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	
X20AI4632	X20 analog input module, 4 inputs, ±10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions	
	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	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20AI4632 - Order data

1.3 Module description

The module is equipped with 4 inputs with 16-bit digital converter resolution and very fast conversion time. It is possible to select between the current and voltage signal using different terminals.

Functions:

- Scaling
- Filtering
- Error monitoring
- Analysis functions

Scaling

The A/D converter data can optionally be scaled by the user to ensure the greatest possible flexibility.

Input filter

An input filter can be configured for each individual analog input.

Error monitoring

The input signal is monitored for range overshoot, synchronization errors and invalid sampling cycles. User-defined limit values can also be defined.

Analysis functions

In addition to sampling the analog input signal, the values determined can also be analyzed:

- Limit value analysis
- Recording the sampled values
- Trace

2 Technical description

2.1 Technical data

Order number	X20AI4632
Short description	
I/O module	4 analog inputs ±10 V or 0 to 20 mA
General information	
B&R ID code	0x1BA1
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
Channel type	Yes, using software
Power consumption	
Bus	0.01 W
Internal I/O	1.5 W [1)]
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
KC	Yes
Analog inputs	
Input	±10 V or 0 to 20 mA, via different terminal connections
Input type	Differential input
Digital converter resolution	
Voltage	±15-bit
Current	15-bit
Conversion time	50 µs for all inputs
Output format	INT
Output format	
Voltage	INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 µV
Current	INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA
Input impedance in signal range	
Voltage	20 MΩ
Current	-
Load	
Voltage	-
Current	<400 Ω
Input protection	Protection against wiring with supply voltage
Permissible input signal	
Voltage	Max. ±30 V
Current	Max. ±50 mA

Table 2: X20AI4632 - Technical data

Technical description

Order number	X20AI4632
Output of digital value during overload	
Undershoot	
Voltage	0x8001
Current	0x0000
Overshoot	
Voltage	0x7FFF
Current	0x7FFF
Conversion procedure	SAR
Input filter	Hardware - Third-order low-pass filter / cutoff frequency 10 kHz
Max. error	
Voltage	
Gain	0.08% 2)
Offset	0.01% 3)
Current	
Gain	0.08% 2)
Offset	0.02% 4)
Max. gain drift	
Voltage	0.01%/°C 2)
Current	0.01%/°C 2)
Max. offset drift	
Voltage	0.001%/°C 3)
Current	0.002%/°C 4)
Common-mode rejection	
DC	70 dB
50 Hz	70 dB
Common-mode range	±12 V
Crosstalk between channels	<-70 dB
Nonlinearity	
Voltage	<0.01% 3)
Current	<0.015% 4)
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	See section "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 X20TB12 separately. Order 1x bus module X20BM11 separately.
Pitch	$12.5^{+0.2}$ mm

Table 2: X20AI4632 - 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.

