X20AI2437

Data sheet
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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	
X20AI2437	X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel galvanically isolated and with own sensor power supply, NetTime function	
	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: X20AI2437 - Order data

1.3 Module description

The module is equipped with 2 current measurement inputs with 16-bit digital converter resolution.

Each current measurement input has its own sensor supply. The two channels with their respective sensor supplies are electrically isolated from each other. The user can select between the two measurement ranges 4 to 20 mA and 0 to 25 mA.

Functions:

- Configurable conversion rate / filter time
- Monitoring the input signal
- NetTime Technology

Conversion rate and filter time

The sampling time of the A/D converter can be configured individually for each channel together with the filter time.

Monitoring the input signal

The input signal is monitored for upper and lower limit values, open circuit and the status of the power supply. In addition to the status information, user-defined limit values can be defined as well as replacement values that are output if the limit values are overshot or undershot.

NetTime timestamp of the measurement

Not only is the measured value important for many applications, but also the exact time when the measurement takes place. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded measurement with microsecond accuracy.

2 Technical description

2.1 Technical data

Order number	X20AI2437
Short description	
I/O module	2 analog inputs 4 to 20 mA or 0 to 25 mA
General information	
B&R ID code	0xB784
Status indicators	I/O function per channel, operating state, module status, sensor power supply per channel
Diagnostics	
Module run/error	Yes, using LED status indicator and software
Inputs	Yes, using LED status indicator and software
Sensor power supply	Yes, using LED status indicator and software
Power consumption	
Bus	0.05 W
Internal I/O	1.15 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	4 to 20 mA or 0 to 25 mA configurable using software
Input type	Differential input
Digital converter resolution	16-bit
Data output rate	4.7 to 960 samples per second, configurable using software
Output format	INT
Output format	
4 to 20 mA	INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 488.281 nA
0 to 25 mA	INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 762.939 nA
0 to 25000 µA	INT 0x0000 - 0x61A8 / 1 LSB = 0x0001 = 1000 nA
Load	I_IN ≥ 0.1 mA: R < 8000 Ω I_IN ≥ 1 mA: R < 1100 Ω I_IN ≥ 4 mA: R < 510 Ω
Input protection	Up to 30 VDC, reverse polarity protection (max. 0.1 A)
Open-circuit detection	Yes, using software
Permissible input signal	0 to 25 mA
Output of digital value during overload	Configurable
Conversion procedure	Sigma-delta
Max. error	
Gain	
0 to 25 mA	<0.046% [2]
4 to 20 mA	<0.046% [2]
Offset	
0 to 25 mA	<0.004% [3]
4 to 20 mA	<0.013% [3]

Table 2: X20AI2437 - Technical data

Order number	X20AI2437
Common-mode rejection	
DC	80 dB
50 Hz	Depends on the sampling rate: e.g. >130 dB for 50 samples per second
Common-mode range	0 to 7 V
Nonlinearity	<0.003% 3)
Input filter	
Hardware	First-order low-pass filter / cutoff frequency 2.5 kHz
Software	$Sinc^4$ filter
Max. gain drift	
0 to 25 mA	0.003 %/°C 2)
4 to 20 mA	0.003 %/°C 2)
Max. offset drift	
0 to 25 mA	0.0002 %/°C 3)
4 to 20 mA	0.0007 %/°C 3)
Test voltage	
Channel - Channel	1000 VAC
Channel - Bus	1000 VAC
Channel - Ground	1000 VAC
Sensor power supply	
Power consumption	0.75 W per channel
Nominal voltage	25 V ±2%
Nominal output current	Max. 30 mA
Short-circuit proof	Yes, continuous
Max. voltage ripple	
Up to 100 kHz	≤2.2 mV
Up to 1 MHz	≤22 mV
Higher	≤100 mV
Short-circuit current	
Typical	<50 mA
Maximum	60 mA
Behavior on short circuit	Current limiting
Electrical properties	
Electrical isolation	Channel isolated from channel and bus Sensor power supply isolated from sensor power supply Sensor power supply 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	-
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: X20AI2437 - Technical data

1) To reduce power dissipation, B&R recommends leaving unused inputs open.
2) Based on the current measured value.
3) Based on the 25 mA measurement range.

2.2 LED status indicators

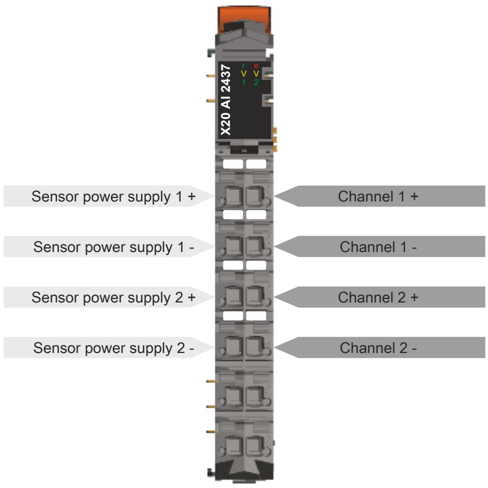
For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

