X20AI2322

Data sheet
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Translation of the original documentation

Publishing information

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Disclaimer

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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
	Analog input modules	
X20AI2322	X20 analog input module, 2 inputs, 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, configurable input filter	
	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: X20AI2322 - Order data

1.3 Module description

The module is equipped with 2 inputs with 12-bit digital converter resolution. It is possible to select between the two current ranges 0 to 20 mA and 4 to 20 mA.

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.

Functions:

- Input filter
- Monitoring the input signal

Analog input filter

The module is equipped with a configurable input filter with input ramp limiting.

Monitoring the input signal

The input signal of the analog inputs is monitored against the upper and lower limit values.

2 Technical description

2.1 Technical data

Order number	X20AI2322
Short description	
I/O module	2 analog inputs 0 to 20 mA / 4 to 20 mA
General information	
B&R ID code	0xCAB2
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	0.8 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
Analog inputs	
Input	0 to 20 mA / 4 to 20 mA
Input type	Differential input
Digital converter resolution	12-bit
Conversion time	300 µs for all inputs
Output format	
Data type	INT
Current	0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA
Load	<400 Ω
Input protection	Protection against wiring with supply voltage
Permissible input signal	Max. ±50 mA
Output of digital value during overload	Configurable
Conversion procedure	SAR
Input filter	Third-order low-pass filter / Cutoff frequency 1 kHz
Max. error	
Gain	
0 to 20 mA	0.08% [1]
4 to 20 mA	0.1% [1]
Offset	
0 to 20 mA	0.03% [2]
4 to 20 mA	0.16% [2]
Max. gain drift	
0 to 20 mA	0.009%/°C [1]
4 to 20 mA	0.0113% / °C [1]
Max. offset drift	
0 to 20 mA	0.004%/°C [2]
4 to 20 mA	0.005 %/°C [2]

Table 2: X20AI2322 - Technical data

Order number	X20AI2322
Common-mode rejection	
DC	70 dB
50 Hz	70 dB
Common-mode range	±12 V
Crosstalk between channels	-70 dB
Nonlinearity	<0.05% 2)
Insulation voltage between channel and bus	500 V_{eff}
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: X20AI2322 - Technical data

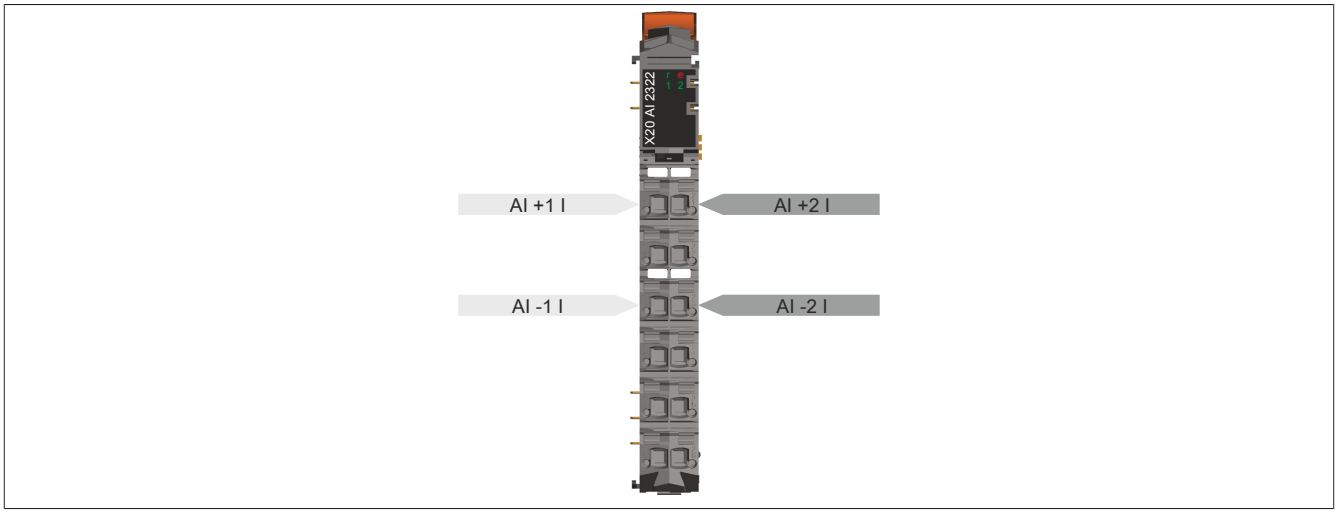
1) Based on the current measured value.
2) Based on the 20 mA measurement range.

