

X20AI2322

1 General information

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.

- 2 analog inputs, 0 to 20 mA or 4 to 20 mA
- 12-bit digital converter resolution

2 Order data


Model number	Short description	Figure
	Analog inputs	
X20AI2322	X20 analog input module, 2 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter	
	Required accessories	
	Bus modules	
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	
	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

3 Technical data

Model 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 status LED and software
Inputs	Yes, using status LED 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
EAC	Yes
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X
DNV GL	Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck)
LR	ENV1
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	3rd-order low pass / cutoff frequency 1 kHz
Max. error at 25°C	
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⁾
Common-mode rejection	
DC	70 dB
50 Hz	70 dB
Common-mode range	±12 V
Crosstalk between channels	-70 dB
Nonlinearity	<0.05% ²⁾
Isolation 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

Table 2: X20AI2322 - Technical data


Model number	X20AI2322
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
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 X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately
Spacing	12.5 ^{+0.2} mm

Table 2: X20AI2322 - Technical data

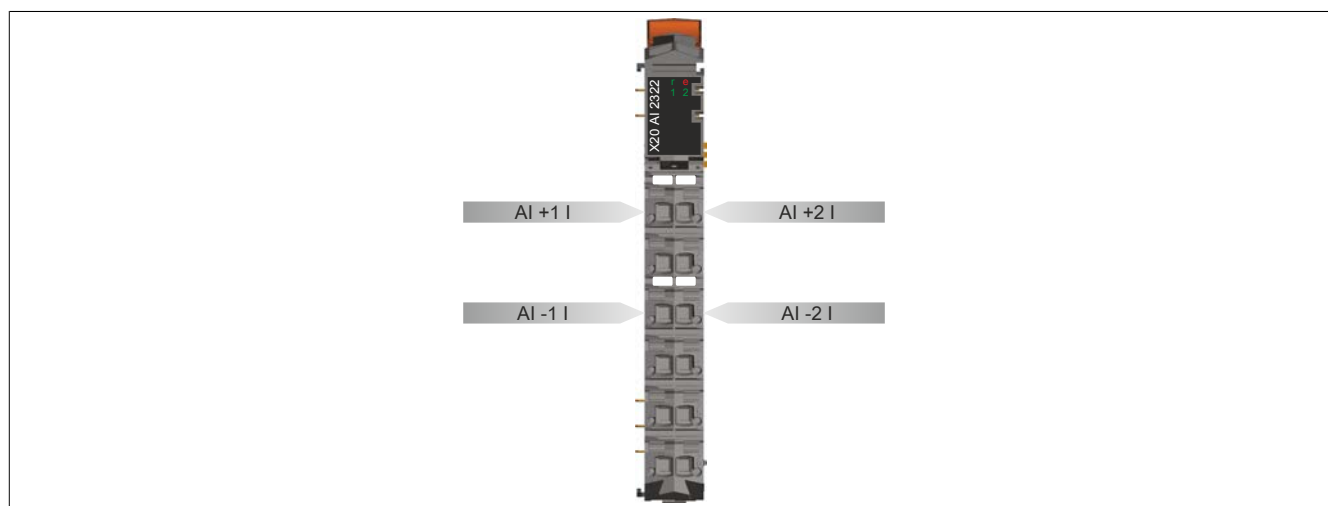
- 1) Based on the current measured value.
2) Based on the 20 mA measurement range.