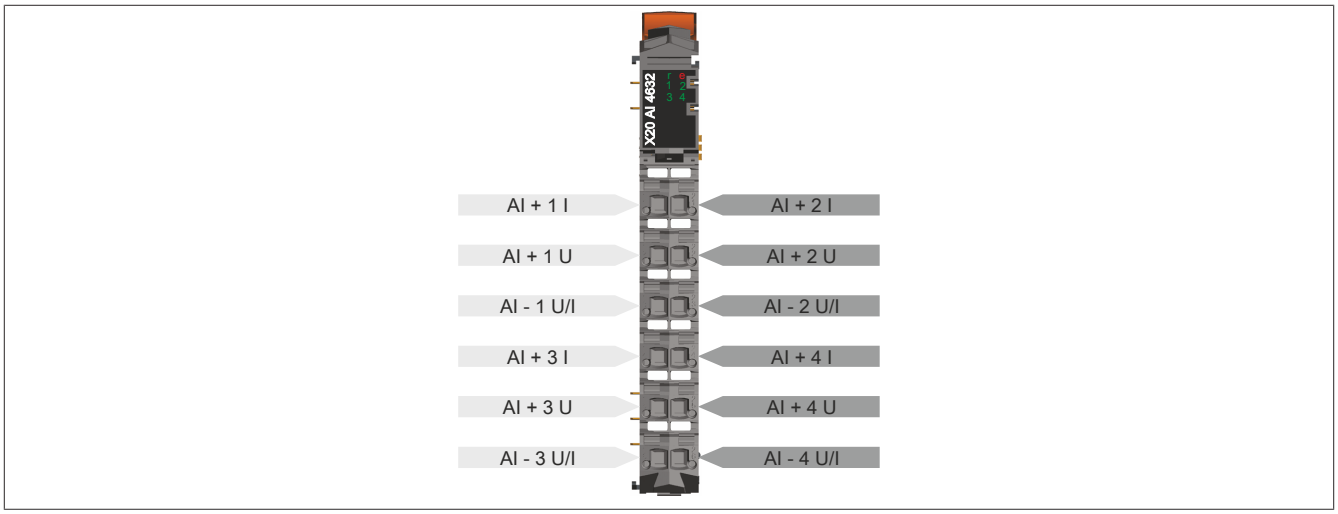
2.2 LED status indicators

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
			Double flash	BOOT mode (during firmware update)[1]
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
			Double flash	System error: • Violation of the scan time • Synchronization error
	1 - 4	Green	Off	Open line[2] or sensor is disconnected
			On	Analog/digital converter running, value OK

1) Depending on the configuration, a firmware update can take up to several minutes.
2) Open line detection only possible when measuring voltage.

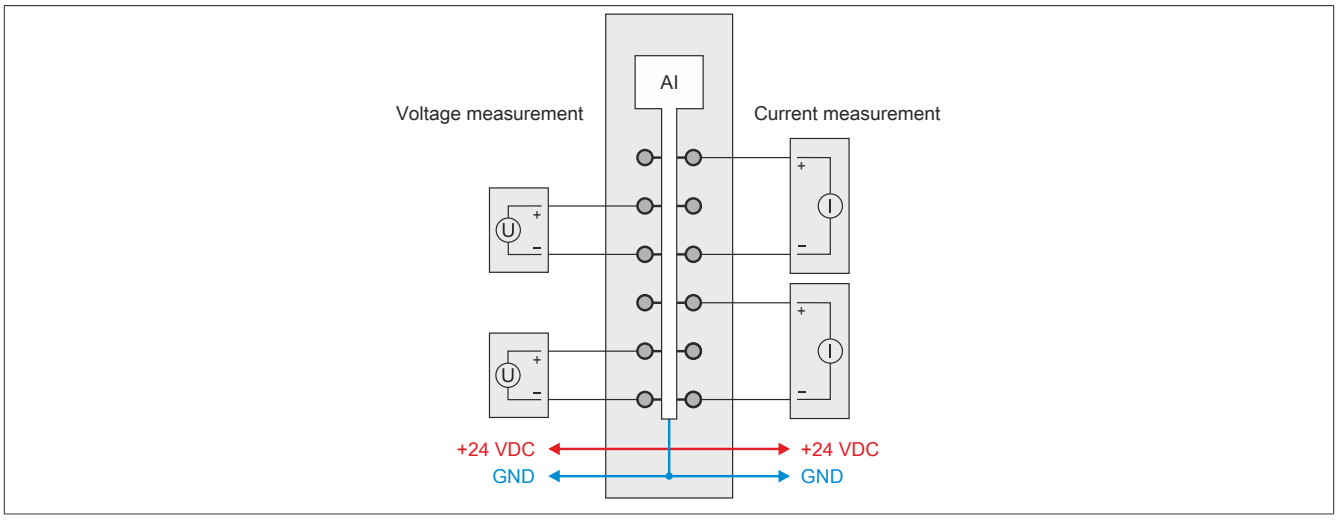
2.3 Pinout



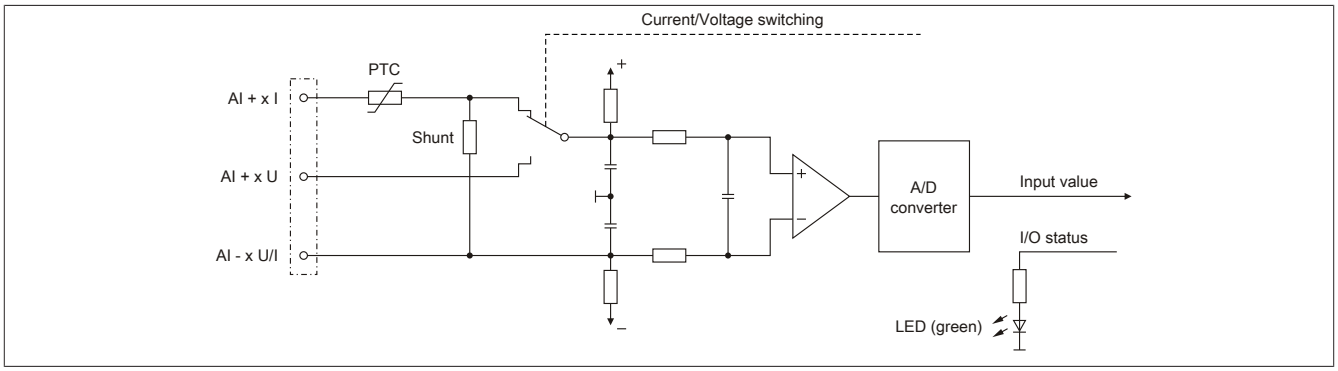
2.4 Connection example

To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Power supply module X20PS9600/X20PS9602
- Controller



