------|
| INT       | -2000 to 8500 (for -200.0 to 850.0°C) | PT100 sensor type                     |
|           | -2000 to 8500 (for -200.0 to 850.0°C) | PT1000 sensor type                    |
| UINT      | 1 to 45000 (resolution 0.1 Ω)         | Resistance measurement 0.1 to 4500 Ω  |
|           | 1 to 45000 (resolution 0.05 Ω)        | Resistance measurement 0.05 to 2250 Ω |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the mode until the first conversion:
  - from "Resistance measurement" to "Sensor type PTxx": 0x8000
  - from "Sensor type PTxx" to "Resistance measurement": 0xFFFF
- If the input is not switched on, 0x8000 is output.

### 8.6.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Value    | Information       |
|-----------|----------|-------------------|
| USINT     | 0 to 255 | Repeating counter |

### 8.6.3 Input status

Name:

StatusInput01

The module's inputs are monitored. A change in the monitoring status generates an error message.

| Data type | Values                 |
|-----------|------------------------|
| USINT     | See the bit structure. |

Bit structure:

| Bit   | Description | Value | Information                |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1   | 00    | No error                   |
|       |             | 01    | Lower limit value exceeded |
|       |             | 10    | Upper limit value exceeded |
|       |             | 11    | Open line                  |
| 2 - 3 | Channel 2   | 00    | No error                   |
|       |             | 01    | Lower limit value exceeded |
|       |             | 10    | Upper limit value exceeded |
|       |             | 11    | Open line                  |
| 4 - 7 |             | 0     |                            |

### Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs.

| Error status               | Temperature measurement<br>Digital value for error  | Resistance measurement<br>Digital value for error |
|----------------------------|---|---|
| Open line                  | 32767 (0x7FFF)  | 65535 (0xFFFF)                                    |
| Upper limit value exceeded | 32767 (0x7FFF)  | 65535 (0xFFFF)                                    |
| Lower limit value exceeded | -32767 (0x8001)   | 0 (0x0000)  |
| Invalid value              | -32768 (0x8000) <sup>1)</sup><br>32767 (0x7FFF) <sup>2)</sup><br>65535 (0xFFFF) <sup>3)</sup> | 65535 (0xFFFF)                                    |

1) Default value or channel was disabled in the I/O configuration.

2) After switching off the channel during operation.

3) Value in function model 254 - Bus controller.

### 8.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |  |
|--------------------|--|
| 100 $\mu$ s        |  |

### 8.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |                          |
|-------------------------|--------------------------|
| 1 input                 | Equal to the filter time |
| 2 inputs                | 2 · 20 ms + filter time  |