4 LED status indicators

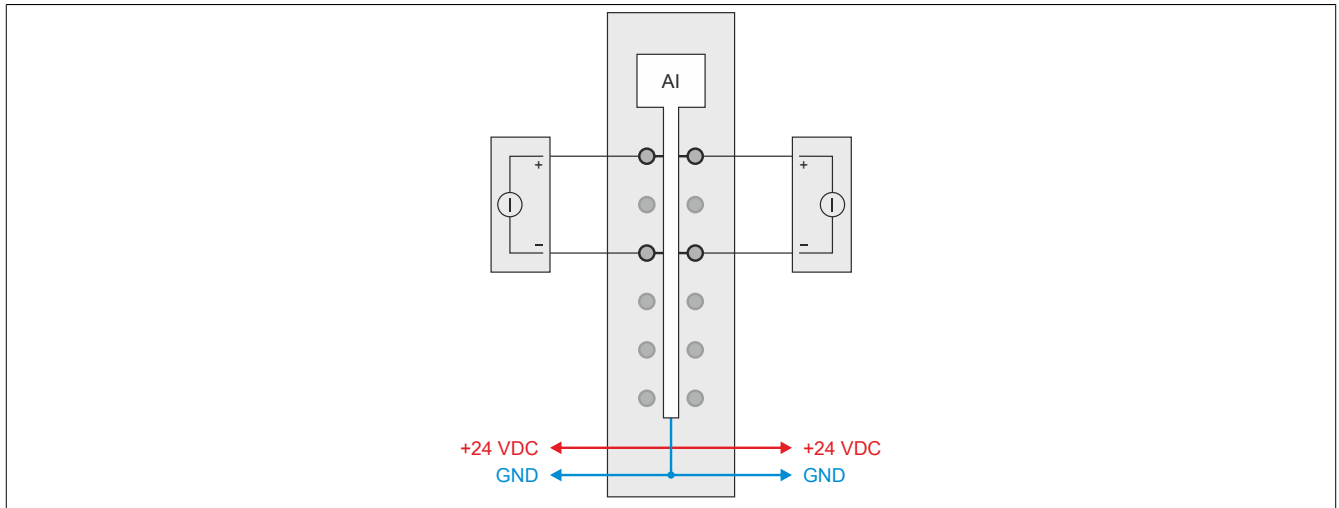
For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" of the X20 system user's manual.

Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	RESET mode
			Blinking	PREOPERATIONAL mode
			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

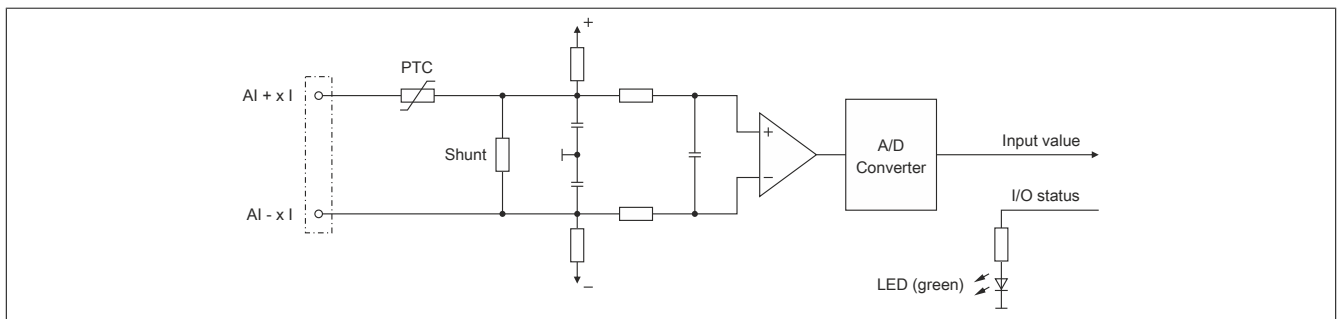
5 Pinout



6 Connection example



7 Input circuit diagram



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 - 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	•			

8.3 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.

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 Analog inputs

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

8.5 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)

8.6 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>500\ \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the scan rate for the channels is measured in ms. The time offset between the channels is $200\ \mu\text{s}$. The conversion takes place asynchronously to the network cycle.

8.6.1 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 \pm the limit value.

Adjustable 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 jump 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

