X20AI2237

1 General information

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

Each voltage input has its own sensor supply. The two channels with their respective sensor supplies are electrically isolated from each other.

- 2 analog voltage inputs
- Electrically isolated analog channels
- Electrically isolated sensor supplies
- 16-bit digital converter resolution
- Very high sampling rate
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

2 Order data

Order number	Short description	Figure
	Analog inputs	
X20AI2237	X20 analog input module, 2 inputs, ±10 V, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function	
	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 power supply connected through	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20AI2237 - Order data

3 Technical data

Order number	X20AI2237
Short description	
I/O module	2 analog inputs ±10 V
General information	
B&R ID code	0xC9C4
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	1.05 W (Rev. ≥ D0), 1.15 W (Rev. < D0) [1]
Additional power dissipation caused by actuators (resistive) [W]	-
Certifications	
CE	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
EAC	Yes
Analog inputs	
Input	±10 V
Input type	Differential input
Digital converter resolution	±15-bit
Data output rate	10000 samples per second
Output format	
Data type	INT
Voltage	INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 µV
Input impedance in signal range	20 MΩ
Input protection	Up to 30 VDC, reverse polarity protection
Open-circuit detection	Yes, using software
Permissible input signal	Max. ±30 V
Output of digital value during overload	Configurable
Conversion procedure	SAR
Input filter	Fourth-order low-pass filter / Cutoff frequency 10 kHz
Max. error	
Gain	0.013% [2]
Offset	0.0035% [3]
Max. gain drift	<0.0008%/°C [2]
Max. offset drift	<0.0025%/°C [3]
Common-mode rejection	
DC	84 dB
Up to 60 Hz	84 dB
Up to 10 kHz	82 dB
Common-mode range	±14 V
Nonlinearity	<0.003% [3]
Test voltage	
Channel - Channel	1000 VAC
Channel - Bus	1000 VAC
Channel - Ground	1000 VAC
Bus - Ground	800 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

Table 2: X20AI2237 - Technical data

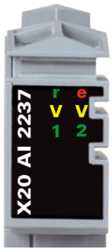
Order number	X20AI2237
Electrical properties	
Electrical isolation	Channel isolated from channel and bus Sensor power supply isolated from sensor power supply Sensor power supply not isolated from channel
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above 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: X20AI2237 - Technical data

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

4 LED status indicators

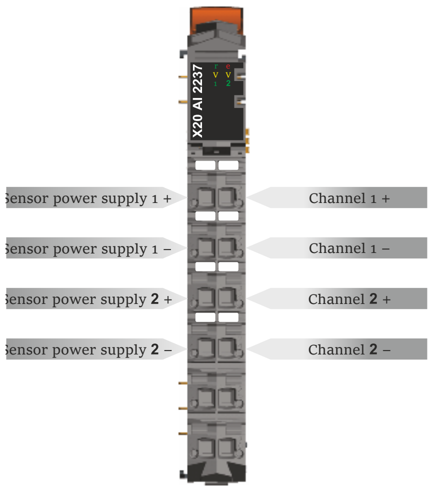
For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

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	PREOPERATIONAL mode
			On	RUN mode
	Module status			
	e	Red	Off	No power to module or everything OK
			On	Error or reset status
	Sensor supply			
	V	Yellow	Off	Module supply not connected or 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
			On	Analog/digital converter running, value OK

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

5 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.

