

X20AI4622

1 General information

The X20AI4622 module is equipped with four inputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different connection terminal points.

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

2 Order data


Model number	Short description	Figure
	Analog input modules	
X20AI4622	X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit resolution, configurable input filter	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 V keyed, internal I/O supply continuous	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 V keyed	

Table 1: X20AI4622 - Order data

3 Technical data

Product ID	X20AI4622
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
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
cULus	Yes
cCSAus HazLoc Class 1 Division 2	Yes
ATEX Zone 2	Yes
KC	Yes
GOST-R	Yes
Analog inputs	
Input	± 10 V or 0 to 20 mA / 4 to 20 mA, via different connection terminal points
Input type	Differential input
Digital converter resolution	
Voltage	± 12 -bit
Current	12-bit
Conversion time	400 μ s 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 μ A
Input impedance in signal range	
Voltage	20 M Ω
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	
Below lower limit	
Voltage	0x8001
Current	0x0000
Above upper limit	
Voltage	0x7FFF
Current	0x7FFF
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⁾
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

Table 2: X20AI4622 - Technical data

Product ID	X20AI4622
Common-mode range	±12 V
Crosstalk between channels	<-70 dB
Non-linearity	
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 altitudes 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
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
Spacing	12.5 ^{+0.2} mm

Table 2: X20AI4622 - 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.

4 LED status indicators


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

Table 3: LED status indicators

- 1) Open line detection only possible when measuring voltage.