Figure	LED	Color	Status	Description
	**Operating state**			
	r	Green	Off	No power to module
			Single flash	UNLINK mode
			Double flash	BOOT mode (during firmware update)[1]
			Blinking quickly	SYNC mode
			Blinking slowly	Mode PREOPERATIONAL
			On	RUN mode
	Module status			
	e	Red	Off	No power to module or everything OK
			Single flash	A conversion error has occurred. This status is output along with a double flash on the channel LED of the analog input where the error occurs.
			On	Error or reset status
	Sensor supply			
	V	Yellow	Off	Overload
			On	Sensor supply in its normal operating range
	Analog input			
	1 - 2	Green	Off	Indicates one of the following cases: • No power to module • Channel disabled • Open line
			Single flash	Input signal overflow or underflow
			Double flash	A conversion error has occurred. A single flash is output on the red "e" module status LED.
			On	Analog/digital converter running, value OK

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

2.3 Pinout

Shielded twisted pair cables should be used to minimize coupling disturbances. Use either one cable for each channel or a multiple twisted pair cable for both channels.

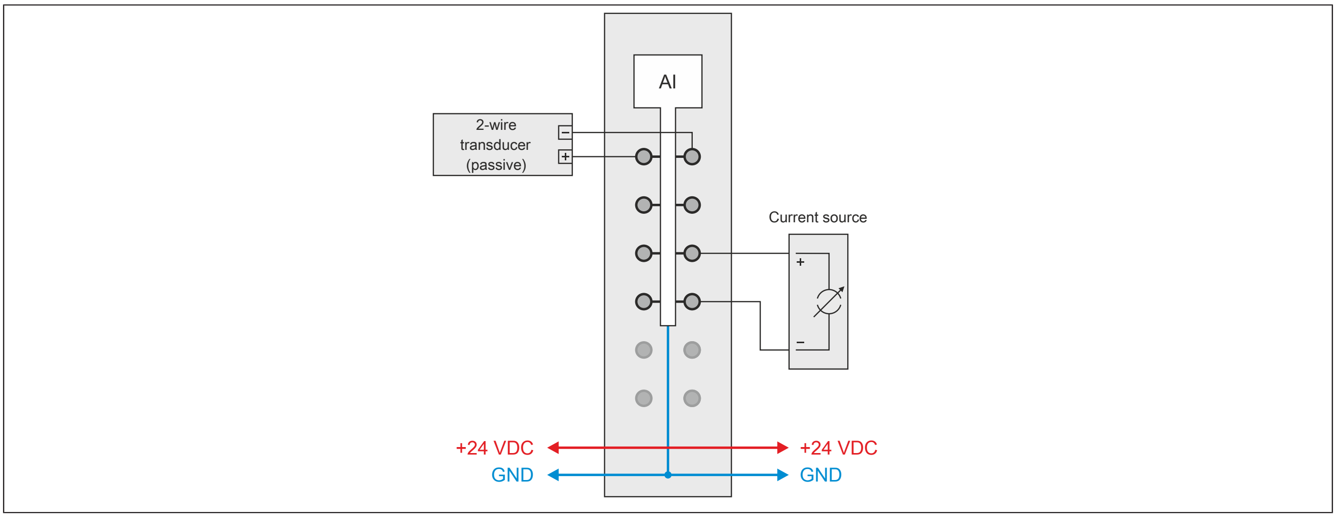


2.4 Connection examples

2-wire connections

A 2-wire connection can be implemented as follows:

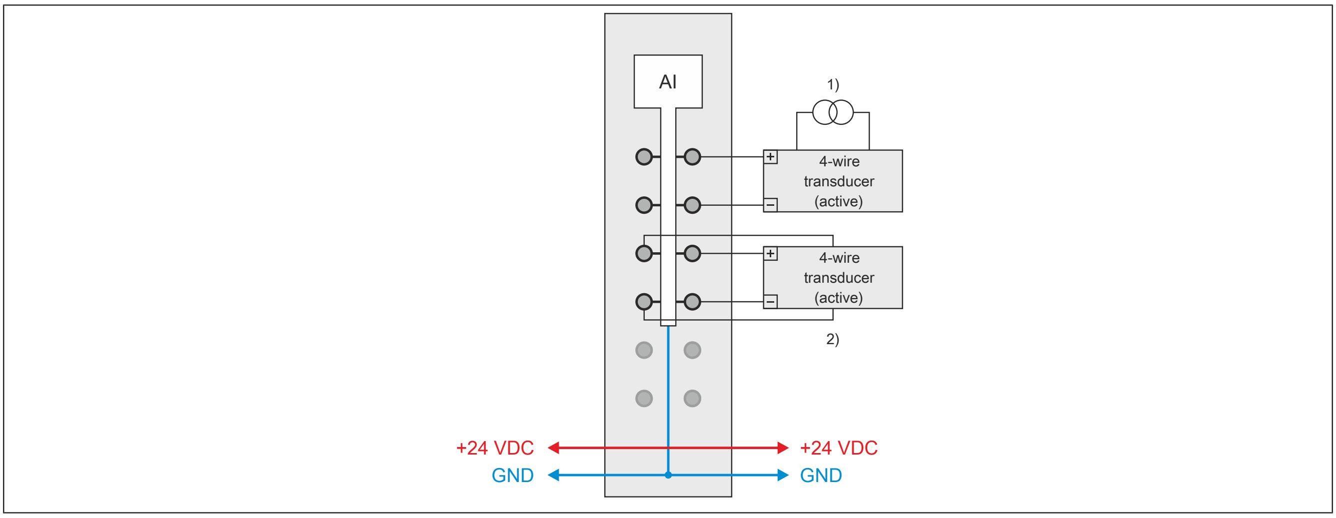
- 2-wire transducer
- Active current source



