X20(c)AT4222

1 General information

The module is equipped with 4 inputs for PT100/PT1000 resistance temperature measurement.

- 4 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

1.1 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.
The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days

1.1.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature in a voltage-free state at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in the closed control cabinet, e.g. due to the use of a fan or ventilation slots.

1.2 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 system user's manual
MAEMV	Installation / EMC guide

2 Order data

Order number	Short description	Figure
	Temperature measurement	
X20AT4222	X20 temperature input module, 4 resistance measurement inputs, Pt100, Pt1000, resolution 0.1°C, 3-wire connections	
X20cAT4222	X20 temperature input module, coated, 4 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	
X20cBM11	X20 bus module, coated, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20AT4222, X20cAT4222 - Order data

3 Technical description

3.1 Technical data

Order number	X20AT4222	X20cAT4222
Short description		
I/O module	4 inputs for Pt100 or Pt1000 resistance temperature measurement	
General information		
B&R ID code	0x1BA7	0xE215
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 - 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)	
LR	ENV1	
KR	Yes	
ABS	Yes	
EAC	Yes	
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 - 4 channels	40 ms per channel with 50 Hz filter	
Conversion procedure	Sigma-delta	
Output format	INT or UINT for resistance measurement	

Table 2: X20AT4222, X20cAT4222 - Technical data

Order number	X20AT4222	X20cAT4222
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)	
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	-	
Starting temperature	-	Yes, -40°C
Storage	-40 to 85°C	
Transport	-40 to 85°C	

Table 2: X20AT4222, X20cAT4222 - Technical data

Order number	X20AT4222	X20cAT4222
Relative humidity		
Operation	5 to 95%, non-condensing	Up to 100%, condensing
Storage	5 to 95%, non-condensing	
Transport	5 to 95%, non-condensing	
Mechanical properties		
Note	Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately.	Order 1x terminal block X20TB12 separately. Order 1x bus module X20cBM11 separately.
Pitch	12.5$^{+0.2}$ mm	

