1 General information

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 System user's manual

1.2 Order data

Order number	Short description	Figure
	Temperature measurement	
X20AT2222	X20 temperature input module, 2 resistance measurement inputs, Pt100, Pt1000, resolution 0.1°C, 3-wire connections	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O power supply connected through	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB06	X20 terminal block, 6-pin, 24 VDC keyed	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20AT2222 - Order data

1.3 Module description

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

Functions:

- Sensor type and measurement range
- Monitoring the input signal

Sensor type and measurement range

The module can be used for both measurement sensor and resistance measurement. The measurement range varies depending on the operating mode set.

Monitoring the input signal

The input signal of the analog inputs is monitored against the upper and lower limit values as well as for open circuit.

2 Technical description

2.1 Technical data

Order number	X20AT2222
Short description	
I/O module	2 inputs for Pt100 or Pt1000 resistance temperature measurement
General information	
B&R ID code	0x1BA6
Status indicators	I/O function per channel, operating state, module status
Diagnostics	
Module run/error	Yes, using LED status indicator and software
Inputs	Yes, using LED status indicator 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
UKCA	Yes
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
DNV	Temperature: **B** (0 to 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)
CCS	Yes
LR	ENV1
KR	Yes
ABS	Yes
BV	**EC33B** Temperature: 5 - 55°C Vibration: 4 g EMC: Bridge and open deck
KC	Yes
Resistance measurement temperature inputs	
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	First-order low-pass filter / cutoff frequency 500 Hz
Sensor standard	EN 60751
Common-mode range	>0.7 V
Insulation voltage between channel and bus	500 V_{eff}
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% [1]
Offset	±0.0015% [2]
Max. gain drift	±0.004%/°C [1]

Table 2: X20AT2222 - Technical data

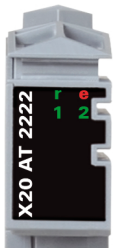
Order number	X20AT2222
Max. offset drift	±0.00015%/°C 2)
Nonlinearity	<0.001% 2)
Crosstalk between channels	<-93 dB
Temperature sensor resolution	
Pt100	1 LSB = 0.1°C
Pt1000	1 LSB = 0.1°C
Resistance measurement resolution	
G = 1	0.1 Ω
G = 2	0.05 Ω
Common-mode rejection	
50 Hz	>80 dB
DC	>95 dB
Standardized range of values for resistance measurement	
G = 1	0.1 to 4500 Ω
G = 2	0.05 to 2250 Ω
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
Electrical properties	
Electrical isolation	Channel isolated from bus Channel not isolated from channel
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP20
Ambient conditions	
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
Mechanical properties	
Note	Order 1x terminal block X20TB06 or X20TB12 separately. Order 1x bus module X20BM11 separately.
Pitch	$12.5^{+0.2}$ mm

Table 2: X20AT2222 - Technical data

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

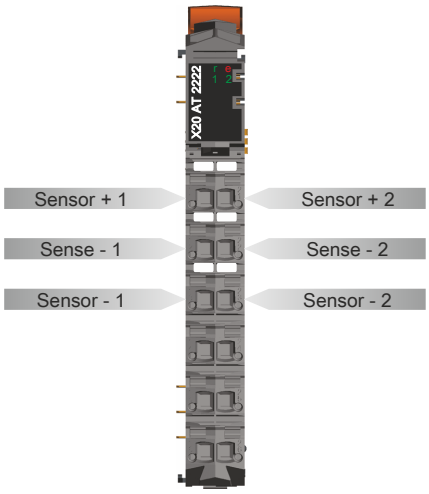
2.2 LED status indicators

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

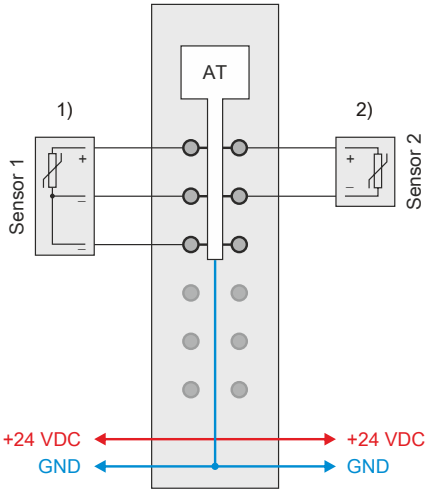
Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	RESET mode
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning/Error on an I/O channel. Overflow or underflow of the analog 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

2.3 Pinout

Channels that are not being used should be disabled.