4-wire connections

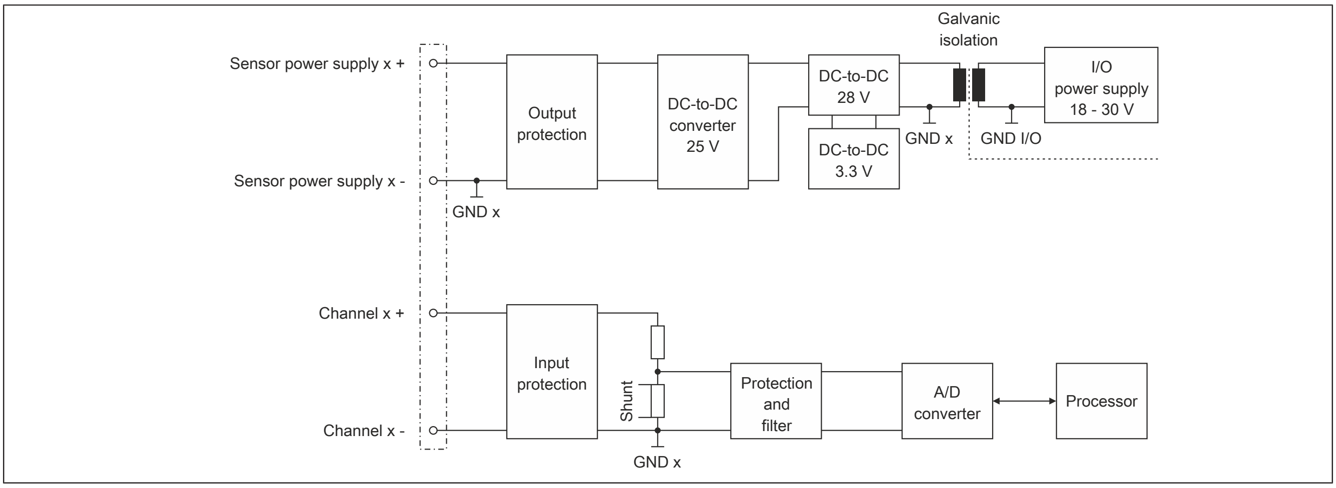
A 4-wire connection can be implemented as follows:

- 4-wire transducer with external supply
- 4-wire transducer supplied by the module



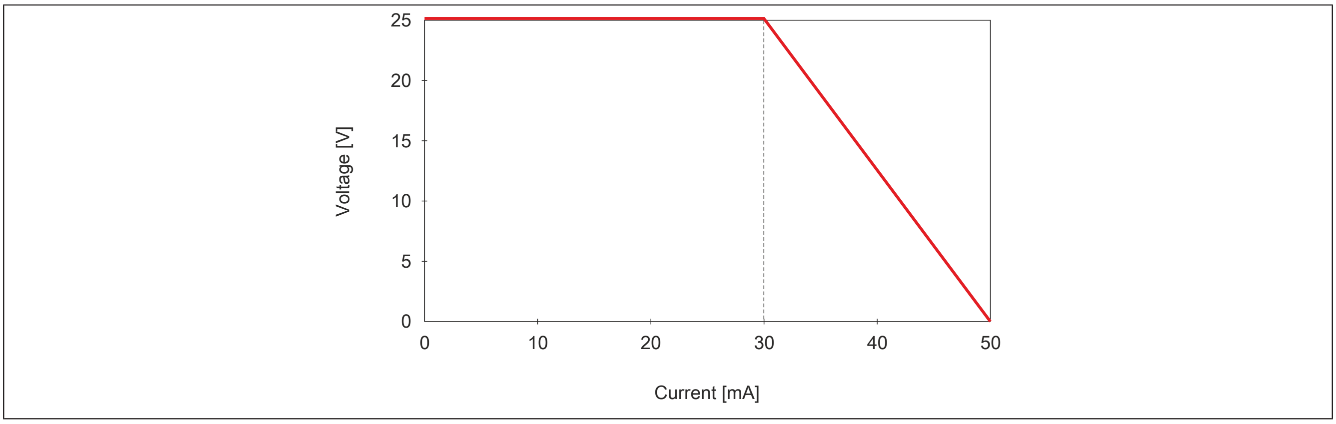
1) With external power supply.
2) With internal power supply. The internal power supply is only permitted to be loaded with max. 30 mA.

2.5 Input circuit diagram



2.6 Behavior in the event of short circuit

In the event of a short circuit, the output current for the sensor supply is limited according to the following diagram.