Table 2: X20AT4222, X20cAT4222 - Technical data

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

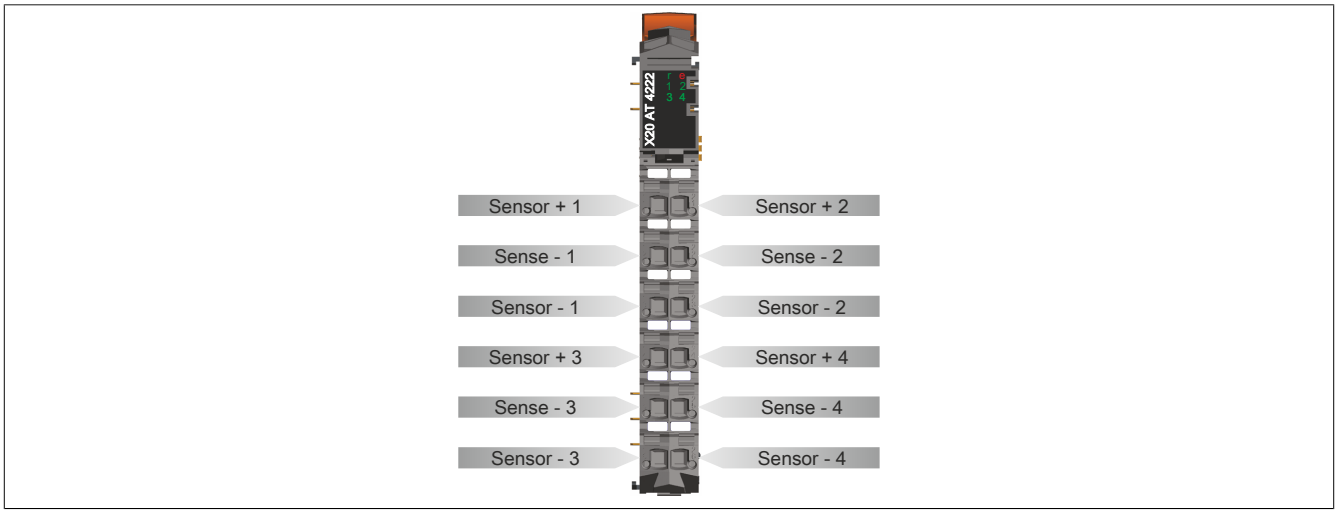
3.2 LED status indicators

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

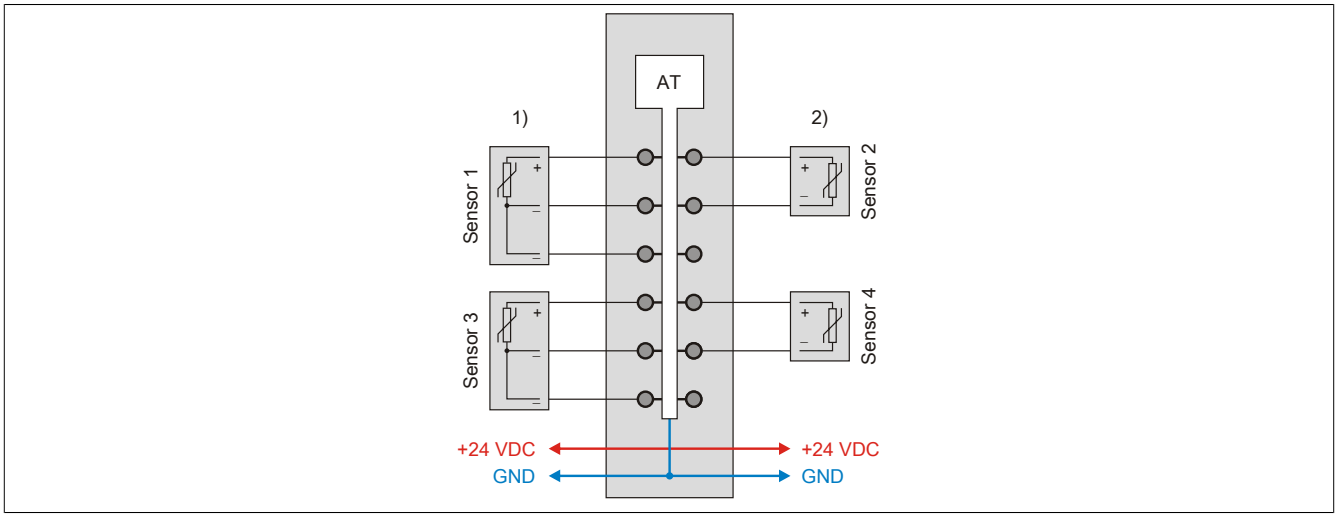
Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	RESET mode
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning/Error on an I/O channel. Overflow or underflow of the analog inputs.
	e + r	Red on / Green single flash		Invalid firmware
	1 - 4	Green	Off	The input is switched off
			Blinking	Overflow, underflow or open line
			On	Analog/digital converter running, value OK

3.3 Pinout

Channels that are not being used should be disabled.