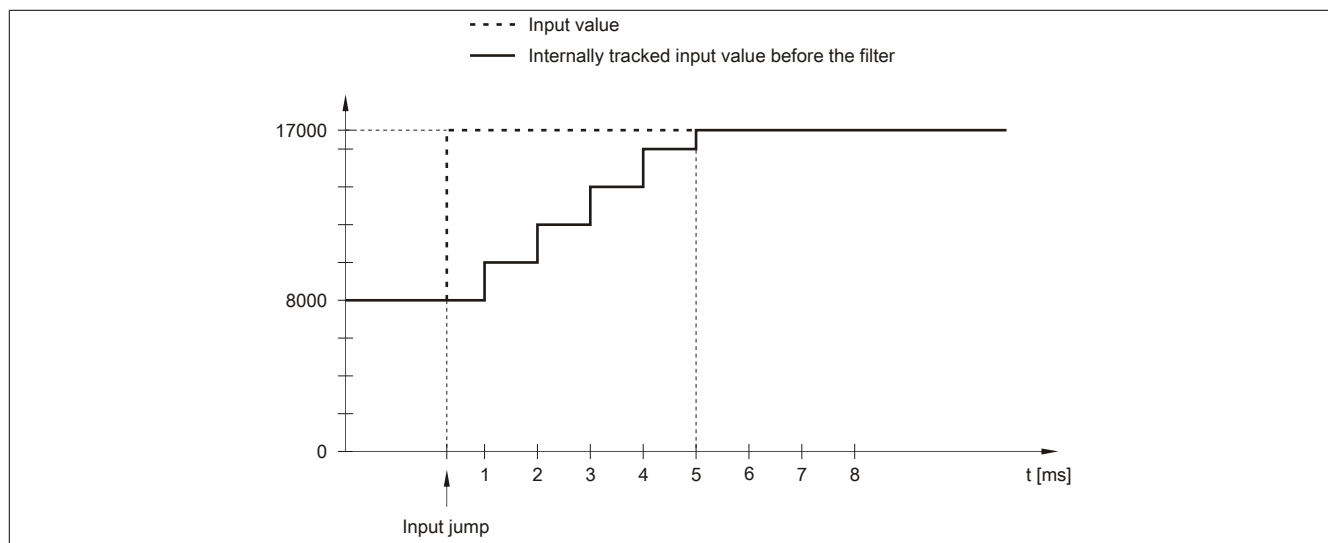


Figure 1: Tracked input value for input jump

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

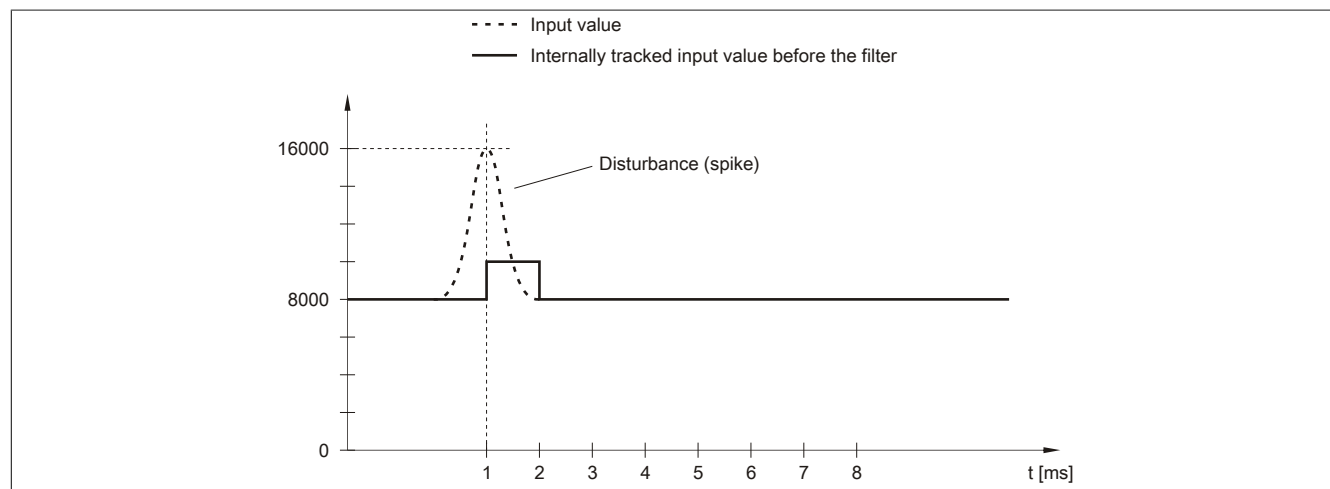


Figure 2: Adjusted input value for disturbance

8.6.2 Filter level

A filter can be defined to prevent large input jumps. 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 input ramp limitation.

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 how filtering works in the event of an input jump or 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