3 Function description

3.1 Analog inputs

The module is equipped with 2 independent galvanically isolated channels. An analog signal can be read in via both channels. All the necessary registers are duplicated so that the channels can be configured and operated independently of each other.
The current input signals (0 to 25 mA) can be displayed in various formats:

Values	Information
0 to 25000	Normalization option 0 to 25 mA
0 to 32767	Normalization option 0 to 25 mA
-8192 to 32767	Normalization option 4 to 20 mA (value 0 corresponds to 4 mA)
0 to 65535	Normalization option 0 to 25 mA

Predefining values and timing
If a replacement value strategy has been configured, value "0" (zero) is output at the beginning until a valid measured value has been calculated.

The timing of the measured value acquisition is determined by the converter hardware and the set sampling rate. The two channels are converted independently and not synchronized with the X2X Link network.

Conversion time
Sampling rate of channel 0x

Information:

The register is described in "Analog input values" on page 21.

3.1.1 Configurable conversion rate / filter time

The sampling time of the A/D converter is configured together with the filter time. A conversion rate can be configured independently for the two analog inputs. Based on the desired sampling frequency, the following formula results for this parameter:

Conversion rate for A/D converter = (4920000 / 1024) / Sampling frequency

Values	Filter time in milliseconds	Conversion rate in s^{-1}
4	1	1000
9	2	500
48	10	100
80	16.7	60
96	20 (bus controller default setting)	50
160	33.3	30
192	40	25
320	66.7	15
480	100	10
960	200	5

Information:

The register is described in "Sample rate" on page 18.

3.2 Monitoring the input signal

The input signal is monitored against the upper and lower limit values as well as for open circuit. The status of the power supply can also be read out. Some error information is delayed according to the previously set condition.

Packed status information

Setting "Format status information" in Automation Studio makes it possible to specify whether the status information is transferred as USINT or bit by bit.

The following values are monitored:

Name	Value	Information
UnderflowAnalogInput Depending on the configuration, the error state of the signal undershoot is mapped here. 1)	0 1	No error Lower limit value undershot
OverflowAnalogInput Depending on the configuration, the error state of the signal overshoot is mapped here. 1)	0 1	No error Upper limit value overshot
OpenLineAnalogInput Depending on the configuration, the measurement information is checked for <2 mA for the failure signal. Open-circuit detection takes place by means of a configurable hysteresis (default: 100 µA). It is possible to disable open-circuit monitoring in order to suppress alarm generation if hardware is missing. 1)	0 1	No error Open circuit detected
ConversionErrorAnalogInput The error state triggered by a hardware conversion timeout is displayed here.	0 1	No error Conversion error detected
SumErrorAnalogInput This error information is derived from the status of the individual errors and is only enabled after a configurable delay time [ms]. Linking this error information in the application makes it possible to hide temporary overshoots or undershoots of the temperature value, for example.	0 1	No error Composite error detected
SensorErrorAnalogInput This error information is derived from the status of the individual errors and is only enabled after a configurable delay time [ms]. Linking this error information in the application makes it possible to hide temporary overshoots or undershoots of the temperature value, for example.	0 1	Sensor voltage OK Sensor load too high
IoSuppErrorAnalogInput This error is enabled immediately after a supply voltage undershoot (<20 VDC) is detected.	0 1	I/O power supply OK I/O power supply error detected

1) This error information is only enabled after a configurable delay as a multiple of the conversion cycles.

> **Information:**
>
> **The register is described in "Status of the inputs" on page 22.**

3.2.1 Limit and replacement values

3.2.1.1 Limit value monitoring

In addition to the qualitative assessment of the input, the module is also equipped with the function of adjusting the permissible range of values to the requirements of the application. In addition, the permissible upper and lower limits can be further limited. In this case, the set replacement value strategy is applied sooner.

If user-specific limit values are used, a hysteresis range should also be defined. This configures how far the limit value must be overshot in order to trigger a reaction.

3.2.1.2 Replacement value strategy

To ensure the quality of the read-in value, the detected voltage is assessed. If a logically impermissible voltage value or open circuit is detected, for example, limit value monitoring is triggered.

The reaction to this is determined by the user via the replacement value strategy. With option "Use replacement values in the event of error", the user defines two values for the overshoot or undershoot that are used to replace the converted value in the event of a limit value violation. With the alternative "Keep last valid converted value", the last value deemed good is retained. The assessment takes more time, however. Depending on the defined preparation interval, the current read-in value is delayed.

Information:

The registers are described in "Configuring the limit values" on page 19.

3.2.1.3 Receiving the measured value

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

<table>
<tr><td rowspan="4">Functionality:
Depending on the configured input filter, measured values are continuously converted and stored in the measured value memory. The current content of the measured value memory is checked within the set interval time. If a permissible value is present, the content of the temporary memory is transferred to the output memory and the content of the measured value memory is transferred to the temporary memory.
If the check results in an impermissible value, the content of the measured value memory is discarded. The copy direction between the output memory and temporary memory is reversed, and the next-to-last valid value is still output.</td><td colspan="2">"Application"
Value being measured (analog)</td></tr>
<tr><td>↓</td><td>Condition:
- Conversion interval (A/D converter) elapsed</td></tr>
<tr><td colspan="2">"Measured value memory"
Measured value (digital)</td></tr>
<tr><td>↓</td><td>Condition:
- PreparationInterval elapsed
- Measured value permissible</td></tr>
<tr><td rowspan="3">Information:
With the "Hold last valid value" configuration, the delay from measurement to the output of the value is at least twice the time of the preparation interval. In the worst case, however, it can also take twice the interval time plus the configured conversion cycle of the A/D converter.</td><td colspan="2">"Buffer"
Last valid value</td></tr>
<tr><td>↓</td><td>Condition:
- PreparationInterval elapsed
- Measured value permissible</td></tr>
<tr><td colspan="2">"Output memory"
Next-to-last valid/
displayed value</td></tr>
</table>

Information:

The register is described in "Preparation time for the measured values" on page 21.