2.2 LED status indicators

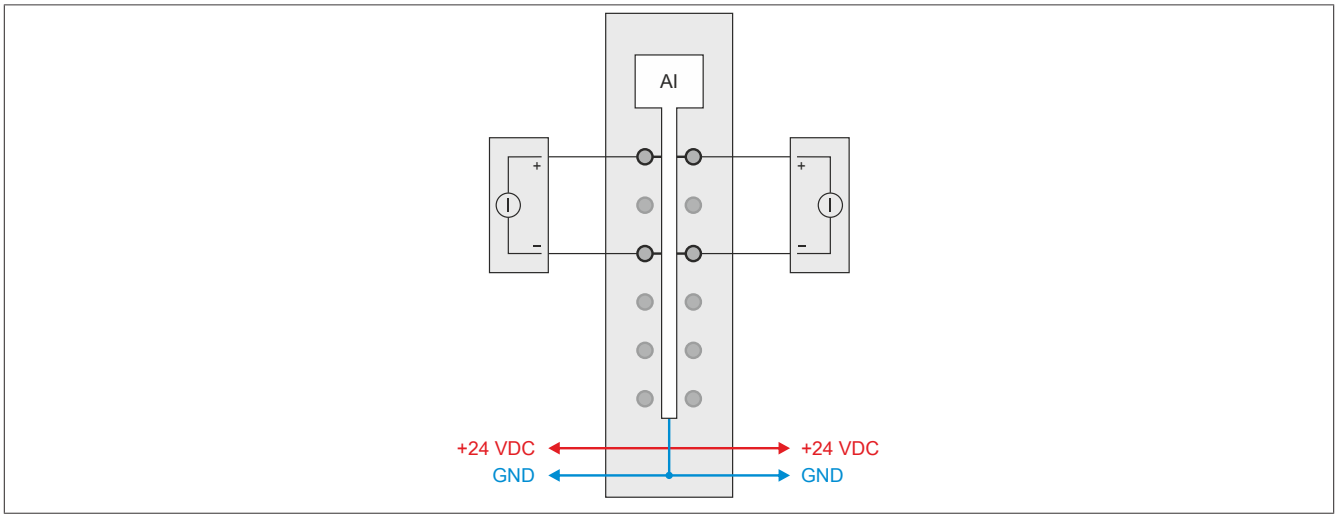
For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

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
	e + r	Red on / Green single flash		Invalid firmware
	1 - 2	Green	Blinking	Input signal overflow or underflow
			On	Analog/digital converter running, value OK