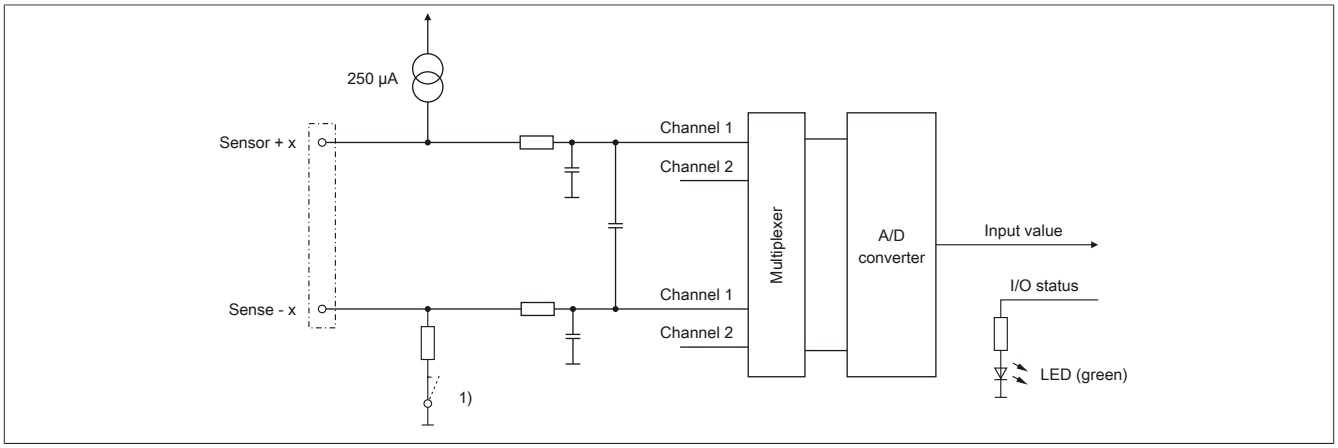
2.4 Connection example



1) 3-wire connections
2) 2-wire connections

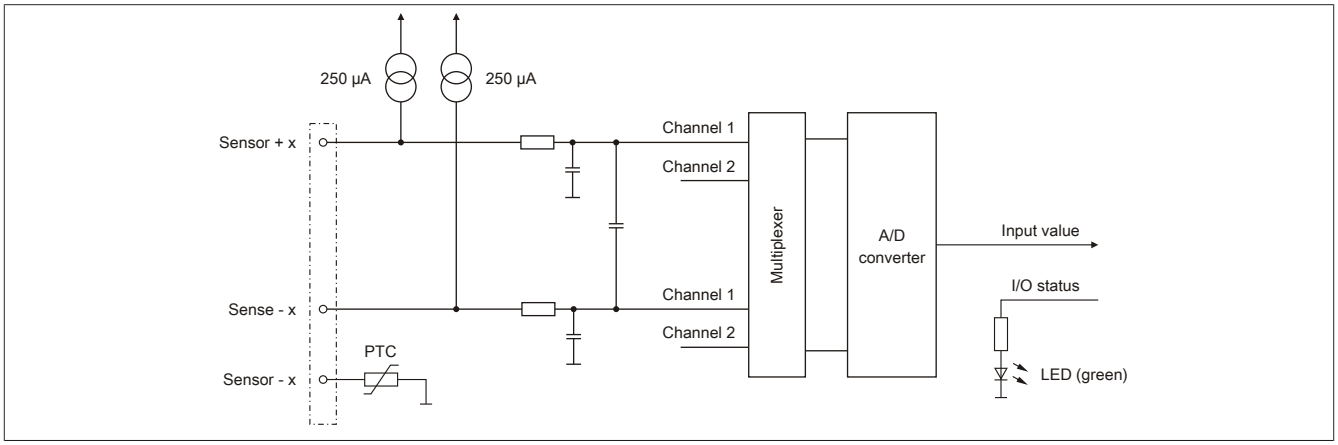
2.5 Input circuit diagram

2-wire connections



1) Switch is closed for 2-wire connections.