5 Pinout

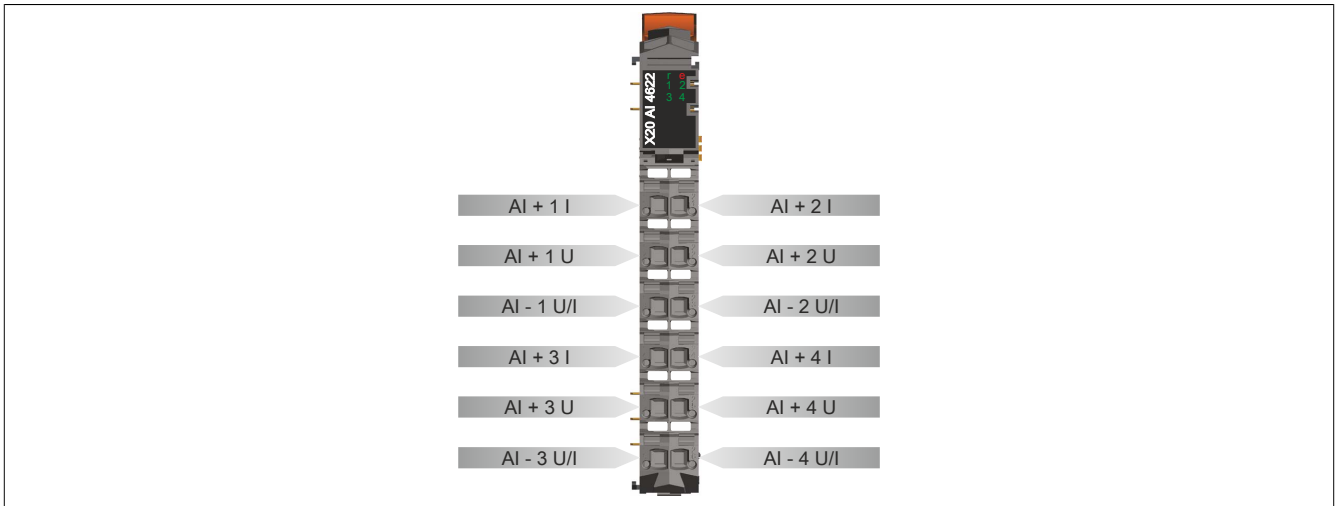


Figure 1: Pinout

6 Connection example

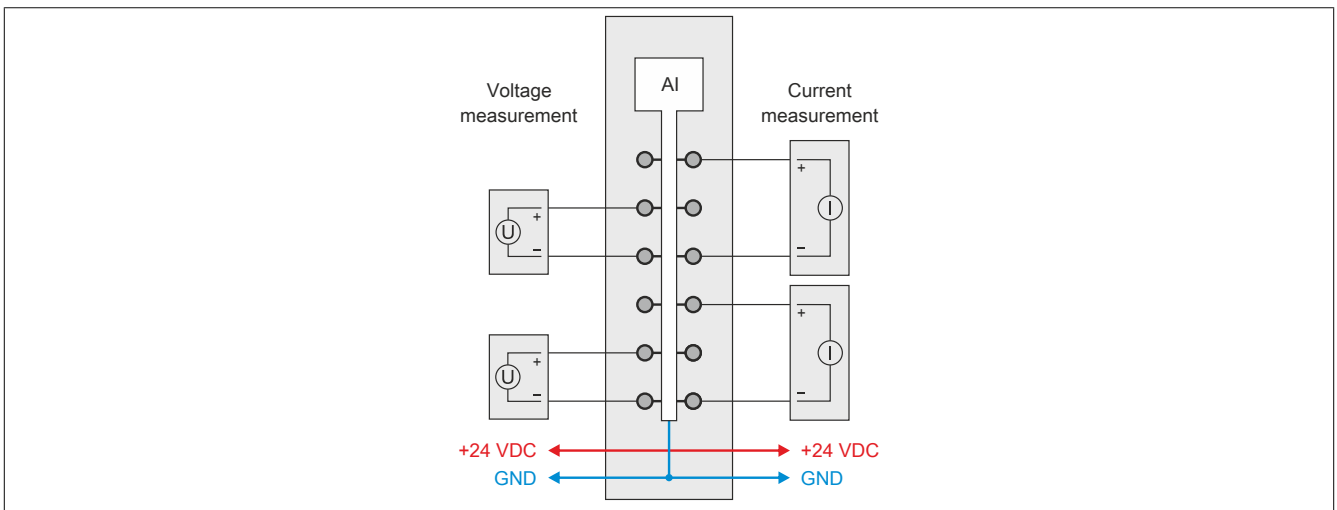


Figure 2: Connection example

7 Input circuit diagram

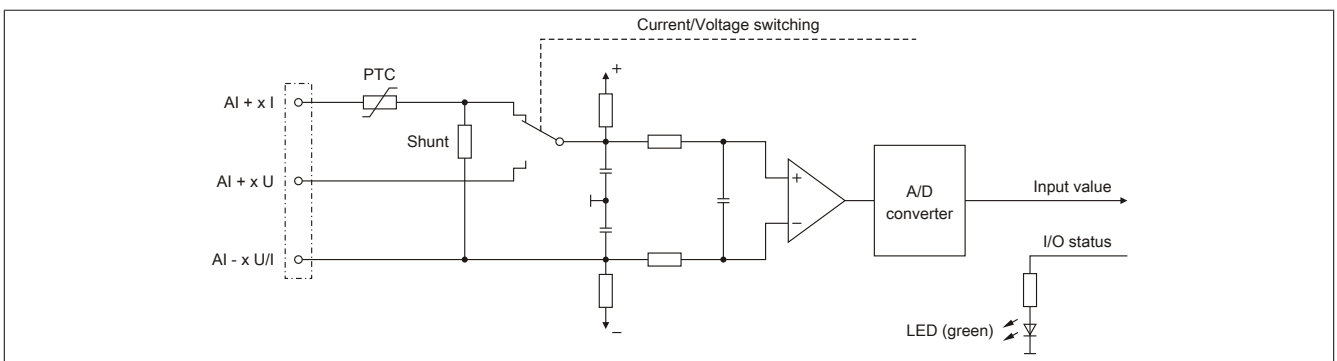


Figure 3: Input circuit diagram

8 Register description

8.1 Function model 0 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
0	AnalogInput01	INT	•			
2	AnalogInput02	INT	•			
4	AnalogInput03	INT	•			
6	AnalogInput04	INT	•			
16	ConfigOutput01	USINT				•
18	ConfigOutput02	USINT				•
20	ConfigOutput03	INT				•
22	ConfigOutput04	INT				•
30	StatusInput01	USINT	•			

8.2 Function model 254 - Bus controller

Register	Offset ¹⁾	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
0	0	AnalogInput01	INT	•			
2	2	AnalogInput02	INT	•			
4	4	AnalogInput03	INT	•			
6	6	AnalogInput04	INT	•			
16	-	ConfigOutput01	USINT				•
18	-	ConfigOutput02	USINT				•
20	-	ConfigOutput03	INT				•
22	-	ConfigOutput04	INT				•
30	-	StatusInput01	USINT		•		

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

8.3 Analog inputs

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

8.4 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

8.5 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be >500 µs. 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 µs. The conversion takes place asynchronously to the network cycle.