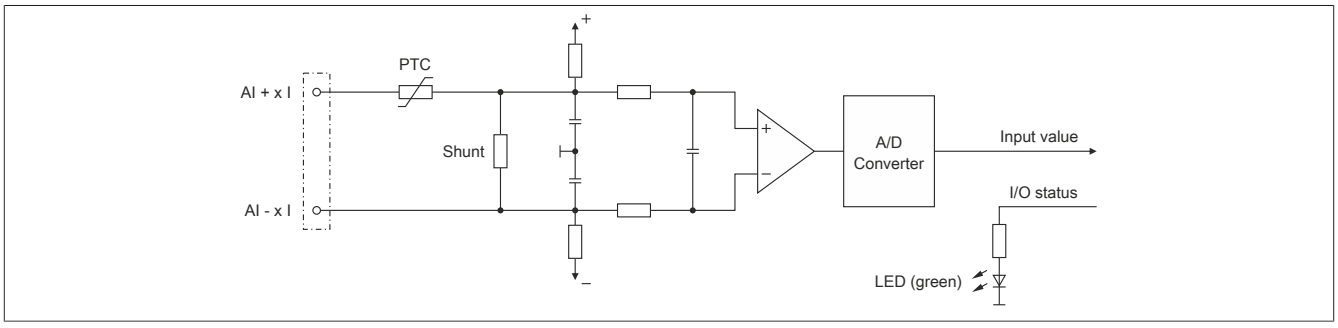
2.3 Pinout



2.4 Connection example



2.5 Input circuit diagram



3 Function description

3.1 Input filter

The module is equipped with a configurable input filter. The minimum cycle time must be >500 µs. The filter function is disabled for shorter cycle times.

When the input filter is activated, the channels are sampled at millisecond intervals. The time offset between the channels is 200 µs. The conversion takes place asynchronously to the network cycle.

Information:

The register is described in "Configuring the input filter" on page 13.

3.1.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value ± the limit value.

Configurable limit values:

Value	Limit value
0	The input value is used without limitation.
1	0x3FFF = 16383
2	0x1FFF = 8191
3	0x0FFF = 4095
4	0x07FF = 2047
5	0x03FF = 1023
6	0x01FF = 511
7	0x00FF = 255