3.3 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (controller, I/O modules, X2X Link, POWERLINK, etc.).

This allows the moment that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a specified moment.

NetTime TECHNOLOGY

3.3.1 Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with microsecond resolution. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 µs; an overflow occurs after 71 min, 34 s, 967 ms and 296 µs.

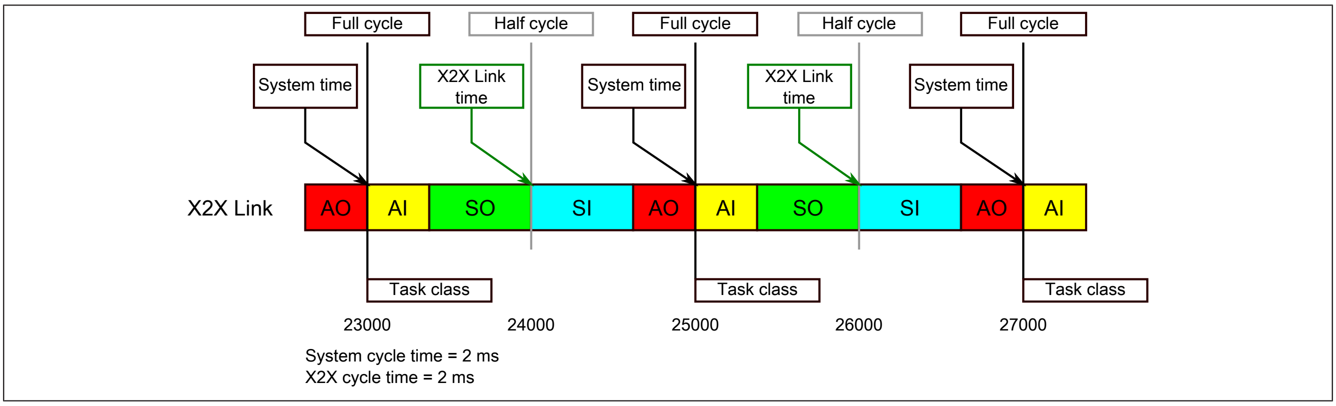
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

3.3.1.1 Controller data points

The NetTime I/O data points of the controller are latched to each system clock and made available.

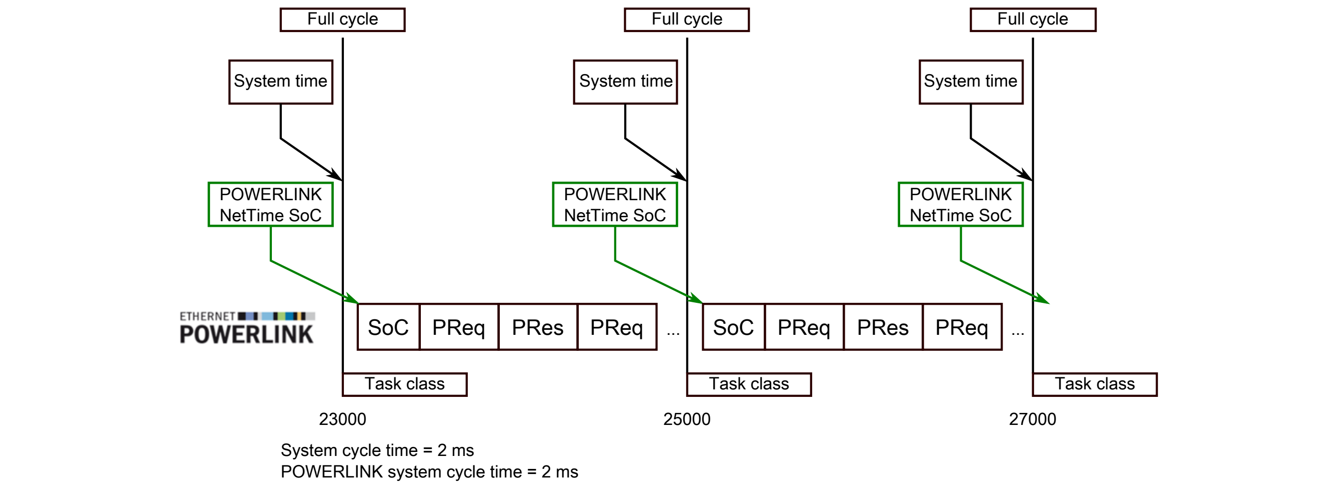
3.3.1.2 X2X Link - Reference time point



The reference time point on the X2X Link network is always calculated at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference time point when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference time returns the value 24000.

