

# X20AI8221

## 1 General information

The module is equipped with 8 inputs with 13-bit (including sign) digital converter resolution. It can be used to capture voltage signals in the range from  $\pm 10$  V.

- 8 analog inputs  $\pm 10$  V
- 13-bit digital converter resolution

## 2 Order data


Model number	Short description	Figure
	<b>Analog inputs</b>	
X20AI8221	X20 analog input module, 8 inputs, $\pm 10$ V, 13-bit converter resolution	
	<b>Required accessories</b>	
	<b>Bus modules</b>	
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	
	<b>Terminal blocks</b>	
X20TB1F	X20 terminal block, 16-pin, 24 VDC keyed	

Table 1: X20AI8221 - Order data

### 3 Technical data

<b>Model number</b>	<b>X20AI8221</b>
<b>Short description</b>	
I/O module	8 analog inputs $\pm 10$ V
<b>General information</b>	
B&R ID code	0xD82F
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	1.04 W <sup>1)</sup>
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) FTZÚ 09 ATEX 0083X
DNV GL	Temperature: <b>B</b> (0 - 55°C) Humidity: <b>B</b> (up to 100%) Vibration: <b>B</b> (4 g) EMC: <b>B</b> (bridge and open deck)
LR	ENV1
KR	Yes
<b>Analog inputs</b>	
Input	$\pm 10$ V
Input type	Differential input
Digital converter resolution	$\pm 12$ -bit
Conversion time	1 ms for all inputs
Output format	
Data type	INT
Voltage	INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV
Input impedance in signal range	20 M $\Omega$
Input protection	Protection against wiring with supply voltage
Open-circuit detection	Yes, using software
Reverse polarity protection	Yes
Permissible input signal	Max. $\pm 30$ V
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	0.08% <sup>2)</sup>
Offset	0.015% <sup>3)</sup>
Max. gain drift	0.006 %/°C <sup>2)</sup>
Max. offset drift	0.002 %/°C <sup>3)</sup>
Common-mode rejection	
DC	70 dB
50 Hz	70 dB
Common-mode range	$\pm 12$ V
Crosstalk between channels	-70 dB
Nonlinearity	<0.025% <sup>3)</sup>
Isolation voltage between channel and bus	500 VDC, 1 min
<b>Electrical properties</b>	
Electrical isolation	Channel isolated from bus Channel not isolated from channel
<b>Operating conditions</b>	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
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

Table 2: X20AI8221 - Technical data


<b>Model number</b>	<b>X20AI8221</b>	
<b>Ambient conditions</b>		
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	
<b>Mechanical properties</b>		
Note	Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately	
Spacing	12.5 <sup>+0.2</sup> mm	

Table 2: X20AI8221 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.