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

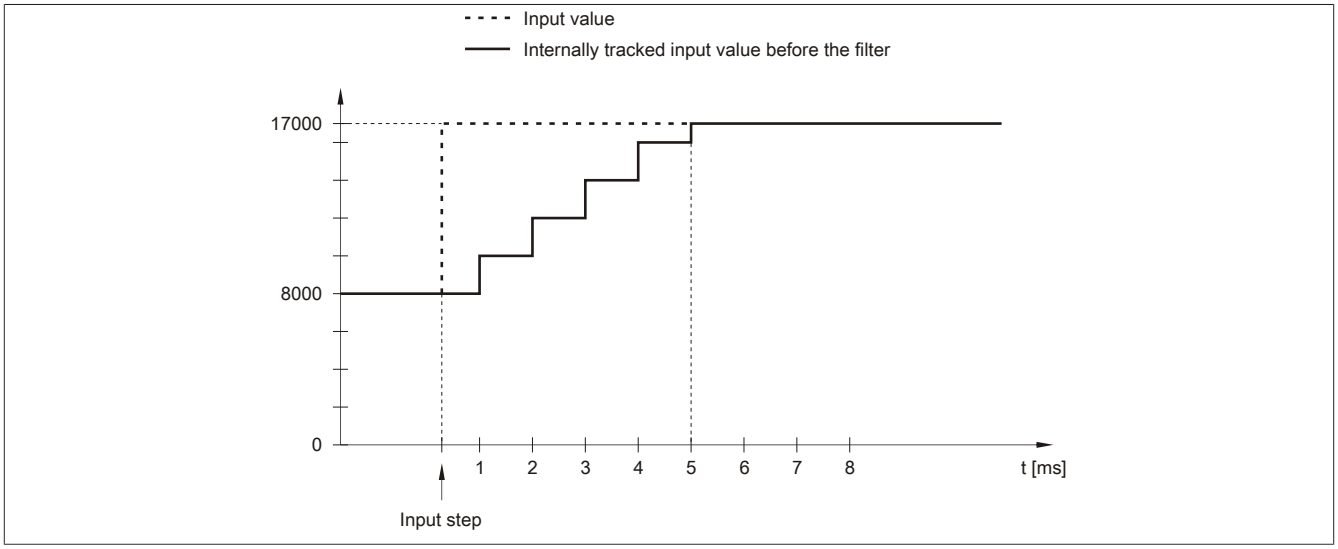


Figure 1: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

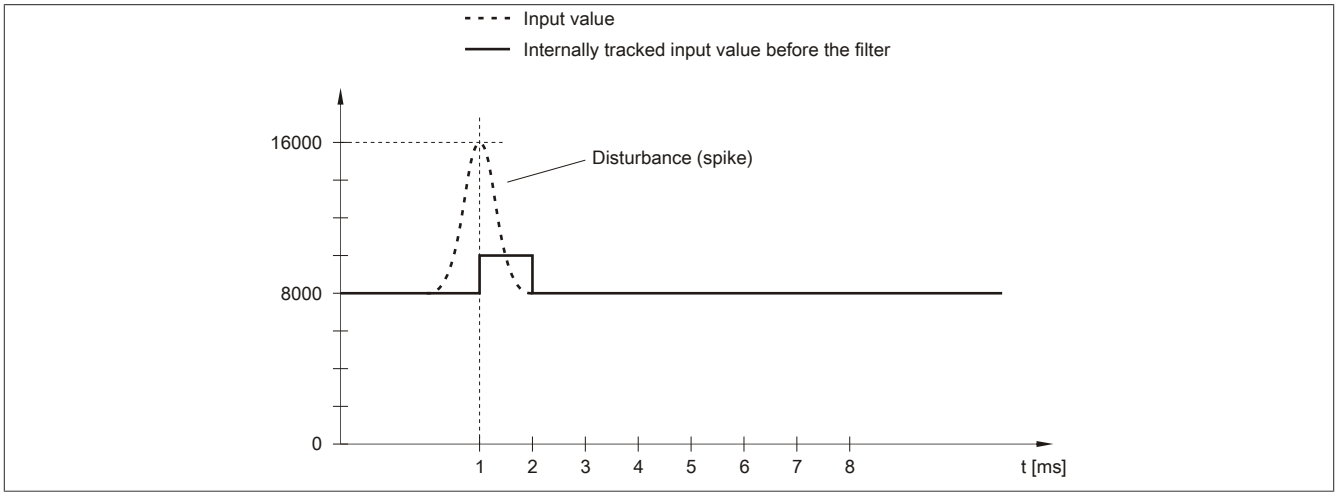


Figure 2: Tracked input value for disturbance

3.1.2 Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.
Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

Value	Filter level
0	Filter switched off
1	Filter level 2
2	Filter level 4
3	Filter level 8
4	Filter level 16
5	Filter level 32
6	Filter level 64
7	Filter level 128