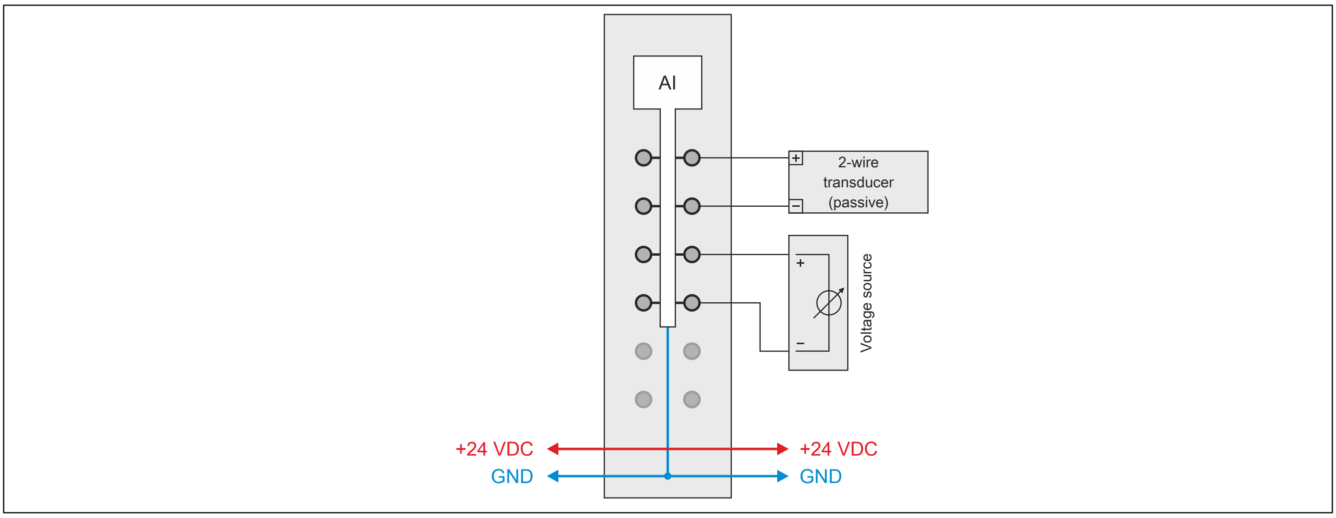


6 Connection examples

2-wire connections

A 2-wire connection can be implemented as follows:

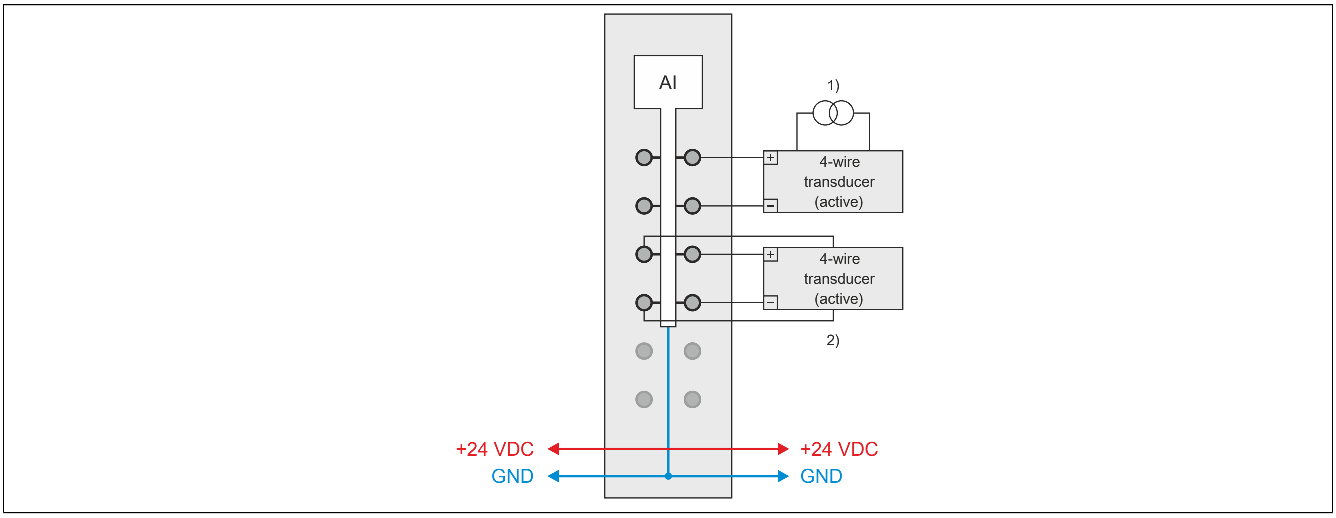
- 2-wire transducer
- Active voltage source



4-wire connections

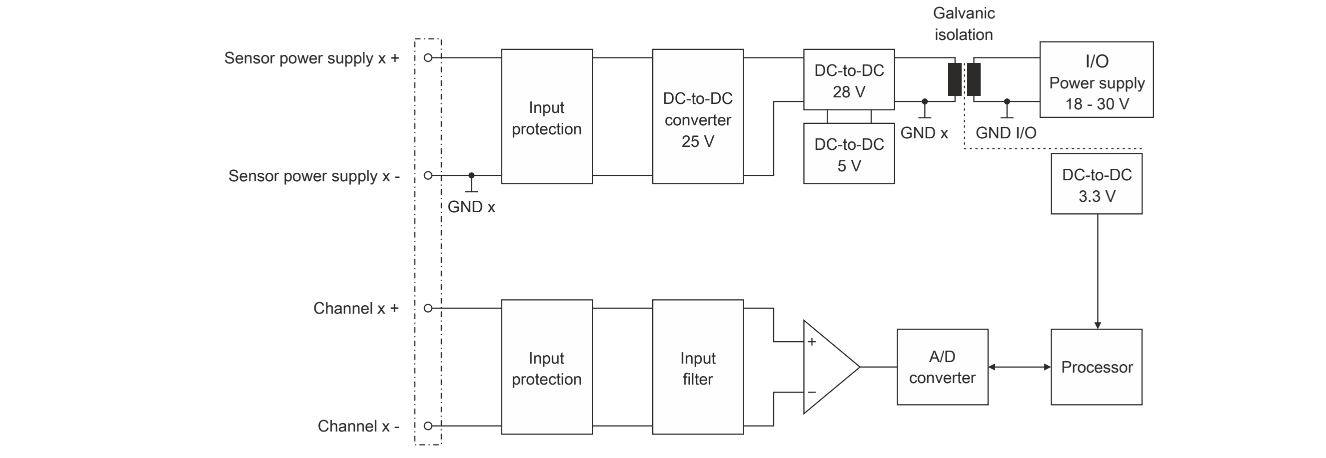
A 4-wire connection can be implemented as follows:

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



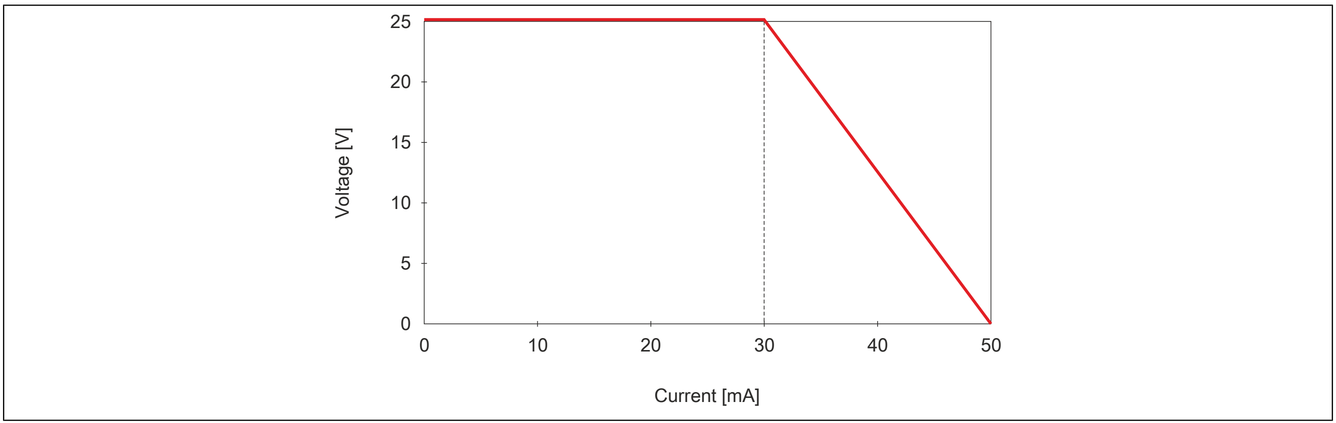
1) With external power supply.
2) With internal power supply. The internal power supply is only permitted to be loaded with max. 30 mA.

7 Input circuit diagram



8 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.



9 Register description

9.1 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.

9.2 Function model 0 - default

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Analog input - Configuration						
390 434	AnalogFilter01 AnalogFilter02	UINT				•
386 430	AnalogMode01 AnalogMode02	UINT				•
402 446	UpperLimit01 UpperLimit02	INT				•
398 442	LowerLimit01 LowerLimit02	INT				•
406 450	Hysteres01 Hysteres02	INT				•
414 458	ReplacementUpper01 ReplacementUpper02	INT				•
410 454	ReplacementLower01 ReplacementLower02	INT				•
426 470	PreparationInterval01 PreparationInterval02	UINT				•
418 462	ErrorDelay01 ErrorDelay02	UINT				•
422 466	SumErrorDelay01 SumErrorDelay02	UINT				•
Analog input - Communication						
0 2	AnalogInput01 (limited) AnalogInput02 (limited)	INT	•			
258 262	AnalogInput01 (original value) AnalogInput02 (original value)	INT	•			
284 292	AnalogSampletime01 (32-bit) AnalogSampletime02 (32-bit)	DINT	•			
282 290	AnalogSampletime01 (16-bit) AnalogSampletime02 (16-bit)	INT	•			
273 275	AnalogStatus01 AnalogStatus02	USINT	•			
	UnderflowAnalogInput01 or 02	Bit 0				
	OverflowAnalogInput01 or 02	Bit 1				
	OpenLineAnalogInput01 or 02	Bit 2				
	SumErrorAnalogInput01 or 02	Bit 4				
	SensorErrorAnalogInput01 or 02	Bit 6				
	IoSuppErrorAnalogInput01 or 02	Bit 7				

9.3 Function model 254 - Bus controller

Register	Offset[1]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Analog input - Configuration							
390 434	- -	AnalogFilter01 AnalogFilter02	UINT				●
386 430	- -	AnalogMode01 AnalogMode02	UINT				●
402 446	- -	UpperLimit01 UpperLimit02	INT				●
398 442	- -	LowerLimit01 LowerLimit02	INT				●
406 450	- -	Hysteres01 Hysteres02	INT				●
414 458	- -	ReplacementUpper01 ReplacementUpper02	INT				●
410 454	- -	ReplacementLower01 ReplacementLower02	INT				●
426 470	- -	PreparationInterval01 PreparationInterval02	UINT				●
418 462	- -	ErrorDelay01 ErrorDelay02	UINT				●
422 466	- -	SumErrorDelay01 SumErrorDelay02	UINT				●
Analog input - Communication							
0 2	0 2	AnalogInput01 AnalogInput02	INT	●			
273 275	- -	AnalogStatus01 AnalogStatus02	USINT		●		
		UnderflowAnalogInput01 or 02	Bit 0				
		OverflowAnalogInput01 or 02	Bit 1				
		OpenLineAnalogInput01 or 02	Bit 2				
		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.