8.5.1 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 8,000 to 17,000. The diagram shows the adjusted input value with the following settings:

Input ramp limitation = 4 = 0x07FF = 2047

Filter level = 2

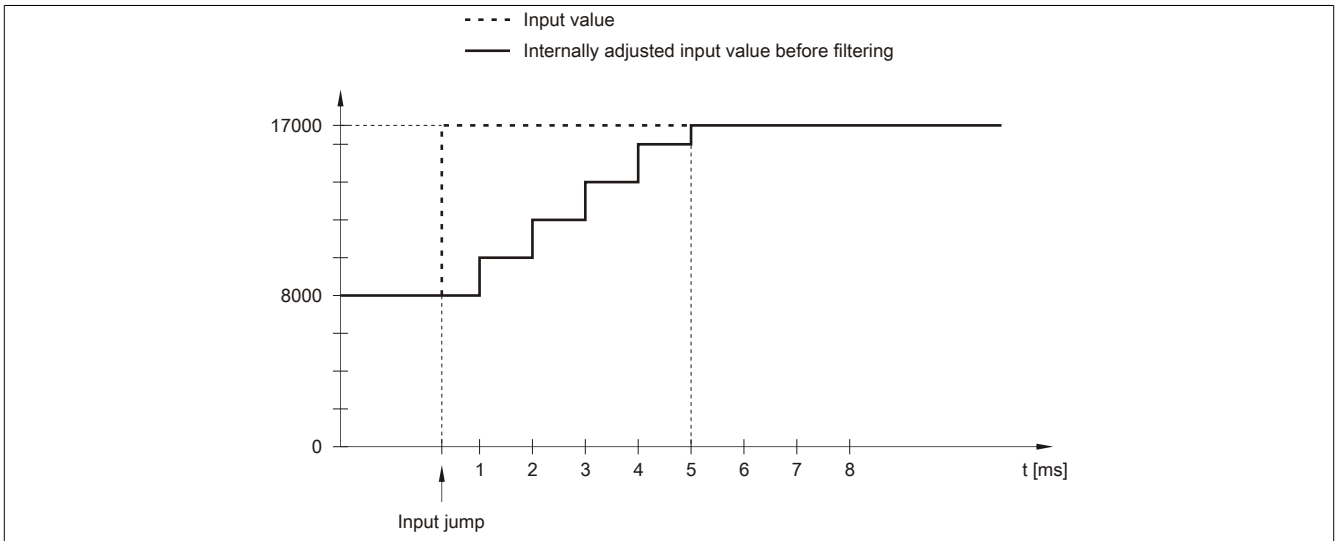


Figure 4: Adjusted input value for input jump

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

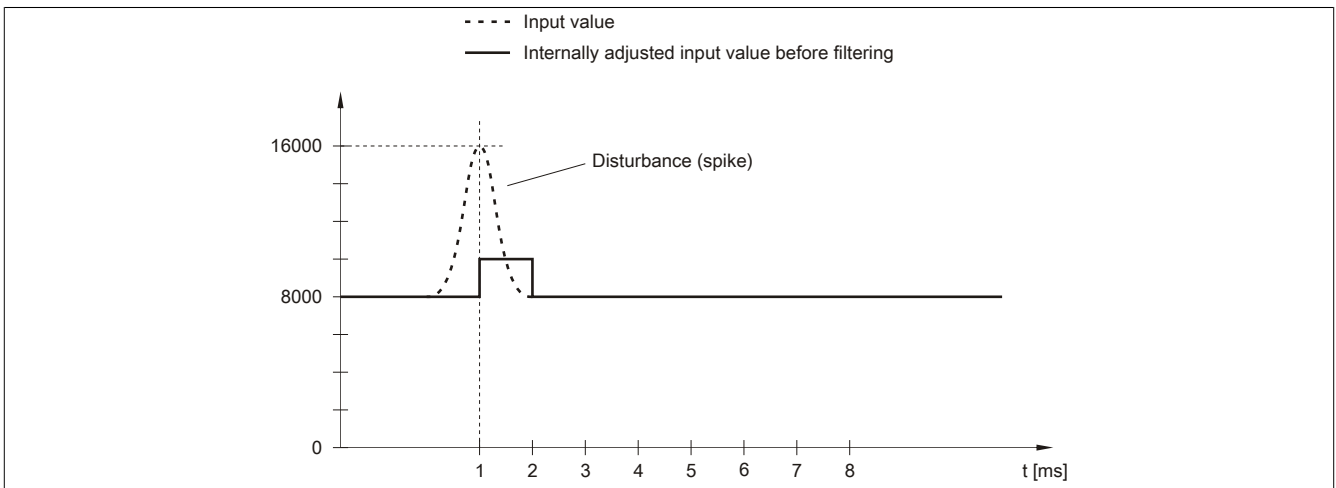


Figure 5: Adjusted input value for disturbance

8.5.2 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 8,000 to 16,000. The diagram shows the calculated value with the following settings:

Input ramp limitation = 0

Filter level = 2 or 4

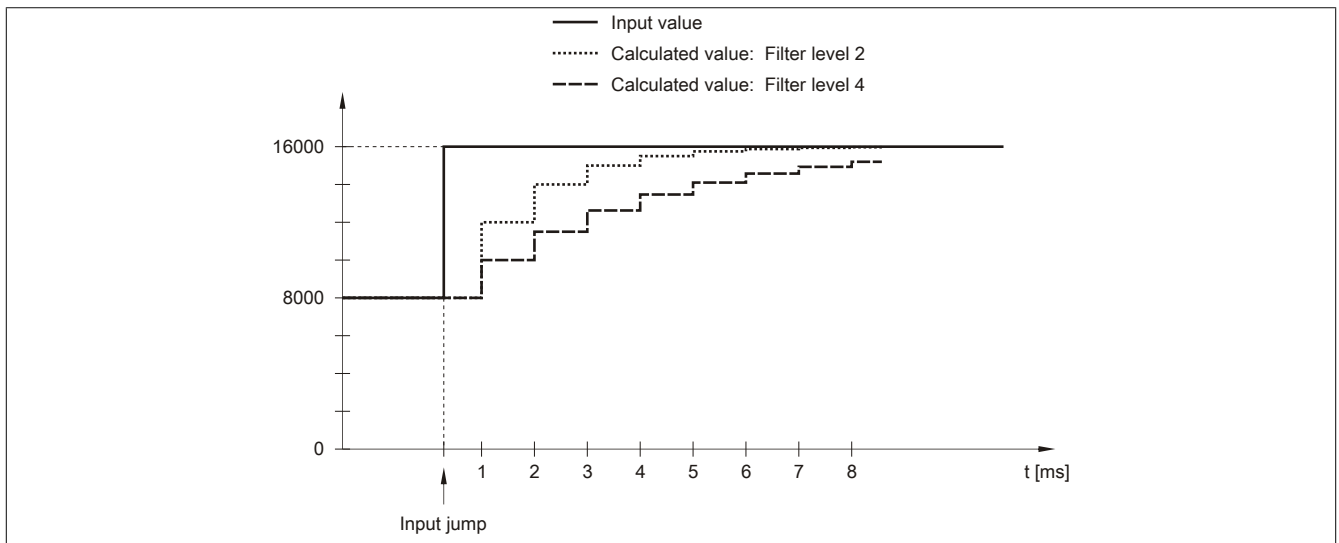


Figure 6: Calculated value during input jump

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

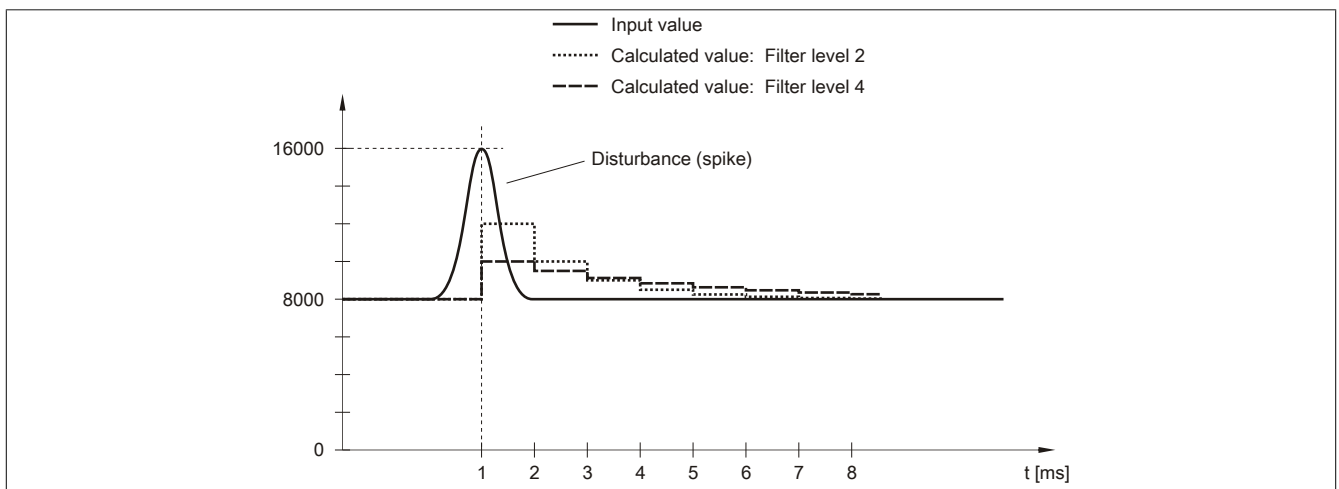


Figure 7: Calculated value during disturbance

8.6 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	Value
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 limitation	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	

8.7 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 multiple connection terminal points 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	Value
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

8.8 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

8.8.1 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!

8.8.2 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!

8.9 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	Value
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)

8.10 Minimum cycle time

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

Minimum cycle time	
Inputs without filtering	100 μ s
Inputs with filtering	500 μ s

8.11 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 μ s for all inputs
Inputs with filtering	1 ms