X20(c)AI4622

1 General information

The module is equipped with 4 inputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog inputs
- Either current or voltage signal possible
- 13-bit digital converter resolution

2 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

3 Order data

Model number	Short description	Figure
	Analog inputs	
X20AI4622	X20 analog input module, 4 inputs, ±10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter	
X20cAI4622	X20 analog input module, coated, 4 inputs, ±10 V or 0 to 20 mA / 4 to 20 mA, 13-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	
X20cBM11	X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20AI4622, X20cAI4622 - Order data

4 Technical data

Model number	X20AI4622	X20cAI4622
Short description		
I/O module	4 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA	
General information		
B&R ID code	0x1BAA	0xE1EF
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	
Channel type	Yes, using software	
Power consumption		
Bus	0.01 W	
Internal I/O	1.1 W [1]	
Additional power dissipation caused by the actuators (resistive) [W]	-	
Electrical isolation		
Channel - Bus	Yes	
Channel - Channel	No	
Certification		
CE	Yes	
KC	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 = 0 - Max. 60°C FTZÚ 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)	
GOST-R	Yes	
Analog inputs		
Input	±10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections	
Input type	Differential input	
Digital converter resolution		
Voltage	±12-bit	
Current	12-bit	
Conversion time	400 µs for all inputs	
Output format	INT	
Output format		
Voltage	INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV	
Current	INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA	
Input impedance in signal range		
Voltage	20 MΩ	
Current	-	
Load		
Voltage	-	
Current	<400 Ω	
Input protection	Protection against wiring with supply voltage	
Permitted input signal		
Voltage	Max. ±30 V	
Current	Max. ±50 mA	
Output of the digital value during overload	Configurable	
Conversion procedure	SAR	
Input filter	3rd-order low pass / cutoff frequency 1 kHz	
Max. error at 25°C		
Voltage		
Gain	0.08% [2]	
Offset	0.015% [3]	
Current		
Gain	0 to 20 mA = 0.08 % / 4 to 20 mA = 0.1 % [2]	
Offset	0 to 20 mA = 0.03 % / 4 to 20 mA = 0.16 % [4]	
Max. gain drift		
Voltage	0.006 %/°C [2]	
Current	0 to 20 mA = 0.009 %/°C 4 to 20 mA = 0.0113 %/°C [2]	

Table 2: X20AI4622, X20cAI4622 - Technical data

Model number	X20AI4622	X20cAI4622
Max. offset drift		
Voltage	0.002 %/°C [3]	
Current	0 to 20 mA = 0.004 %/°C 4 to 20 mA = 0.005 %/°C [4]	
Common-mode rejection		
DC	70 dB	
50 Hz	70 dB	
Common-mode range	±12 V	
Crosstalk between channels	<-70 dB	
Nonlinearity		
Voltage	<0.025% [3]	
Current	<0.05% [4]	
Isolation voltage between channel and bus	500 V_{eff}	
Operating conditions		
Mounting orientation		
Horizontal	Yes	
Vertical	Yes	
Installation at elevations above sea level		
0 to 2000 m	No limitations	
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m	
EN 60529 protection	IP20	
Environmental conditions		
Temperature		
Operation		
Horizontal installation	-25 to 60°C	
Vertical installation	-25 to 50°C	
Derating	-	
Storage	-40 to 85°C	
Transport	-40 to 85°C	
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 characteristics		
Note	Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately	Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately
Spacing	12.5$^{+0.2}$ mm	12.5 $^{+0.2}$ mm

Table 2: X20AI4622, X20cAI4622 - Technical data

1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
2) Based on the current measured value.
3) Based on the 20 V measurement range.
4) Based on the 20 mA measurement range.