3.3.1.3 POWERLINK - Reference time point

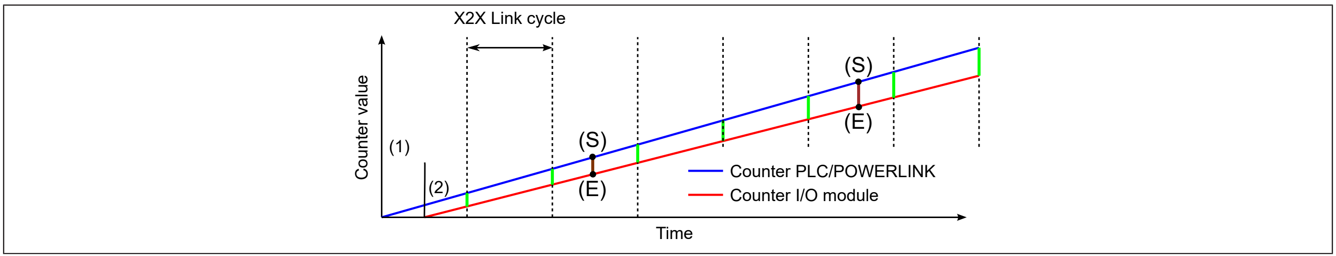


The POWERLINK reference time point is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system clock due to the system. This results in the following difference between the system time and the POWERLINK reference time:

POWERLINK reference time = System time - POWERLINK cycle time + 20 µs

In the example above, this means a difference of 1980 µs, i.e. if the system time and POWERLINK reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference time returns the value 23020.

3.3.1.4 Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the controller/POWERLINK (1) and the I/O module (2) start at different times and increase the values with microsecond resolution.

At the beginning of each X2X Link cycle, the controller or POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system moment (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

3.3.2 Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the controller, including this precise moment, the controller can then evaluate the data using its own NetTime (or system time), if necessary.
For details, see the respective module documentation.

3.3.2.1 Time-based inputs

NetTime Technology can be used to determine the exact moment of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

Information:

The determined moment always lies in the past.

3.3.2.2 Time-based outputs

NetTime Technology can be used to specify the exact moment of a rising edge on an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

Information:

The specified time must always be in the future, and the set X2X Link cycle time must be taken into account for the definition of the moment.

3.3.2.3 Time-based measurements

NetTime Technology can be used to determine the exact moment of a measurement that has taken place. Both the starting and end moment of the measurement can be transmitted.

4 Commissioning

4.1 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 other registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" in the X20 user's manual (version 3.50 or later).

4.1.1 CAN I/O bus controller

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

5 Register description

5.1 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" in the X20 System user's manual.

5.2 Function model 0 - default

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Analog signal - Configuration						
386 426	AnMode_1 AnMode_2	UINT				•
390 430	Samplerate_1 Samplerate_2	UINT				•
394 434	OpenLoopLimit_1 OpenLoopLimit_2	(U)INT				•
398 438	LowerLimit_1 LowerLimit_2	(U)INT				•
402 442	UpperLimit_1 UpperLimit_2	(U)INT				•
406 446	Hysteres_1 Hysteres_2	(U)INT				•
410 450	ReplacementLower_1 ReplacementLower_2	(U)INT				•
414 454	ReplacementUpper_1 ReplacementUpper_2	INT				•
418 458	ErrorDelay_1 ErrorDelay_2	UINT				•
422 462	SumErrorDelay_1 SumErrorDelay_2	UINT				•
466 482	PreparationInterval_1 PreparationInterval_2	UINT				•
Analog signal - Communication						
266 270	AnalogInput01 (if replacement value strategy on) AnalogInput02 (if replacement value strategy on)	(U)INT	•			
258 262	AnalogInput01 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off)	(U)INT	•			
282 290	AnalogSampletime01 (16-bit) AnalogSampletime02 (16-bit)	INT	•			
284 292	AnalogSampletime01 (32-bit) AnalogSampletime02 (32-bit)	DINT	•			
30 31	AnalogStatus01 AnalogStatus02	USINT	•			
	UnderflowAnalogInput01 or 02	Bit 0				
	OverflowAnalogInput01 or 02	Bit 1				
	OpenLineAnalogInput01 or 02	Bit 2				
	ConversionErrorAnalogInput01 or 02	Bit 3				
	SumErrorAnalogInput01 or 02	Bit 4				
	SensorErrorAnalogInput01 or 02	Bit 6				
	IoSuppErrorAnalogInput01 or 02	Bit 7				

5.3 Function model 254 - Bus controller

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Analog signal - Configuration							
386 426	- -	AnMode_1 AnMode_2	UINT				•
390 430	- -	Samplerate_1 Samplerate_2	UINT				•
394 434	- -	OpenLoopLimit_1 OpenLoopLimit_2	INT				•
398 438	- -	LowerLimit_1 LowerLimit_2	(U)INT				•
402 442	- -	UpperLimit_1 UpperLimit_2	(U)INT				•
406 446	- -	Hysteres_1 Hysteres_2	(U)INT				•
410 450	- -	ReplacementLower_1 ReplacementLower_2	(U)INT				•
414 454	- -	ReplacementUpper_1 ReplacementUpper_2	(U)INT				•
418 458	- -	ErrorDelay_1 ErrorDelay_2	UINT				•
422 462	- -	SumErrorDelay_1 SumErrorDelay_2	UINT				•
466 482	- -	PreparationInterval_1 PreparationInterval_2	UINT				•
Analog signal - Communication							
266 270	0 2	AnalogInput01 (if replacement value strategy on) AnalogInput02 (if replacement value strategy on)	(U)INT	•			
258 262	- -	AnalogInput01 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off)	(U)INT		•		
30 31	- -	AnalogStatus01 AnalogStatus02	USINT		•		
		UnderflowAnalogInput01 or 02	Bit 0				
		OverflowAnalogInput01 or 02	Bit 1				
		OpenLineAnalogInput01 or 02	Bit 2				
		ConversionErrorAnalogInput01 or 02	Bit 3				
		SumErrorAnalogInput01 or 02	Bit 4				
		SensorErrorAnalogInput01 or 02	Bit 6				
		IoSuppErrorAnalogInput01 or 02	Bit 7				