9.3.1 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 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).

9.3.2 CAN I/O bus controller

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

9.4 General information

The module provides 2 electrically isolated channels. Each channel can read an electrical voltage signal in the ±10 V range and supply the signal encoder with 24 VDC.

9.5 Analog input - Configuration

Each channel is configured and enabled separately. First, the user must set the scaling of the input value and select a replacement value strategy. Depending on the requirements of the application, the user can also set user-defined limit values and define an input filter.

Scaling

The module's A/D converter works with a resolution of 16 bits (±15 bits). This allows the input value of ±10 V to be mapped using ±32767 steps. To simplify implementation, the user can configure scaling to ±10000 steps. The conversion value corresponds to the voltage in mV, and with a resolution of more than 14 bits (±13 bits) is still precise enough for the many different application that use this technology.

Replacement value strategy

The detected voltage is evaluated in order to ensure the quality of the read value. For example, if a logically impermissible voltage value or an open line is detected, the limit monitor triggers an appropriate response.

The response is determined by the replacement value strategy selected by the user. With the option "Replace with static value", the user defines two values that replace the converted value when the upper and lower limits are exceeded. The alternative "Retain last valid value" keeps the last validated value. However, the evaluation for this option takes more time. Depending on the "preparation interval", the value currently being read may be delayed.

Limit Value Monitoring

In addition to the qualitative evaluation of the input, the module also provides the option of adapting the range of permitted values to the requirements of the application. The registers "UpperLimit" on page 14 and "LowerLimit" on page 14 can be used to place additional restrictions on the permitted upper and lower limit. When this feature is used, the selected replacement value strategy is implemented according to the new limits.

9.5.1 Input filter

Analog input signals can experience brief disturbances caused by external factors (EMC). The A/D converters high sampling rate allows you to filter out these types of signal peaks without hindering the application processes.

2 configuration points are available for interpolating the input signal:

- "Input ramp limiting" on page 10
- "Filter level" on page 11

9.5.1.1 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 ± 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 limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step 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