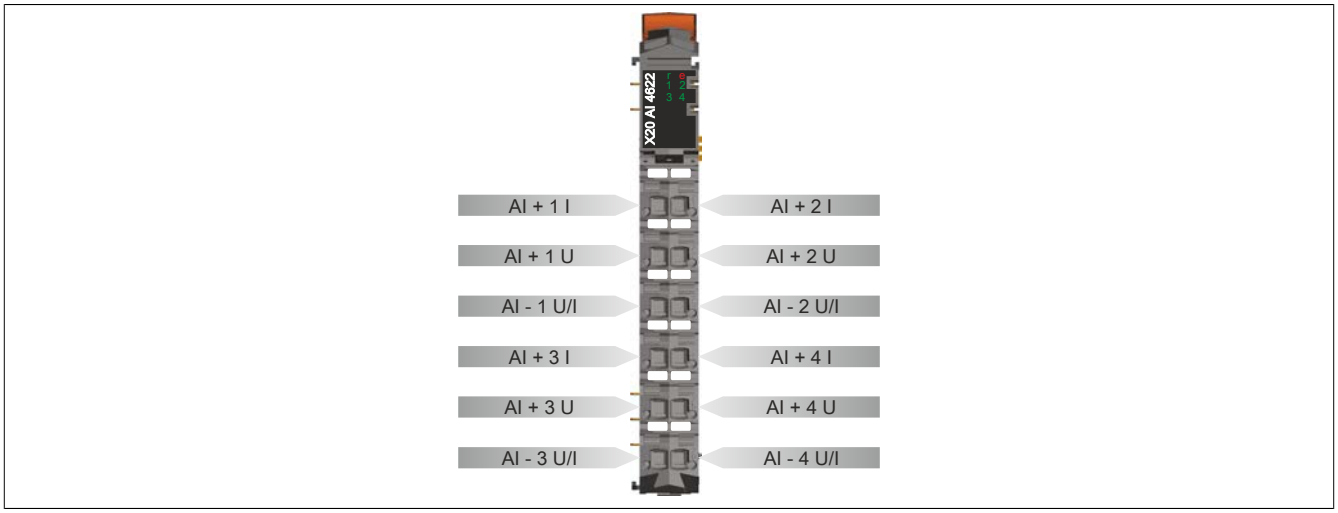
5 LED status indicators

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

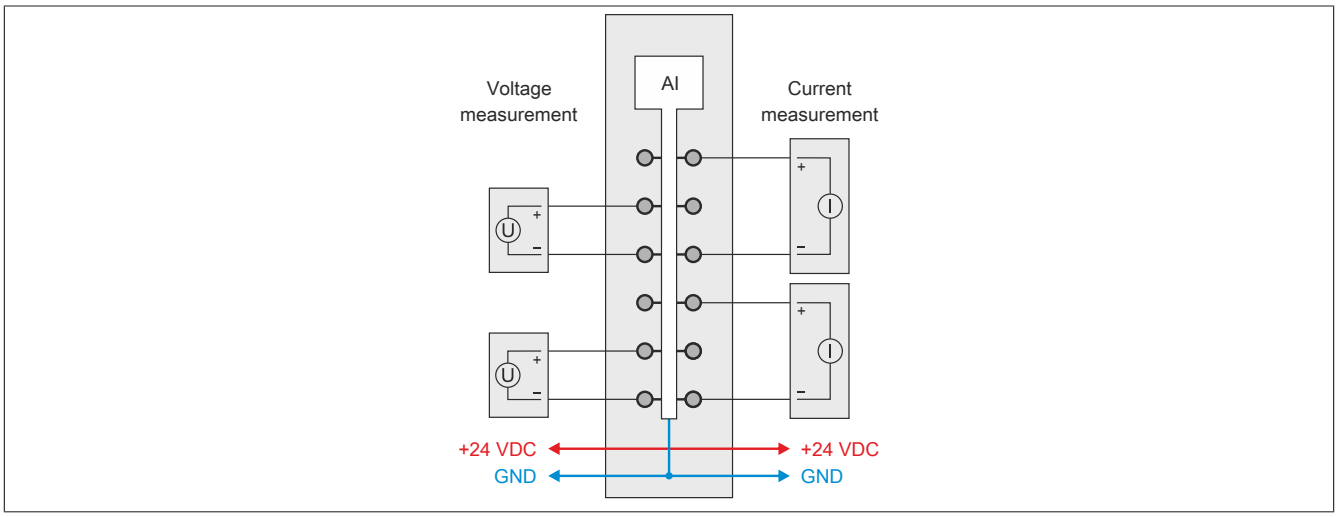
Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	RESET mode
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
	e + r	Red on / Green single flash		Invalid firmware
	1 - 4	Green	Off	Open line[1] or sensor is disconnected
			Blinking	Input signal overflow or underflow
			On	Analog/digital converter running, value OK

1) Open line detection only possible when measuring voltage.