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

5.4 Analog signal - Configuration

How the analog signal is displayed can be adapted to the requirements of the application. Separate configuration registers per channel are available to aid in this.

5.4.1 Channel parameters

Name:
AnMode_1 to AnMode_2

These registers are used to specify the operating parameters that the module uses for the associated channel. Each channel must be enabled individually and can be configured and operated independently of the other.

> **Information:**
>
> **Different limit values must be configured for any display normalizing that needs to take place.**

Data type	Values	Bus controller default setting
UINT	See bit structure.	29

Bit structure:

Bit	Name	Value	Information
0	Channel	0	Channel 0x turned off
		1	Channel 0x enabled (bus controller default setting)
1	Open line detection	0	Open line monitoring turned off
		1	Open circuit monitoring enabled (bus controller default setting)
2	Underflow detection	0	Underflow detection turned off
		1	Underflow detection enabled (bus controller default setting)
3	Replacement value strategy	0	Use replacement values in the event of error (bus controller default setting)
		1	Keep the last valid converted value
4 - 5	Normalization	00	Displays 0 to 25 mA as 0 to 32767
		01	Display 0 to 25 mA as 0 to 25000 [µA] (bus controller default setting)
		10	Displays 4 to 20 mA as 0 to 32767
		11	Displays 0 to 25 mA as 0 to 65535
6 - 15	Reserved	-	

5.4.2 Sample rate

Name:
Samplerate_1 to Samplerate_2

A conversion rate can be configured independently for the two analog inputs. Based on the desired sampling frequency, the following formula results for this parameter:

Sampling rate for A/D converter = (4920000 / 1024) / Sampling frequency

Data type	Value	Information
UINT	4 to 1023	Sample rate **Examples of configurable values** **Value** / **Time** / **Frequency** 960 ... 200 ms ... 5 Hz 480 ... 100 ms ... 10 Hz 320 ... 66.7 ms ... 15 Hz 192 ... 40 ms ... 25 Hz 160 ... 33.3 ms ... 30 Hz 96 ... 20 ms ... 50 Hz (bus controller default setting) 80 ... 16.7 ms ... 60 Hz 48 ... 10 ms ... 100 Hz 9 ... 2 ms ... 500 Hz 4 ... 1 ms ... 1000 Hz

Setting to 1000 Hz will result in jitter when acquiring measured values. Jitter-free operation is possible up to 960 Hz (sample rate setting = 5).

5.4.3 Delaying error messages

Name:
ErrorDelay_1 to ErrorDelay_2

This register describes the number of consecutive conversion operations for which an error must be pending until the corresponding single error status bit is set. The delay acts on underflow, overflow and open circuit errors. This delay can be used to hide short-term deviations of the measured value, for example.

Data type	Value	Information
UINT	0 to 10	Error formation delay in conversion cycles. Bus controller default setting: 2

5.4.4 Time for composite error bit

Name:
SumErrorDelay_1 to SumErrorDelay_2

This register specifies the time in milliseconds that one of the individual error bits must be pending until the composite error status bit is set.

Data type	Value	Information
UINT	0 to 65535	Composite error bit delay in ms. Bus controller default setting: 4000

5.5 Configuring the limit values

5.5.1 Limit value for open line detection

Name:
OpenLoopLimit_1 to OpenLoopLimit_2

The limit value for the respective analog input must be set when open circuit monitoring is enabled and if required by the configured normalization.

Data type	Value	Information
INT	-32767 to 32767	Open circuit limit value. Bus controller default setting: 2621
UINT	0 to 65535	Open circuit limit value

If limit value monitoring is enabled and after a set delay, the corresponding error state is calculated if this value is undershot. Based on default value 2000 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 2000
- Displays 0 to 25 mA as 0 to 32767: 2621, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: -4096, limit value = (([µA] * 1.31068) - 5242.72) * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 5243, limit value = ([µA] * 65535) / 25000

5.5.2 Lower limit value

Name:
LowerLimit_1 to LowerLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific lower limit values.

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: 4718
UINT	0 to 65535	

Depending on the set normalization, the limit value must be set for the respective analog input. After a set delay, the corresponding error state is generated if this value is overshot or undershot. If this error state occurs, channel "AnalogInput0x" on page 21 is assessed according to the replacement value strategy. Based on default value 3600 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = (([µA] * 1.31068) - 5242.72) * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = ([µA] * 65535) / 25000

5.5.3 Upper limit value

Name:
UpperLimit_1 to UpperLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific upper limit values.