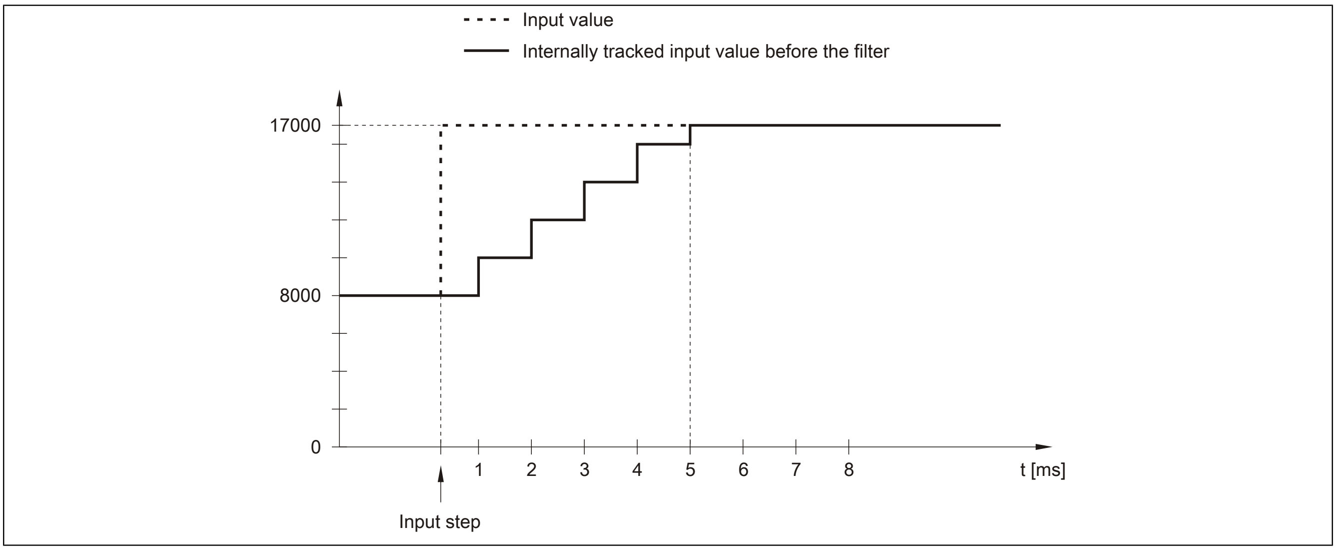


Figure 1: Tracked input value for input step

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

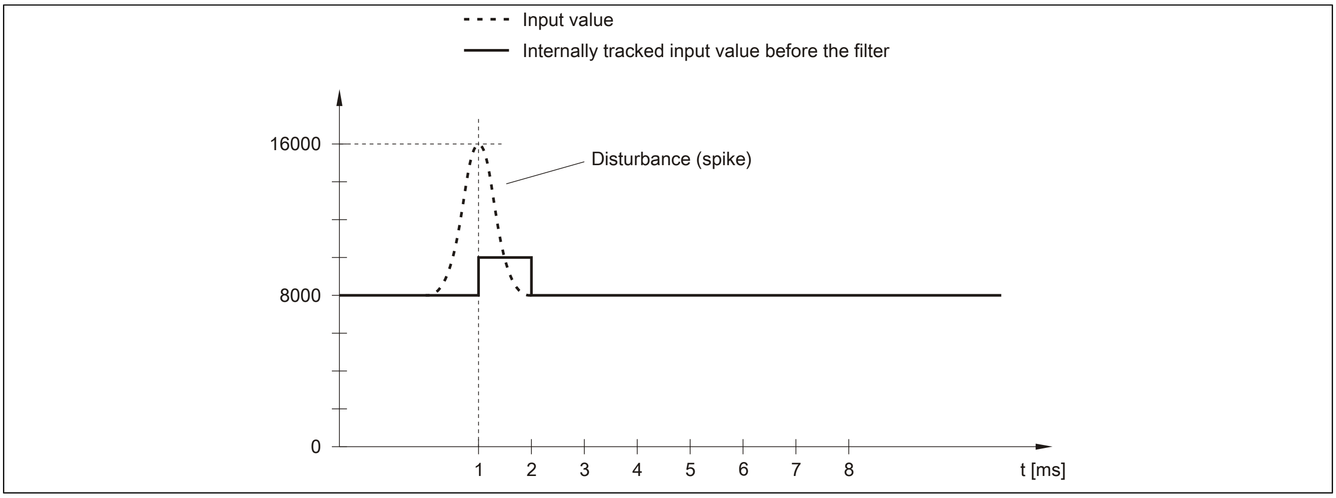


Figure 2: Tracked input value for disturbance

9.5.1.2 Filter level

A filter can be defined to prevent large input steps. 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 any input ramp limiting has been carried out.

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 the functionality of the filter based on an input step and a 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