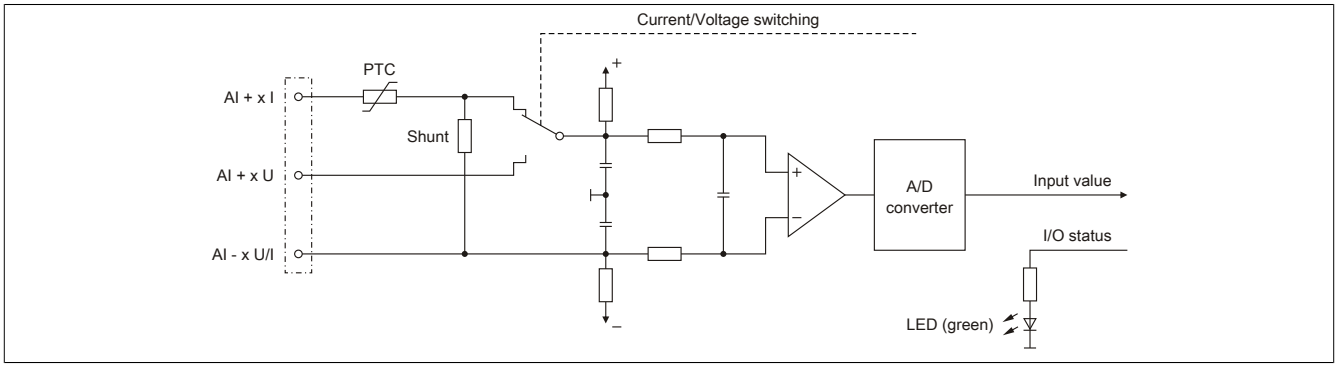
6 Pinout



7 Connection example



8 Input circuit diagram



9 Register description

9.1 General data points

In addition to the registers listed in the register description, the module also has other more general data points. These registers are not specific to the module but contain general information such as serial number and hardware version.

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

9.2 Function model 0 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
16	ConfigOutput01 (Input filter)	USINT				•
18	ConfigOutput02 (Channel type)	USINT				•
20	ConfigOutput03 (Lower limit value)	INT				•
22	ConfigOutput04 (Upper limit value)	INT				•
Communication						
0	AnalogInput01	INT	•			
2	AnalogInput02	INT	•			
4	AnalogInput03	INT	•			
6	AnalogInput04	INT	•			
30	StatusInput01	USINT	•			

9.3 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
16	-	ConfigOutput01 (Input filter)	USINT				•
18	-	ConfigOutput02 (Channel type)	USINT				•
20	-	ConfigOutput03 (Lower limit value)	INT				•
22	-	ConfigOutput04 (Upper limit value)	INT				•
Communication							
0	0	AnalogInput01	INT	•			
2	2	AnalogInput02	INT	•			
4	4	AnalogInput03	INT	•			
6	6	AnalogInput04	INT	•			
30	-	StatusInput01	USINT		•		

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

9.3.1 CAN I/O bus controller

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

9.4 Analog inputs

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

9.5 Analog input values

Name:
AnalogInput01 to AnalogInput04

The analog input value are mapped to this register depending on the configured operating mode.

Data type	Value	Input signal:
INT	-32768 to 32767	Voltage signal -10 to 10 VDC
	0 to 32767	Current signal 0 to 20 mA

9.6 Input filter

This module is equipped with a configurable input filter. The minimum X2X cycle time must be >500 µs. Filtering is disabled for shorter X2X cycle times.

If the input filter is active, then the channels are scanned in 1 ms cycles. The time offset between the channels is 200 µs. Conversion is performed acyclically to the X2X cycle.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

9.6.1 Input ramp limitation

Input ramp limitation can only take place when a filter is used; the input ramp is limited before filtering takes place.

The amount the input value changes is checked to make sure that specified limits are not exceeded. If the values are exceeded, the adjusted 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 limitation is well suited for suppressing disturbances (spikes). The following examples show the function of the input ramp limitation based on an input jump and a disturbance.