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: 27524
UINT	0 to 65535	

Depending on the set normalization, the limit value must be set for the respective analog input. After a set delay, the corresponding error state is generated if this value is overshot or undershot. If this error state occurs, channel "AnalogInput0x" on page 21 is assessed according to the replacement value strategy. Based on default value 21000 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = (([µA] * 1.31068) - 5242.72) * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = ([µA] * 65535) / 25000

5.5.4 Lower replacement value

Name:
ReplacementLower_1 to ReplacementLower_2

This register is used to define the lower static values to be displayed instead of the current measured value when the lower limit is violated.

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: 4718
UINT	0 to 65535	

If replacement value strategy "Use replacement values in the event of error" is enabled and depending on the normalization set, the replacement value must be set for the respective analog input. If the overflow or underflow error state occurs, channel "AnalogInput0x" on page 21 is replaced with the corresponding value. Based on default value 3600 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = (([µA] * 1.31068) - 5242.72) * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = ([µA] * 65535) / 25000

5.5.5 Upper replacement value

Name:
ReplacementUpper_1 to ReplacementUpper_2

These registers are used to specify the upper static values that are displayed instead of the current measured value when a limit value is exceeded.

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: 27524
UINT	0 to 65535	

If replacement value strategy "Use replacement values in the event of error" is enabled and depending on the normalization set, the replacement value must be set for the respective analog input. If the overflow or underflow error state occurs, channel "AnalogInput0x" on page 21 is replaced with the corresponding value. Based on default value 21000 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = (([µA] * 1.31068) - 5242.72) * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = ([µA] * 65535) / 25000

5.5.6 Hysteresis

Name:
Hysteres_1 to Hysteres_2

These registers are used to configure how far the limit value must be overshot in order to trigger a reaction.

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: 131
UINT	0 to 65535	

The hysteresis value must be set for the respective analog input depending on the configured normalization. The error status is cleared if the actual analog value changes by at least this hysteresis value from the limit value in the allowed direction. Using a default value of 100 µA, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 100
- Displays 0 to 25 mA as 0 to 32767: 131, limit value = ([µA] * 32767) / 25000
- Displays 4 to 20 mA as 0 to 32767: 156, limit value = [µA] * 1.5625
- Displays 0 to 25 mA as 0 to 65535: 262, limit value = ([µA] * 65535) / 25000

5.5.7 Preparation time for the measured values

Name:
PreparationInterval01 to PreparationInterval02

If the last valid measured value should be retained in the event of a limit value violation, the preparation interval must be defined. For details, see "Monitoring the input signal" on page 10.

Data type	Value	Information
UINT	0 to 65535	In 0.1 ms steps Bus controller default setting: 0

5.6 Analog signal - Communication

5.6.1 Analog input values

Name:
AnalogInput01 to AnalogInput02

The analog input value is mapped in this register.

Data type	Value	Information
INT	0 to 25000	Normalizing option 0 to 25 mA
	0 to 32,767	Normalizing option 0 to 25 mA
	-8192 to 32767	Normalizing option 4 to 20 mA (value 0 corresponds to 4 mA)
UINT	0 to 65535	Normalizing option 0 to 25 mA

5.6.2 Sample time

Name:
AnalogSampletime01 to AnalogSampletime02

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For additional information about NetTime and timestamps, see "NetTime Technology" on page 12.

Data type	Values	Information
INT	-32,768 to 32767	NetTime timestamp of the current input value in microseconds
DINT	-2147483648 to 2147483647	NetTime timestamp of the current input value in microseconds

5.6.3 Status of the inputs

Name:
AnalogStatus01 to AnalogStatus02
UnderflowAnalogInput01 to UnderflowAnalogInput02
OverflowAnalogInput01 to OverflowAnalogInput02
OpenLineAnalogInput01 to OpenLineAnalogInput02
ConversionErrorAnalogInput01 to ConversionErrorAnalogInput02
SumErrorAnalogInput01 to SumErrorAnalogInput02
SensorErrorAnalogInput01 to SensorErrorAnalogInput02
IoSuppErrorAnalogInput01 to IoSuppErrorAnalogInput02

The current error state of the module channels is indicated in this register regardless of the configured replacement value strategy. Some error information is delayed according to the previously configured condition.

Setting "Format status information" in Automation Studio makes it possible to specify whether the status information is transferred as USINT or bit by bit.

Data type	Values
USINT	See bit structure.

Bit structure:

Bit	Name	Values	Information
0	UnderflowAnalogInput01 or 02	0	No error
		1	Lower limit value undershot
1	OverflowAnalogInput01 or 02	0	No error
		1	Upper limit value overshot
2	OpenLineAnalogInput01 or 02	0	No error
		1	Open circuit determined
3	ConversionErrorAnalogInput01 or 02	0	No error
		1	Conversion error determined
4	SumErrorAnalogInput01 or 02	0	No error
		1	Composite error determined
5	Reserved	-	
6	SensorErrorAnalogInput01 or 02	0	Sensor voltage OK
		1	Sensor load too high
7	IoSuppErrorAnalogInput01 or 02	0	I/O power supply OK
		1	Error in I/O power supply determined

5.7 Minimum cycle time

The minimum cycle time specifies how far 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
200 µs

5.8 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