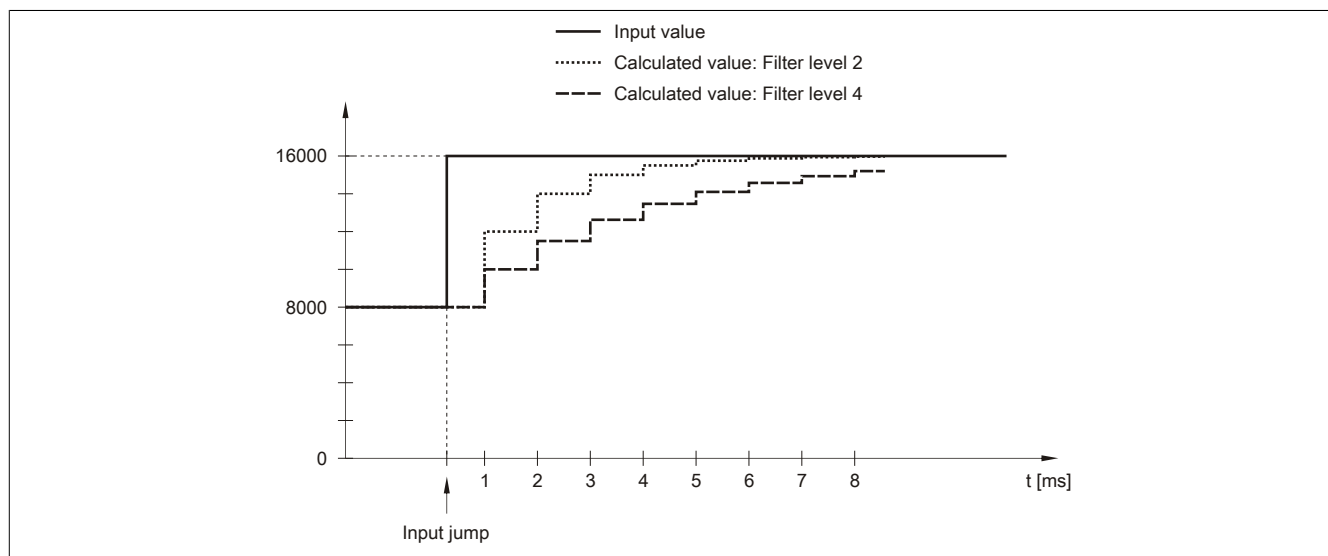


Figure 3: Calculated value during input jump

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

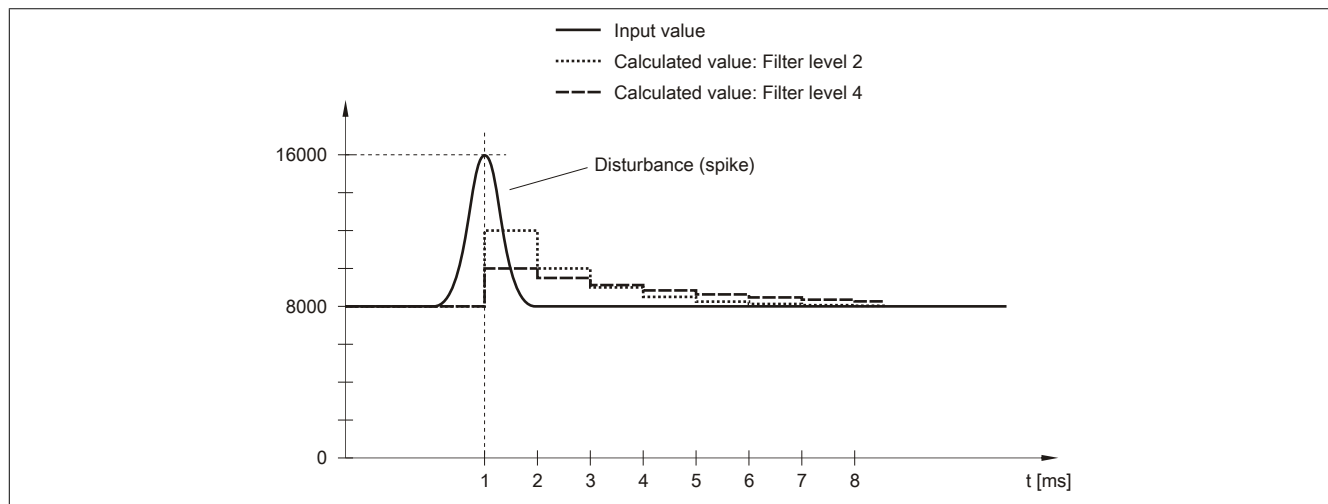


Figure 4: Calculated value during disturbance

8.7 Configuring the input filter

Name:

ConfigOutput01

This register is used to define the filter level and input ramp limitation of the input filter.

Data type	Values	Bus controller default setting
USINT	See 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 the input ramp limit	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	

8.8 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	

8.9 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status 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!

8.10 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status 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!

8.11 Input status

Name:

StatusInput01

This register is used to monitor the module inputs. 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
2 - 3	Channel 2	00	No error
		01	Lower limit value exceeded
		10	Upper limit value exceeded
4 - 7	Reserved	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. The analog value is limited to the new values if the limit values were changed.

Error status	Digital value for error (default values)	
	0 to 20 mA	4 to 20 mA
Upper limit value exceeded	+32767 (0x7FFF)	
Lower limit value exceeded	0	-8191 (0xE001)

8.12 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	
Inputs without filtering	100 µs
Inputs with filtering	500 µs

8.13 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