2.5 Input circuit diagram

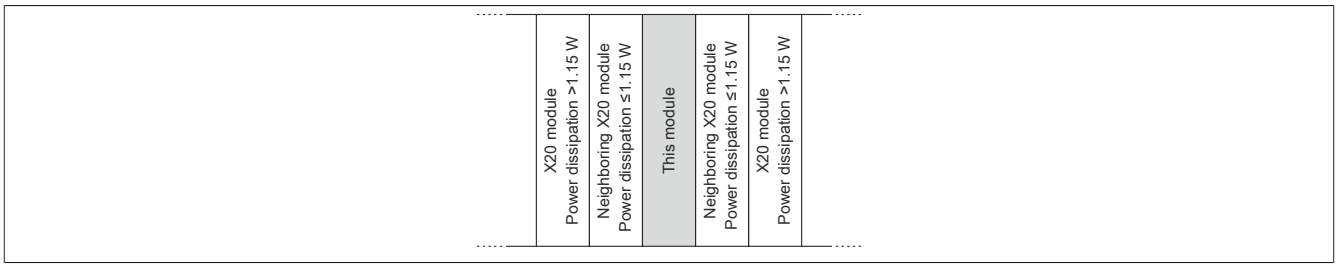


2.6 Derating

There is no derating when operated below 55°C.

When operated above 55°C, the modules to the left and right of this module are permitted to have a maximum power dissipation of 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "Mechanical and electrical configuration - Power dissipation of I/O modules" in the X20 user's manual.



3 Function description

3.1 Analog inputs

The module is equipped with analog inputs with connected 16-bit A/D converters. Each of the inputs can be configured separately for either voltage or current input for the following ranges:

- Permissible voltage: ±10 V
- Permissible current: 0 to 20 mA

Configuration must take place in addition to using suitable terminals.

Information:

The register is described in "Channel configuration" on page 18.

3.1.1 Scaling

The A/D converter data can optionally be scaled by the user. The following additional registers are available for this:

- Gain = ku
- Offset = du

Scaling calculation:

Scaled value = k * A/C value + d

Gain k = $k_{Calibration}$ * ku

Offset d = $d_{Calibration}$ + du

The value must be limited since it can exceed the 16-bit constraints. If the application requires a restriction of the range of values, the user can define custom limit values. These are also used for the module's error statistics.

Information:

Within the module, 32-bit numbers are used for the limit values. A limit value violation can therefore also be detected if the permissible range of values of -32768 to 32767 has been defined.

Information:

The registers are described in "User-defined scaling" on page 19.

3.1.2 Filtering

If filtering has been enabled, the basic data of the A/D converters is filtered per channel. The filter order and respective cutoff frequency of the low-pass filter can be configured for this.

Internal filter orders greater than 1 are implemented as cascaded first-order filters.

Calculating the cutoff frequency of an nth-order filter:

Cutoff frequency = Cutoff frequency$_n$ / ((2 ^ (1 / n) - 1) ^ 0.5)

Approximate calculation

yn = a * xn + b * y(n-1)

a = Sampling time$_{Sec}$ / (Sampling time$_{Sec}$ + 1 / (2 Pi * Cutoff frequency$_{Hz}$))

b = 1 - a

Information:

Since low-pass filtering takes place using an approximation procedure with fixed-point arithmetic, there are discrepancies to the effective cutoff frequency that depend on the sampling cycle and filter sequence.

Information:

The registers are described in "Filtering" on page 19.

3.2 Error monitoring

There are various counter registers in the module that can be used to record the occurrence of certain errors.

The counters in these registers follow the rules of the event error counter, i.e. each occurrence or reset of an error increases the counter value. The last bit of the counter indicates the error state:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

The following errors are monitored:

- **Synchronization error**
  This error shows how often the conversion task was triggered more than 5 µs after the previous X2X cycle.
- **Invalid sampling cycles**
  This error indicates a cycle time violation. The error occurs if the conversion task triggers a sampling task before the last sampling cycle has been completed.
- **Workspace overshoots**
  This indicates errors outside the maximum possible measurement range of the module.
- **Range undershoots**
  This indicates range undershoots below the value set as "Minimum limit value".
- **Range overshoots**
  This indicates range overshoots above the value set as "Maximum limit value".

Overshoots and undershoots

These counters are only operated if the static error counters are enabled in the channel configuration.

Information:

The registers are described in "Error monitoring and counters" on page 21.