Example 1

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

Input ramp limitation = 4 = 0x07FF = 2047

Filter level = 2

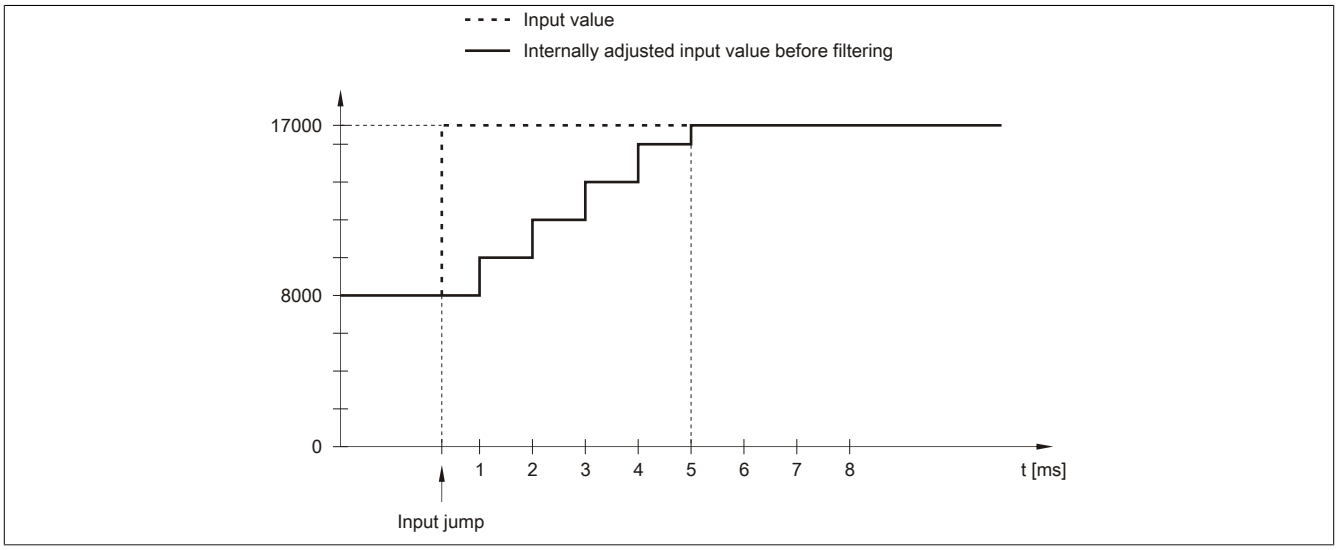


Figure 1: Adjusted input value for input jump

Example 2

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

Input ramp limitation = 4 = 0x07FF = 2047

Filter level = 2

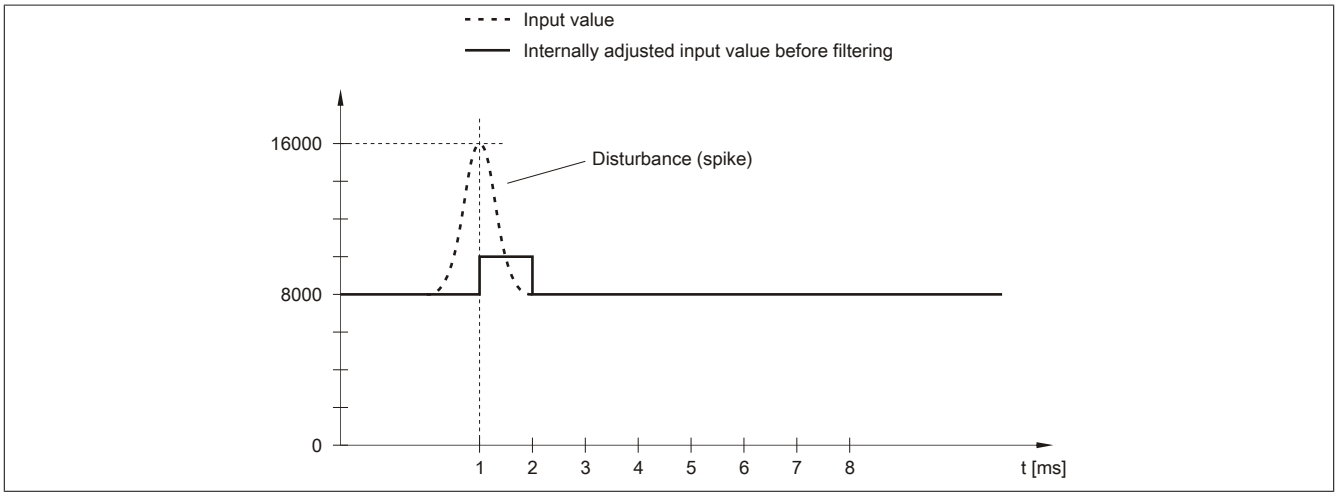


Figure 2: Adjusted input value for disturbance

9.6.2 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 milliseconds.
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 limitation = 0