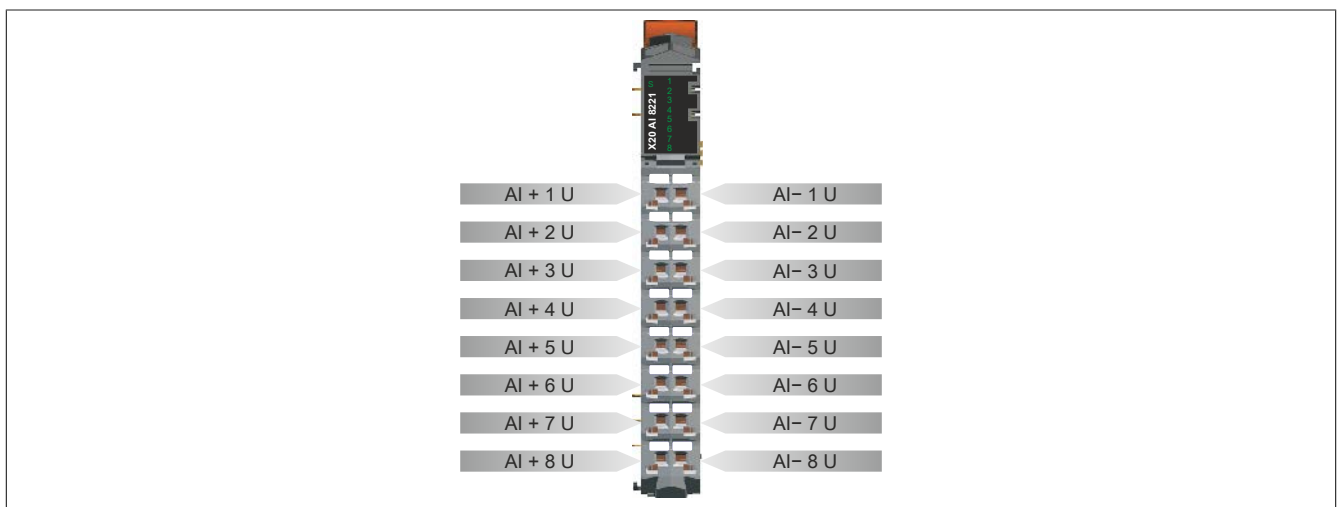
## 4 LED status indicators

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

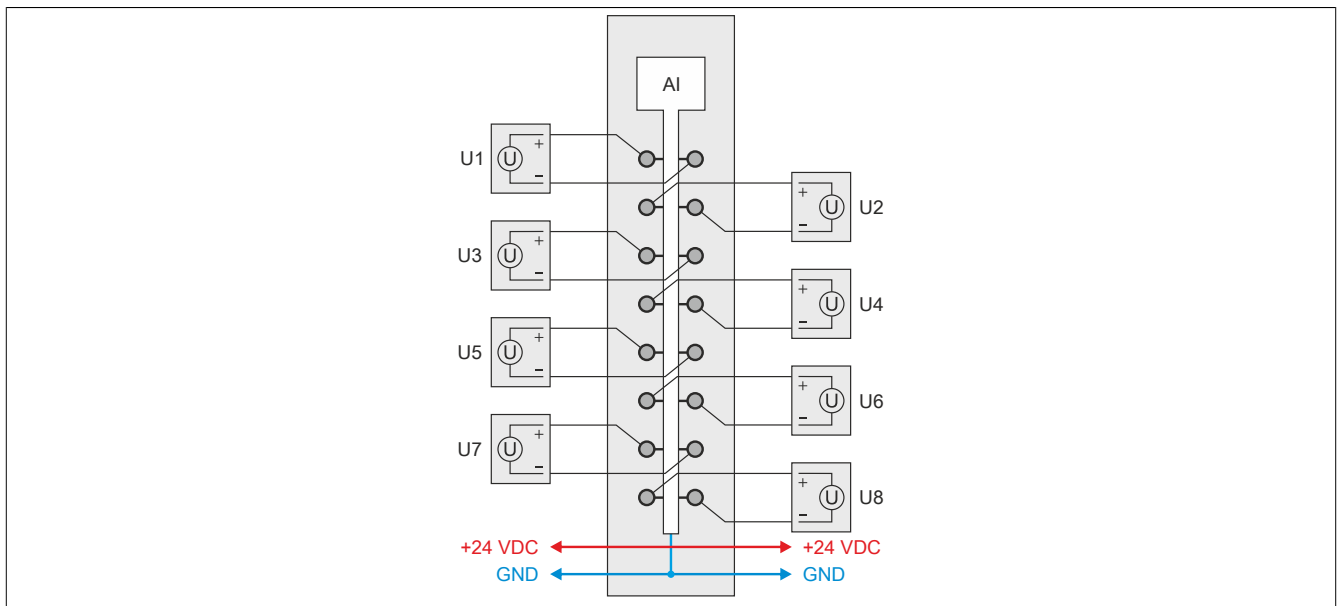
Figure	LED	Color	Status	Description
	S	Green	Off	No power to module
			Single flash	UNLINK mode
			Double flash	BOOT mode (during firmware update) <sup>1)</sup>
			Blinking quickly	SYNC mode
			Blinking slowly	PREOPERATIONAL mode
			On	RUN mode
	1 - 8	Red	Off	No power to module or everything OK
			On	Error or reset status
		Green	Off	Indicates one of the following cases: <ul style="list-style-type: none"> <li>• No power to module</li> <li>• Open line</li> </ul>
			Single flash	Input signal overflow or underflow
On	Analog/digital converter running, value OK			

- 1) Depending on the configuration, a firmware update can take up to several minutes.