3-wire connections



3 Function description

3.1 Sensor type and measurement range

The module can be used for both measurement sensor and resistance measurement. The following measurement ranges result depending on the set operating mode:

Input signal	Measurement range
Pt100 sensor type	-200.0 to 850.0°C
Pt1000 sensor type	-200.0 to 850.0°C
Resistance measurement	0.1 to 4500 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 operating 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.



Information:

The register is described in "Sensor configuration" on page 11.

3.2 Monitoring the input signal

The module's inputs are monitored. A change in the monitoring status is actively transmitted as an error message.

Bit value	Information
00	No error
01	Lower limit value undershot
10	Upper limit value overshot
11	Open circuit

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state.

Error state	Temperature measurement Digital value on error	Resistance measurement Digital value on error
Open circuit	32767 (0x7FFF)	65535 (0xFFFF)
Upper limit value overshot	32767 (0x7FFF)	65535 (0xFFFF)
Lower limit value undershot	-32767 (0x8001)	0 (0x0000)
Invalid value	-32768 (0x8000)[1)] 32767 (0x7FFF)[2)] 65535 (0xFFFF)[3)]	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.



Information:

The register is described in "Input status" on page 12.

4 Commissioning

4.1 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 other registers and functions depending on the fieldbus used.

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

4.1.1 CAN I/O bus controller

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

4.2 Configuring the conversion cycle

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

4.2.1 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.

Use of the channels	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)

4.2.2 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 corresponds to the following:

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

The conversion time for the remaining channel corresponds to the filter time.

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	73.4 ms

5 Register description

5.1 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" in the X20 System user's manual.

5.2 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
Configuration						
16	ConfigOutput01 (Input filter)	USINT				•
18	ConfigOutput02 (Sensor configuration)	USINT				•
Communication						
0	Temperature01	INT	•			
	Resistor01	UINT				
2	Temperature02	INT	•			
	Resistor02	UINT				
28	IOCycleCounter	USINT	•			
30	StatusInput01	USINT	•			

5.3 Function model 254 - Bus controller



Information:

Function model 254 (bus controller) only supports 3-wire connections in the default configuration.

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
16	-	ConfigOutput01 (Input filter)	USINT				•
18	-	ConfigOutput02 (Sensor configuration)	USINT				•
Communication							
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.

5.4 Configuration

5.4.1 Input filter

Name:
ConfigOutput01

The filter time of all analog inputs is defined in this register.

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

5.4.2 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 9).

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 Ω
		0110	Resistance measurement 0.05 to 2250 Ω
		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 Ω
		0110	Resistance measurement 0.05 to 2250 Ω
		0111	Channel switched off
		1000 - 1111	Reserved

5.5 Communication

5.5.1 Analog inputs

The module outputs the converted analog values to the registers. Other ranges of values or data types result depending on resistance or temperature measurement.



Information:

Operating channels outside specifications can affect neighboring channels.

5.5.1.1 Input values of analog inputs

Name:
Temperature01 to Temperature02
Resistor01 to Resistor02

This register contains 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

5.5.2 I/O cycle counter

Name:
IOCycleCounter

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

Data type	Values	Information
USINT	0 to 255	Repeating counter

5.5.3 Input status

Name:
StatusInput01

The module's inputs are monitored. A change in the monitoring status is actively issued as an error message and, in the event of an error, the analog value is fixed at defined values. For details, see "Monitoring the input signal" on page 8.

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	Reserved	0	