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

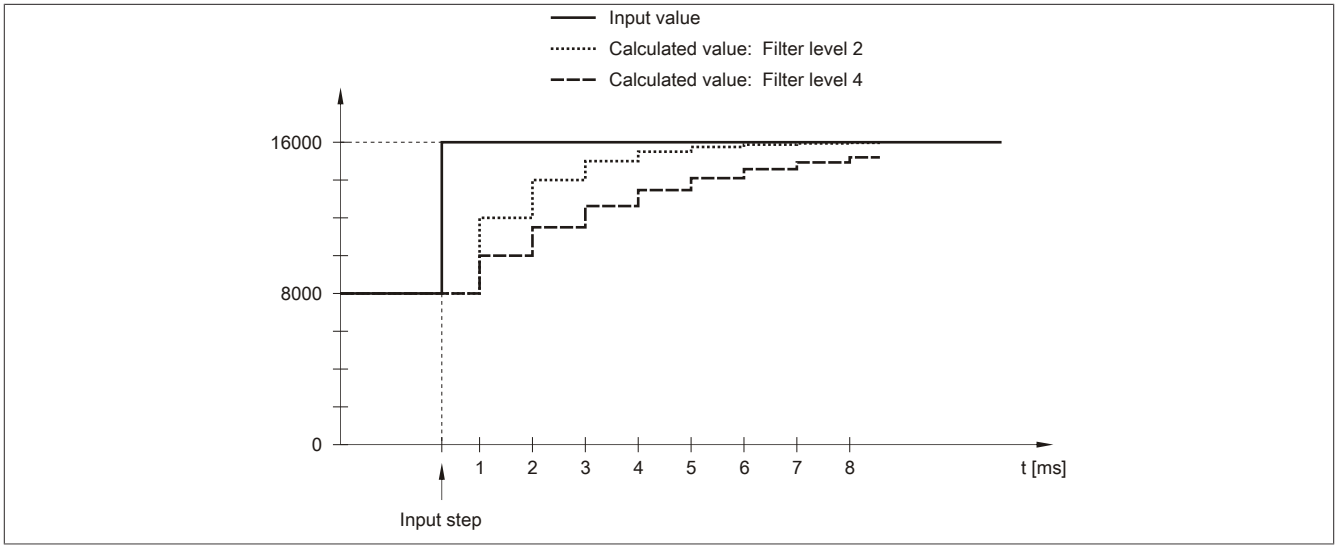


Figure 3: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

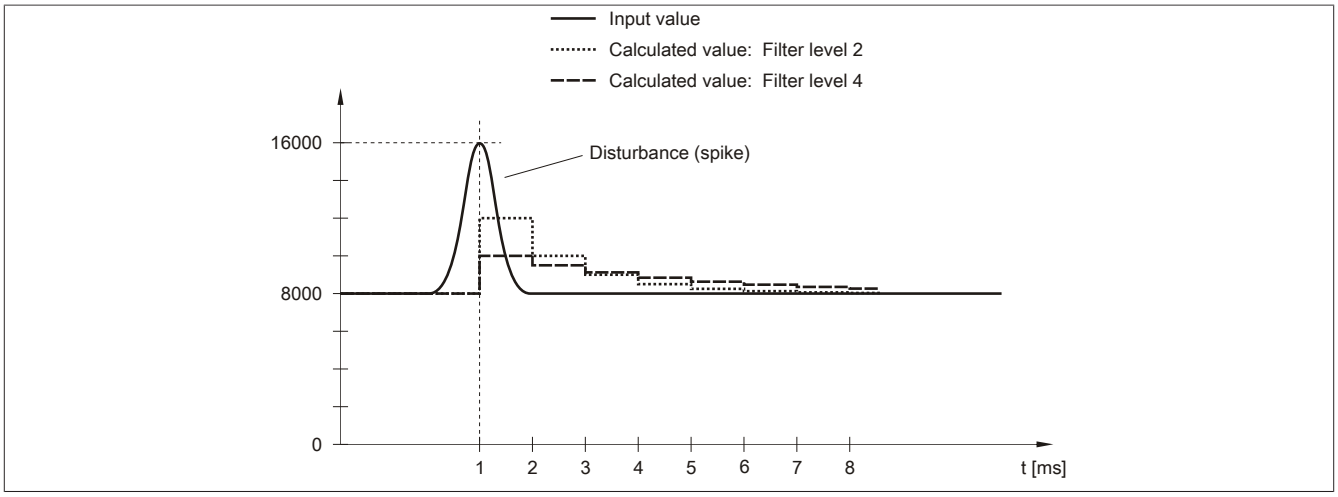


Figure 4: Calculated value during disturbance

3.2 Monitoring the input signal

The input signal is monitored against the upper and lower limit values. These must be defined according to the operating mode:

Limit value (default)	Current signal 0 to 20 mA		Current signal 4 to 20 mA	
Upper maximum limit value	20 mA	+32767 (0x7FFF)	20 mA	+32767 (0x7FFF)
Lower minimum limit value	0 mA	0 (0x0000)	4 mA	-8191 (0xE001)

Other limit values can be defined if necessary. The limit values apply to all channels. These are enabled automatically by writing to the limit value registers. From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register.

Examples of limit value settings

Use case	Limit value settings
Current signal: 4 to 20 mA	If values <4 mA should be measured for a current signal with 4 to 20 mA, a negative limit value must be set: 0 mA corresponds to value -8192 (0xE000).

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. The analog value is limited to the new values if the limit values were changed.

Error state	Digital value on error (default values)	
	0 to 20 mA	4 to 20 mA
Upper limit value overshot	+32767 (0x7FFF)	
Lower limit value undershot	0	-8191 (0xE001)

Information:

The register is described in "Input status" on page 15.

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.