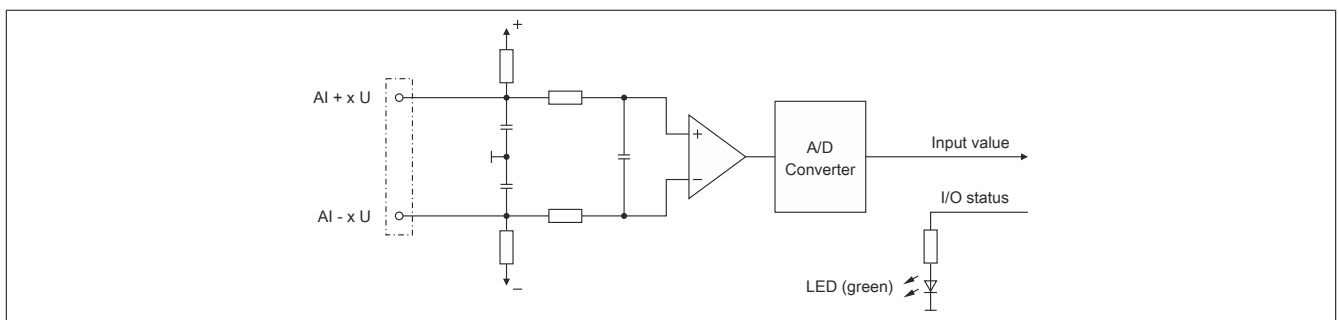
## 5 Pinout



## 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
<b>Analog signal - Configuration</b>						
16	ConfigOutput01 (Input filter)	USINT				•
20	ConfigOutput03 (Lower limit value)	INT				•
22	ConfigOutput04 (Upper limit value)	INT				•
<b>Analog signal - Communication</b>						
Index * 2 - 2	AnalogInput0N (Index N = 1 to 8)	INT	•			
30	StatusInput01	USINT	•			
31	StatusInput02	USINT	•			

### 8.3 Function model 254 - Bus controller

Register	Offset <sup>1)</sup>	Name	Data type	Read		Write	
				Cyclic	Non-cyclic	Cyclic	Non-cyclic
<b>Analog signal - Configuration</b>							
16	-	ConfigOutput01 (Input filter)	USINT				•
20	-	ConfigOutput03 (Lower limit value)	INT				•
22	-	ConfigOutput04 (Upper limit value)	INT				•
<b>Analog signal - Communication</b>							
Index * 2 - 2	Index * 2 - 2	AnalogInput0N (Index N = 1 to 8)	INT	•			
30	-	StatusInput01	USINT		•		
31	-	StatusInput02	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 2 analog logical slots on CAN I/O.

### 8.4 Analog inputs

Input signals are converted asynchronously in a 1 ms interval.

### 8.5 Analog input values

Name:

AnalogInput01 to AnalogInput08

The analog input values are mapped to this register.

Data type	Value	Input signal:
INT	-32,768 to 32,767	Voltage signal -10 to 10 VDC

## 8.6 Input filter

This module is equipped with a configurable input filter.