Filter level = 2 or 4

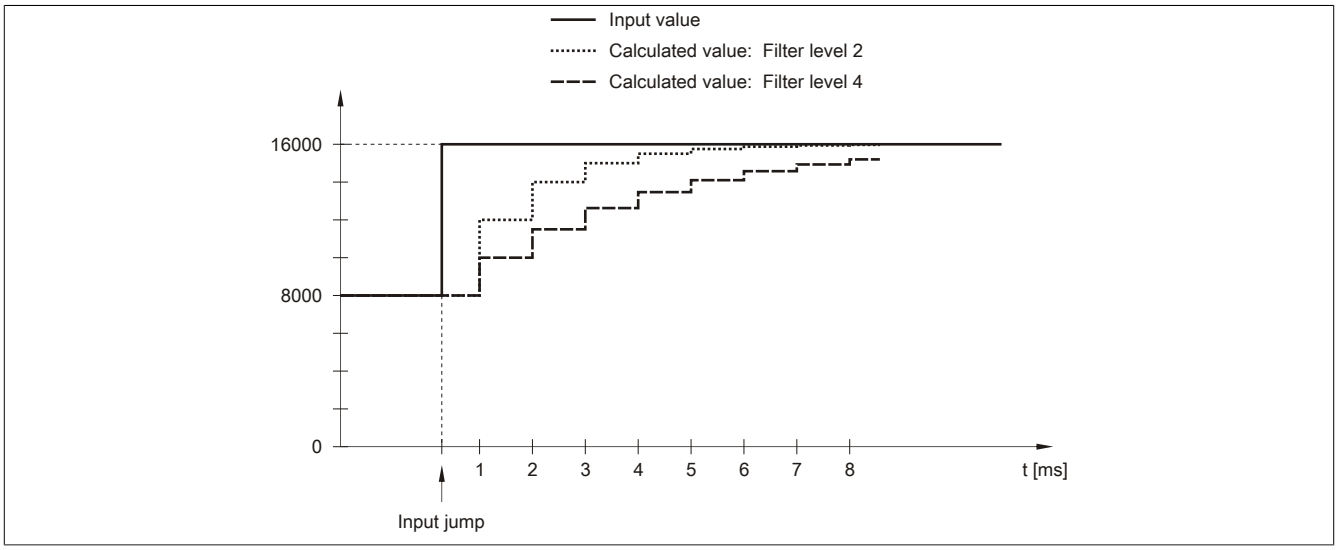


Figure 3: Calculated value during input jump

Example 2

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

Input ramp limitation = 0

Filter level = 2 or 4

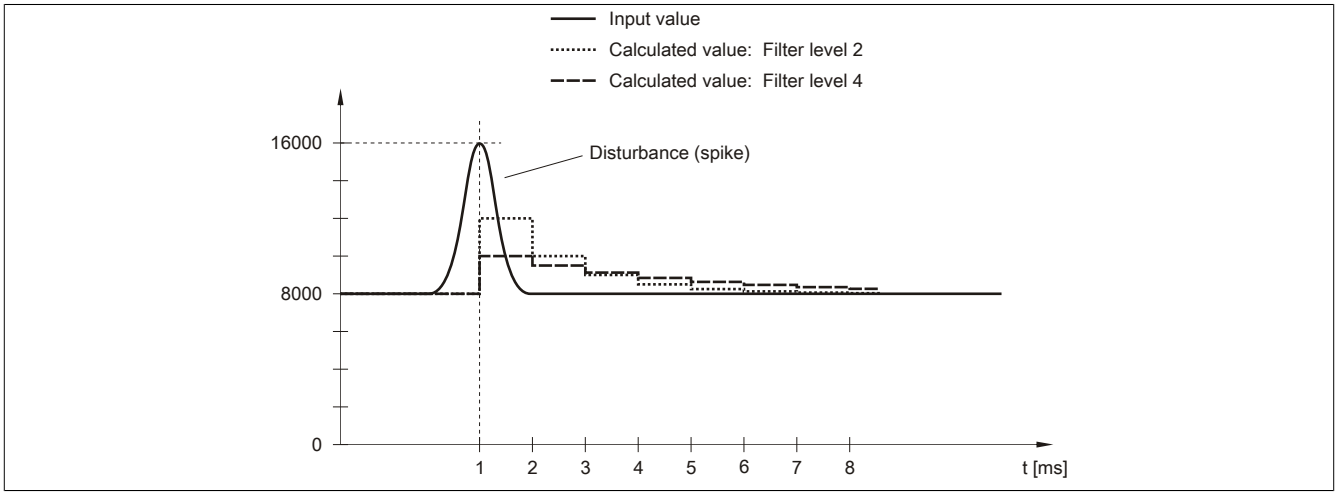


Figure 4: Calculated value during disturbance

9.7 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
USINT	See bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Defines the filter level	000	Filter switched off
		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 used without limitation
		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	

9.8 Channel type

Name:
ConfigOutput02

This register can be used to define the type and range of signal measurement.