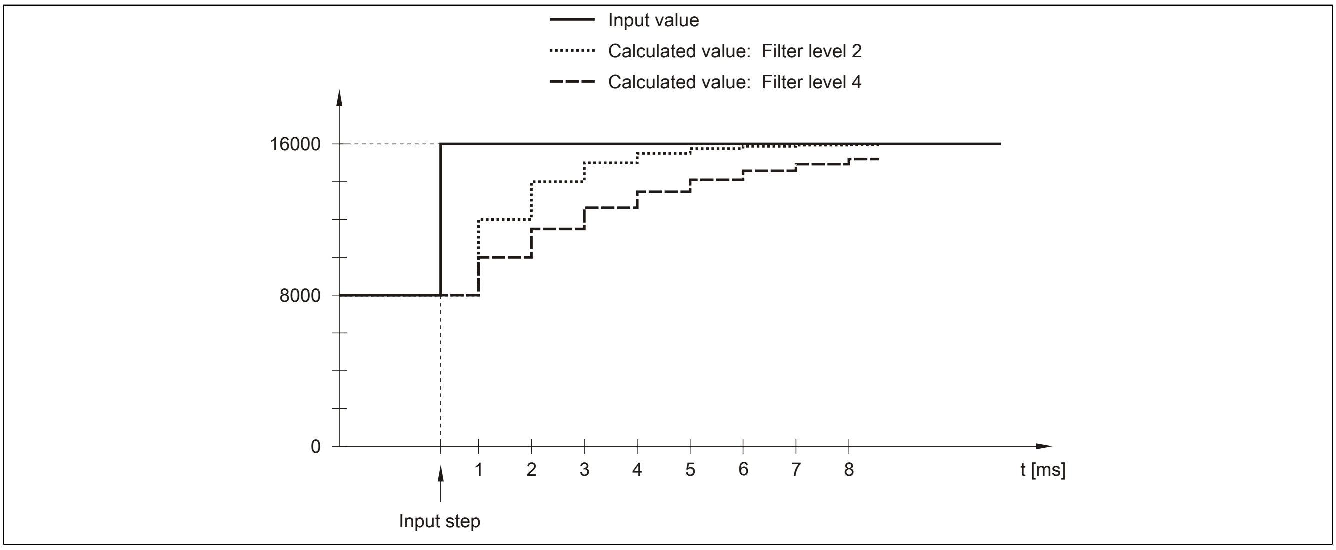


Figure 3: Calculated value during input step

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

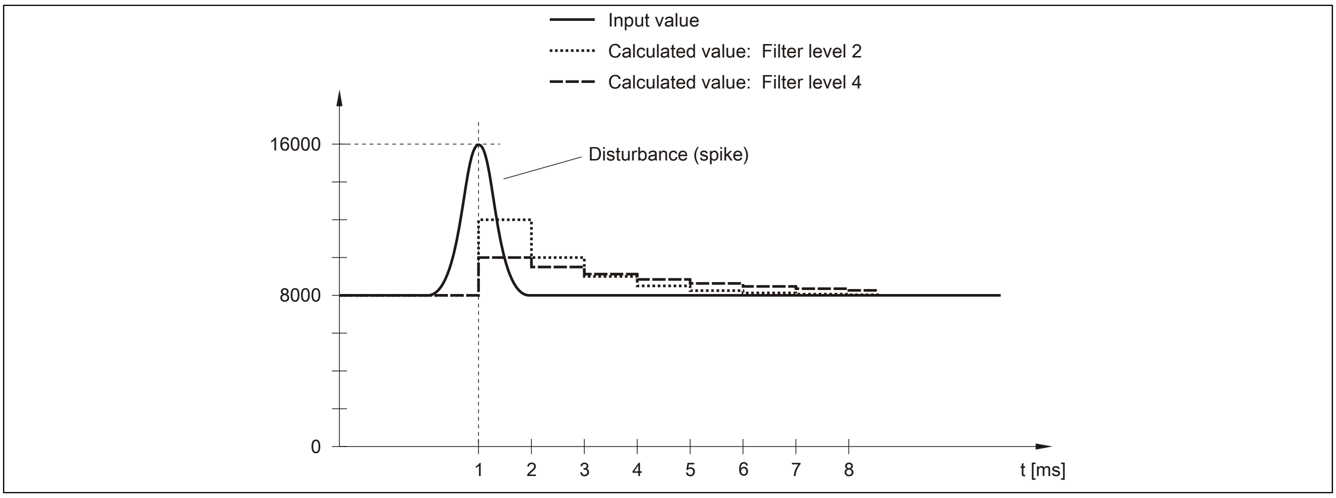


Figure 4: Calculated value during disturbance

9.5.1.3 Configuring filters

Name:
AnalogFilter01 to AnalogFilter02

This register is used to define the filter level and input ramp limitation of the input filter.

Data type	Value	Bus controller default setting
UINT	See 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 input ramp limiting	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	Reserved	0	

9.5.2 Channel parameters

Name:
AnalogMode01 to AnalogMode02

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be enabled individually and can be configured and operated independently.

Information:

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

Data type	Value	Bus controller default setting
UINT	See bit structure.	15

Bit structure:

Bit	Name	Value	Information
0	Channel (on/off)	0	Disabled
		1	Enabled (bus controller default setting)
1	Limit exceeded	0	Disabled
		1	Enabled (bus controller default setting)
2	Lower limit violation	0	Disabled
		1	Enabled (bus controller default setting)
3	Reserved	0	
4	Replacement value strategy	0	Replace with static value
		1	Retain last valid value
5	Measured value scaling	0	±32767 (resolution: 16-bit)
		1	±10000 (resolution: >14-bit)
6 - 15	Reserved	0	

9.5.3 Upper limit value

Name:
UpperLimit01 to UpperLimit02

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: 32767
	-10000 to 10000	

Information:

The defined limit values must take the configured scaling into consideration.

9.5.4 Lower limit value

Name:
LowerLimit01 to LowerLimit02

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: -32767
	-10000 to 10000	

Information:

The defined limit values must take the configured scaling into consideration.

9.5.5 Hysteresis

Name:
Hysteres01 to Hysteres02

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.
The error status is cleared when the scaled input value once again passes the limit by at least the hysteresis value in the permitted direction.

Data type	Value	Information
INT	-32767 to 32767.	Bus controller default setting: 100
	-10000 to 10000	

Information:

The hysteresis value must take the scaling into consideration.

9.5.6 Upper replacement value

Name:
ReplacementUpper01 to ReplacementUpper02

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

Data type	Value	Information
INT	-32767 to 32767.	Bus controller default setting: 32767

9.5.7 Lower replacement value

Name:
ReplacementLower01 to ReplacementLower02

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

Data type	Value	Information
INT	-32767 to 32767	Bus controller default setting: -32767

9.5.8 Preparation time for the measured values

Name:
PreparationInterval01 to PreparationInterval02

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.

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

Functionality:
Measured values are continuously converted and stored to measured value memory depending on the configured input filter. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer.
If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between output and buffer memory reverses and the last valid value continues to be output.

Information:

If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.