### Information:

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

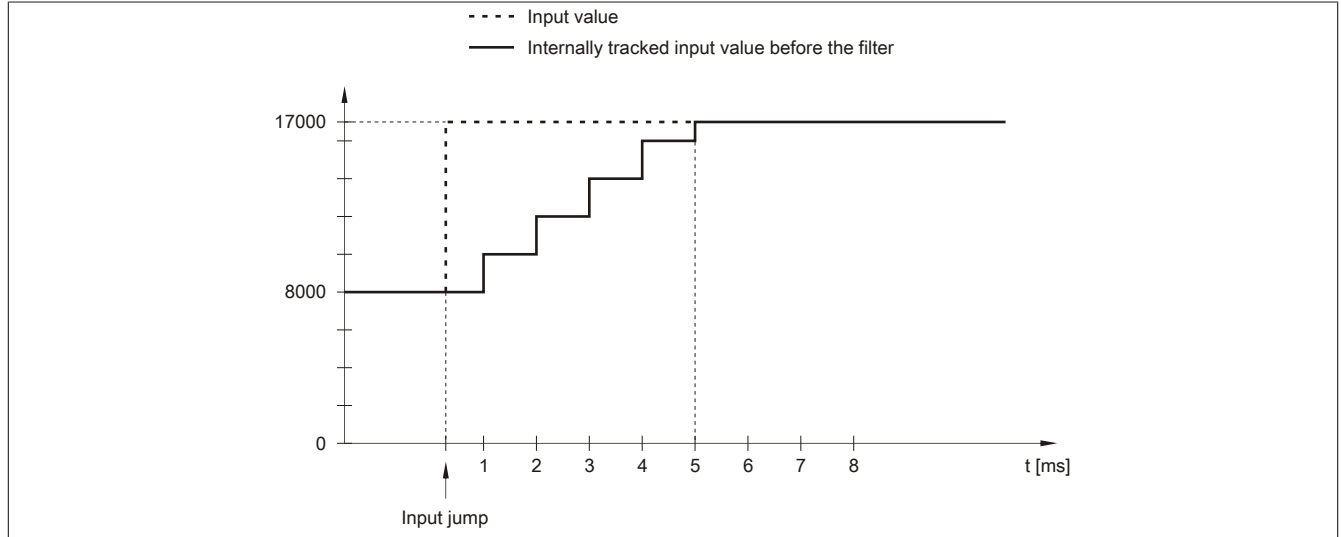


Figure 1: Tracked input value for input jump

### 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

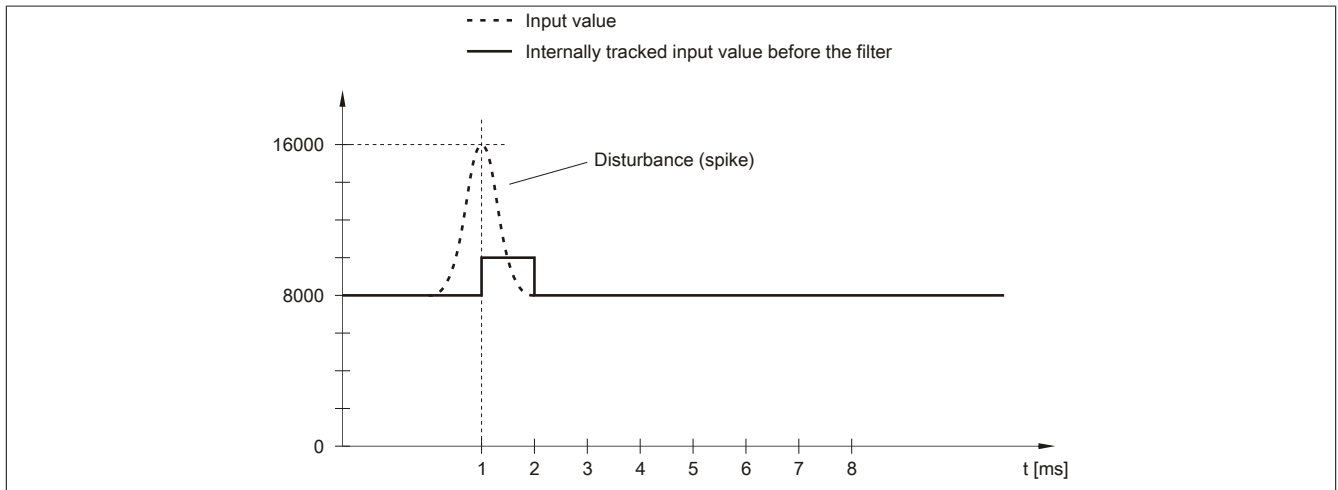


Figure 2: Adjusted input value for disturbance

### 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 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 limiting = 0