Each channel is capable of handling either current or voltage signals. This differentiation is made using different terminals and an integrated switch in the module. The switch is automatically activated by the module depending on the specified configuration. The following input signals can be set:

- ±10 V voltage signal (default)
- 0 to 20 mA current signal
- 4 to 20 mA current signal

Data type	Values
USINT	See bit structure.

Bit structure:

Bit	Description	Value	Information
0	Channel 1	0	Voltage signal
		1	Current signal, measurement range corresponding to bit 4
...		...	
3	Channel 4	0	Voltage signal
		1	Current signal, measurement range corresponding to bit 7
4	Channel 1: Current measurement range	0	0 to 20 mA current signal
		1	4 to 20 mA current signal
...		...	
7	Channel 4: Current measurement range	0	0 to 20 mA current signal
		1	4 to 20 mA current signal

9.9 Limit values

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

Limit value (default)	Voltage signal ±10 V		Current signal 0 to 20 mA		Current signal 4 to 20 mA	
Upper maximum limit value	+10 V	+32767 (0x7FFF)	20 mA	+32767 (0x7FFF)	20 mA	+32767 (0x7FFF)
Lower minimum limit value	-10 V	-32767 (0x8001)	0 mA	0[1)]	4 mA	0[2)]

1) The analog value is limited down to 0.
2) The analog value is limited down to 0 at currents <4 mA. The status bit for the lower limit is set.

Other limit values can be defined if necessary. Limit values are valid for all channels and activated 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

Application case	Limit value settings
Current signal: 4 to 20 mA	A negative limit value must be configured in order to measure values <4 mA with a current signal of 4 to 20 mA: 0 mA is equal to a value of -8192 (0xE000).
Mixed voltage and current signal	The configured limit values are valid for all channels. Mixed operation (voltage and current signal) therefore requires a compromise. The following configuration has proven effective: Upper limit = +32767, lower limit = -32767 This makes it possible to also measure negative voltage values. A lower limit value of 0 would limit the voltage value to 0.
Current signal on all channels	All channels are configured for measuring current. The limit value setting in Automation Studio is not adjusted automatically. That means that +32767 is configured as the upper limit value and -32767 as the lower limit value. The necessary changes must be made by the user, e.g. lower limit value = 0

9.9.1 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	Value
INT	-32768 to 32767

Information:

- **The default value of -32768 corresponds to the minimum default value of -10 VDC.**
- **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.**

Information:

Keep in mind that this setting applies to all channels!

9.9.2 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	Value
INT	-32768 to 32767

Information:

The default value of 32767 corresponds to the maximum default value of 20 mA or +10 VDC.

Information:

Keep in mind that this setting applies to all channels!

9.10 Input status

Name:
StatusInput01

This register is used to monitor the module inputs. A change in the monitoring status generates an error message. The following states are monitored depending on the settings:

Value	Voltage signal ±10 V	Current signal 0 to 20 mA	Current signal 4 to 20 mA
0	No error	No error	No error
1	Lower limit value exceeded	Default setting The input value has a lower limit of 0x0000. Underflow monitoring is therefore not necessary. After lower limit value change The input value is limited to the configured value. The status bit is set when the lower limit value is passed.	Lower limit value exceeded
2	Upper limit value exceeded	Upper limit value exceeded	Upper limit value exceeded
3	Open line	-	-

Data type	Values
USINT	See 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
...		...	
6 - 7	Channel 4	00	No error
		01	Lower limit value exceeded
		10	Upper limit value exceeded
		11	Open line

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)
Open line	+32767 (0x7FFF)
Upper limit value exceeded	+32767 (0x7FFF)
Lower limit value exceeded	-32767 (0x8001)
Invalid value	-32768 (0x8000)

9.11 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring. Note that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

	Minimum cycle time
Inputs without filtering	100 µs
Inputs with filtering	500 µs

9.12 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

	Minimum I/O update time
Inputs without filtering	300 µs for all inputs
Inputs with filtering	1 ms