"Application" Value being measured (analog)	
↓	Condition: - Conversion interval (A/D converter) elapsed
"Measured value memory" Measured value (digital)	
↓	Condition: - PreparationInterval elapsed - Measured value permissible
"Buffer" Last valid value	
↓	Condition: - PreparationInterval elapsed - Measured value permissible
"Output memory" Next-to-last valid/ displayed value	

9.5.9 Delaying error messages

Name:
ErrorDelay01 to ErrorDelay02

This register specifies the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

Data type	Value	Information
UINT	0 to 65535	Bus controller default setting: 2

9.5.10 Time for composite error bit

Name:
SumErrorDelay01 to SumErrorDelay02

This register can be used to set the time that an error must remain pending before the composite error bit is set.

Data type	Value	Information
UINT	0 to 65535	Bus controller default setting: 4000

9.6 Analog input - Communication

The measured voltage data can be obtained via 2 different registers: The unevaluated measured value contains the scaled converter value. The evaluated measured value also takes the limit values and the configured replacement value strategy into consideration.

9.6.1 Analog input values - Original values

Name:
AnalogInput01 to AnalogInput02

These registers are used to indicate the actual input values after standardization.

Data type	Value
INT	-32767 to 32767
	-10000 to 10000

9.6.2 Analog input values - Limited

Name:
AnalogInput01 to AnalogInput02

These registers are used to indicate the actual input values after standardization. In addition, the settings for limit value monitoring and replacement value strategy are applied to this register.

Data type	Value
INT	-32767 to 32767
	-10000 to 10000

9.6.3 Sample time

Name:
Sampletime01 to Sampletime02

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 more information about NetTime and timestamps, see "NetTime Technology" on page 18.

Data type	Values [µs]	Information
INT	-32,768 to 32767	NetTime timestamp of the current input value
DINT	-2,147,483,648 to 2,147,483,647	NetTime timestamp of the current input value

9.6.4 Status of the inputs

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

The current error status of the module channels is displayed in this register, regardless of the configured replacement value strategy. Some error information may be delayed according to the previously configured condition.

Setting "Format of status information" in Automation Studio allows you to specify whether the status information is transferred as USINT or bitwise.

Data type	Value
USINT	See bit structure.

Bit structure:

Bit	Name	Value	Information
0	UnderflowAnalogInput01 or 02	0	No error
		1	Below lower limit value
1	OverflowAnalogInput01 or 02	0	No error
		1	Above upper limit value
2	OpenLineAnalogInput01 or 02	0	No error
		1	Open line detected
3	Reserved	0	
4	SumErrorAnalogInput01 or 02	0	No error
		1	Composite error detected
5	Reserved	0	
6	SensorErrorAnalogInput01 or 02	0	Sensor voltage OK
		1	Sensor load too high
7	IoSuppErrorAnalogInput01 or 02	0	I/O power supply OK
		1	I/O power supply error detected

UnderflowAnalogInput

The signal underflow error status is indicated here according to the configuration. This error information is enabled as a multiple of the conversion cycle only after the configurable delay time has passed (see "ErrorDelay" on page 15 register).

OverflowAnalogInput

The signal overflow error status is indicated here according to the configuration. This error information is enabled as a multiple of the conversion cycle only after the configurable delay time has passed (see "ErrorDelay" on page 15 register).

SumErrorAnalogInput

This error information derives from the status of individual errors and is only activated after the configurable delay time has passed [ms] (see "SumErrorDelay" on page 15 register). Linking this error information to an application makes it possible to hide temporary temperature value overflows and underflows, for example.

SensorErrorAnalogInput

In addition to the analog input, the module also provides the option of supplying the connected encoder with 24 VDC. If the input impedance for the sensor is too high, however, the integrated voltage supply will fail.

IoSuppErrorAnalogInput

This error is activated immediately as soon as the module detects that the necessary supply voltage is no longer being provided (<20 VDC).

9.7 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (CPU, 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

9.7.1 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.

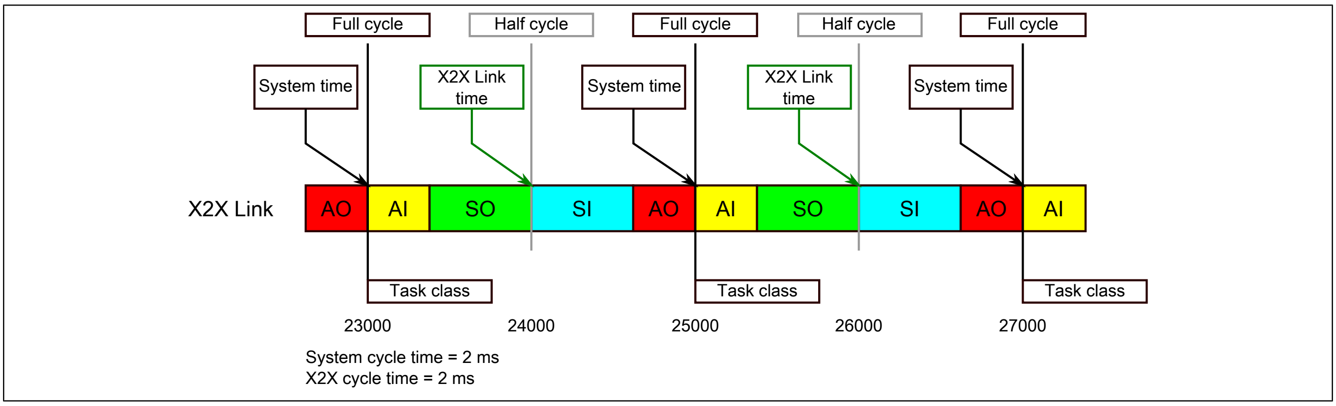
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