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 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Non-cyclic	Cyclic	Non-cyclic
Analog signal - Configuration						
16	ConfigOutput01 (Input filter)	USINT				•
18	ConfigOutput02 (Channel type)	USINT				•
20	ConfigOutput03 (Lower limit value)	INT				•
22	ConfigOutput04 (Upper limit value)	INT				•
Analog signal - Communication						
0	AnalogInput01	INT	•			
2	AnalogInput02	INT	•			
30	StatusInput01	USINT	•			

5.3 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Non-cyclic	Cyclic	Non-cyclic
Analog signal - Configuration							
16	-	ConfigOutput01 (Input filter)	USINT				•
18	-	ConfigOutput02 (Channel type)	USINT				•
20	-	ConfigOutput03 (Lower limit value)	INT				•
22	-	ConfigOutput04 (Upper limit value)	INT				•
Analog signal - Communication							
0	0	AnalogInput01	INT	•			
2	2	AnalogInput02	INT	•			
30	-	StatusInput01	USINT		•		

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

5.4 Analog signal - Configuration

5.4.1 Channel type

Name:
ConfigOutput02

This register can be used to set the range of the current signal. This is determined by how they are configured. The following input signals can be set:

- 0 to 20 mA current signal
- 4 to 20 mA current signal

Data type	Values	Bus controller default setting
USINT	See the bit structure.	3

Bit structure:

Bit	Description	Value	Information
0 - 1	Reserved	1	
2 - 3	Reserved	0	
4	Channel 1: Current measurement range	0	0 to 20 mA current signal (bus controller default setting)
		1	4 to 20 mA current signal
5	Channel 2: Current measurement range	0	0 to 20 mA current signal (bus controller default setting)
		1	4 to 20 mA current signal
6 - 7	Reserved	0	

5.4.2 Configuring the input filter

Name:
ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

Data type	Values	Bus controller default setting
USINT	See the bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 2	Defines the filter level	000	Filter disabled (bus controller default setting)
		001	Filter level 2
		010	Filter level 4
		011	Filter level 8
		100	Filter level 16
		101	Filter level 32
		110	Filter level 64
		111	Filter level 128
3	Reserved	0	
4 - 6	Defines input ramp limiting	000	The input value is applied without limitation (bus controller default setting)
		001	Limit value = 0x3FFF (16383)
		010	Limit value = 0x1FFF (8191)
		011	Limit value = 0x0FFF (4095)
		100	Limit value = 0x07FF (2047)
		101	Limit value = 0x03FF (1023)
		110	Limit value = 0x01FF (511)
		111	Limit value = 0x00FF (255)
7	Reserved	0	

5.4.3 Lower limit value

Name:
ConfigOutput03

The lower limit value for analog values can be set in this register. If the analog value undershoots the limit value, it is frozen at this value and the corresponding error state bit is set.

Data type	Values	Information
INT	-32768 to 32767	Bus controller default setting: -32767

Information:

- **When configured as 0 to 20 mA, this value should be set to 0.**
- **When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.**

Keep in mind that this setting applies to all channels!

5.4.4 Upper limit value

Name:
ConfigOutput04

The upper limit value for analog values can be set in this register. If the analog value overshoots the limit value, it is frozen at this value and the corresponding error state bit is set.

Data type	Values	Information
INT	-32768 to 32767	Bus controller default setting: 32767

Information:

The default value of 32767 corresponds to the maximum default value at 20 mA.

Keep in mind that this setting applies to all channels!

5.5 Analog signal - Communication

5.5.1 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

5.5.2 Analog input values

Name:
AnalogInput01 to AnalogInput02

The analog input values are mapped to this register.

Data type	Value	Input signal:
INT	0 to 32767	Current signal 0 to 20 mA
	-8192 to 32767	Current signal 4 to 20 mA (value 0 corresponds to 4 mA)

5.5.3 Input status

Name:
StatusInput01

The module inputs are monitored in this register. 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 10.

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
2 - 3	Channel 2	00	No error
		01	Lower limit value exceeded
		10	Upper limit value exceeded
4 - 7	Reserved	0	

5.6 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
Inputs without filtering	100 µs
Inputs with filtering	500 µs

5.7 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
Inputs without filtering	300 µs for all inputs
Inputs with filtering	1 ms