Filter level = 2 or 4

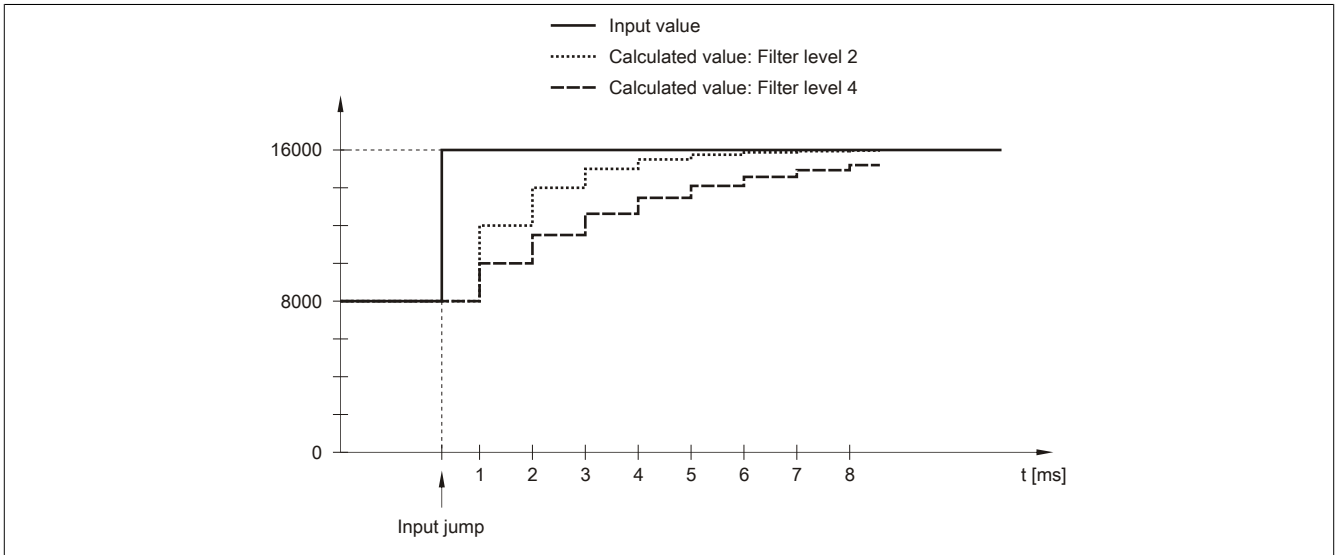


Figure 3: Calculated value during input jump

**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

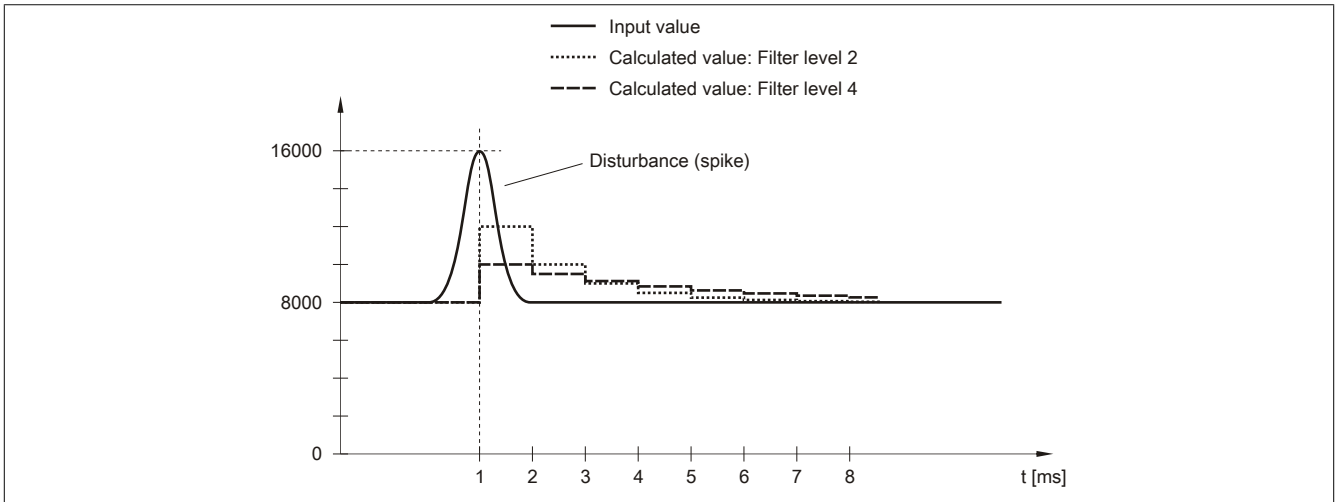


Figure 4: Calculated value during disturbance



## 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 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 the input ramp limitation	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 - 15	Reserved	0	

## 8.8 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	-32767 to 32767	Bus controller default setting: -32767

### Information:

The default value of **-32767** corresponds to the minimum default value of **-10 VDC**.

Keep in mind that this setting applies to all channels!

## 8.9 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	-32767 to 32767	Bus controller default setting: 32767

### Information:

The default value of **32767** corresponds to the maximum default value at **+10 VDC**.

Keep in mind that this setting applies to all channels!

## 8.10 Input status

Name:

StatusInput01 to StatusInput02

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:

StatusInput01 monitors Channels 1 to 4

StatusInput02 monitors Channels 5 to 8

Bit	Description	Value	Information
0 - 1	Channel 1 or 5	00	No error
		01	Lower limit value exceeded
		10	Upper limit value exceeded
		11	Open line
...		...	
6 - 7	Channel 4 or 8	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)

### 8.11 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
150 $\mu$ s

### 8.12 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 ms