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

9.7.1.1 PLC/Controller data points

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

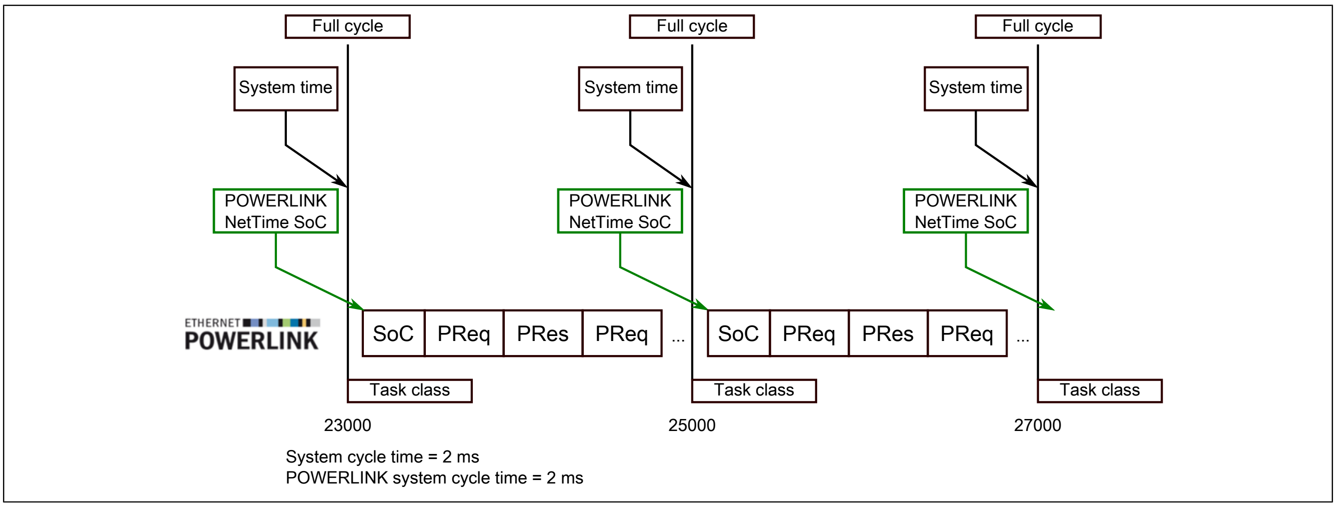
9.7.1.2 X2X Link reference moment



The reference moment 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 moment 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 moment are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference moment returns the value 24000.

9.7.1.3 POWERLINK reference moment

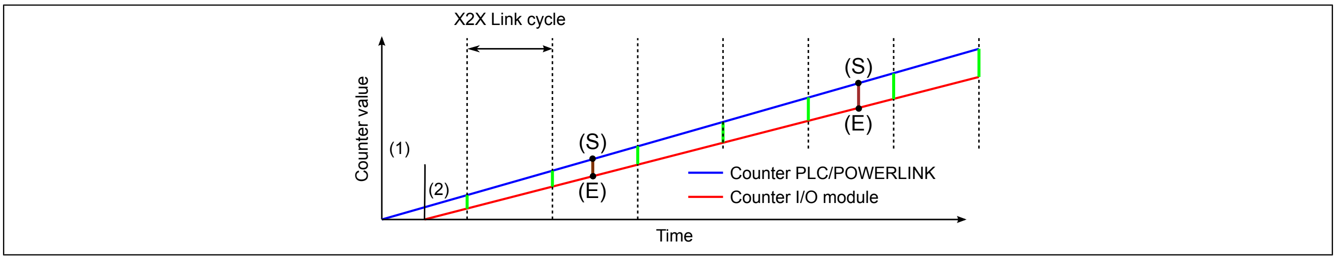


The reference moment on the POWERLINK network is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

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 moment are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference moment returns the value 23020.

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



At startup, the internal counters for the PLC/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 PLC or the 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.

9.7.2 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 CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.7.2.1 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.

9.7.2.2 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.

9.7.2.3 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.

9.8 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

9.9 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