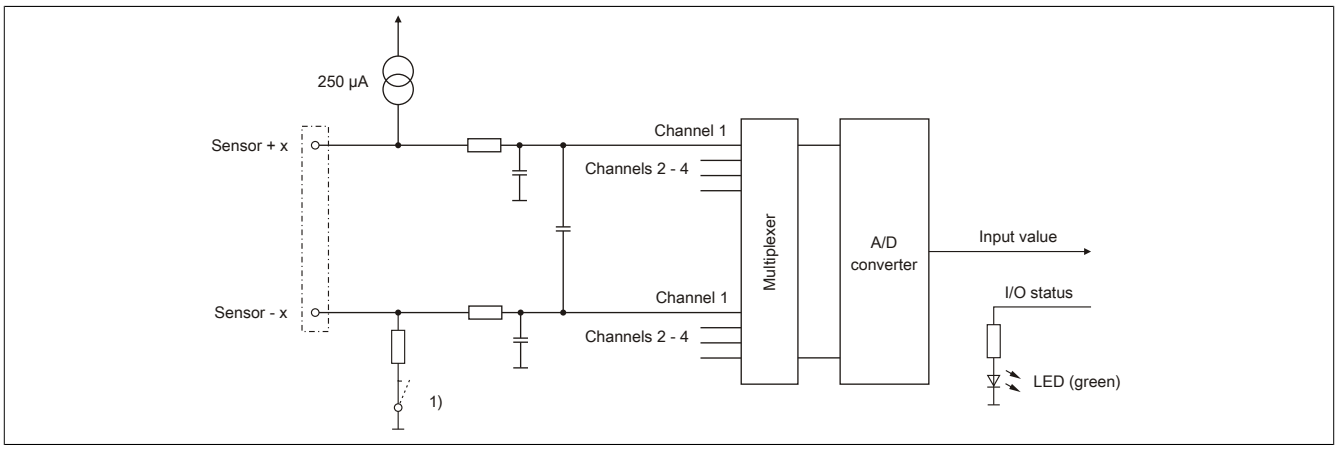
3.4 Connection example



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

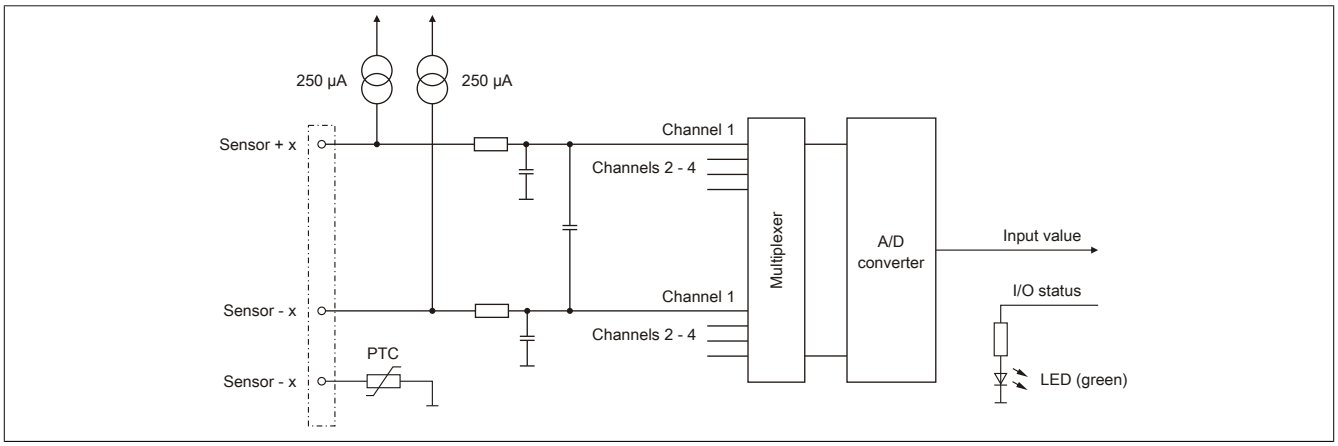
3.5 Input circuit diagram

2-wire connections



1) Switch is closed for 2-wire connections.

3-wire connections



4 Register description

4.1 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.

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

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

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

The registers applied 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)	UINT				•
Communication						
0	Temperature01	INT	•			
	Resistor01	UINT				
2	Temperature02	INT	•			
	Resistor02	UINT				
4	Temperature03	INT	•			
	Resistor03	UINT				
6	Temperature04	INT	•			
	Resistor04	UINT				
28	IOCycleCounter	USINT	•			
30	StatusInput01	USINT	•			

4.3 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)	UINT				•
Communication							
0	0	Temperature01	INT	•			
	0	Resistor01	UINT				
2	2	Temperature02	INT	•			
	2	Resistor02	UINT				
4	4	Temperature03	INT	•			
	4	Resistor03	UINT				
6	6	Temperature04	INT	•			
	6	Resistor04	UINT				
28	-	IOCycleCounter	USINT		•		
30	-	StatusInput01	USINT		•		

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

4.3.1 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 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).

4.3.2 CAN I/O bus controller

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

4.4 General information

4.4.1 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.**

4.4.2 Timing

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.

4.4.3 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.

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)

4.4.4 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.

Calculating the time saved

The amount of time saved can be calculated with the following formula. And "n" corresponds to the number of inputs that are switched off.

$$\text{Time saved} = n \cdot (20\ \text{ms} + \text{filter time})$$

Examples

Inputs are filtered using a 60 Hz filter.

	Example 1	Example 2	Example 3
Switched on inputs	1	1 and 3	1 to 4
Conversion time	16.7 ms	73.4 ms	146.8 ms

4.5 Configuration

4.5.1 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

4.5.2 Sensor configuration

Name:
ConfigOutput02

The sensor type of the individual channels is configured in this register.

This module is designed for temperature and resistance measurement. Due to different adjustment values for temperature and resistance, the sensor type must be selected.

By default, all channels are switched on. To save time, individual channels can be switched off (see "Reduced update time" on page 7).

Data type	Values	Bus controller default setting
UINT	See the bit structure.	8738

Bit structure:

Bit	Description	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
...		...	
12 - 15	Channel 4	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

4.6 Communication

4.6.1 Input values of analog inputs

Name:
Temperature01 to Temperature04
Resistor01 to Resistor04

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

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.

4.6.2 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

4.6.3 Status of the inputs

Name:
StatusInput01

The module's inputs are monitored. A change in the monitoring status is actively transmitted as 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 undershot
		10	Upper limit value overshot
		11	Open circuit
...		...	
6 - 7	Channel 4	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.

4.7 Minimum cycle time

The minimum cycle time specifies how far 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 µs

4.8 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
n inputs	n · (20 ms + filter time)