X20(c)SD1207

Information:

B&R makes every effort to keep data sheets as current as possible. From a safety point of view, however, the current version of the data sheet must always be used.

The certified, currently valid data sheet can be downloaded from the B&R website www.br-automation.com.

Organization of notices

Safety notices

Contain **only** information that warns of dangerous functions or situations.

Signal word	Description
Danger!	Failure to observe these safety guidelines and notices will result in death, severe injury or substantial damage to property.
Warning!	Failure to observe these safety guidelines and notices can result in death, severe injury or substantial damage to property.
Caution!	Failure to observe these safety guidelines and notices can result in minor injury or damage to property.
Notice!	Failure to observe these safety guidelines and notices can result in damage to property.

Table 1: Organization of safety notices

General notices

Contain **useful** information for users and instructions for avoiding malfunctions.

Signal word	Description
Information:	Useful information, application tips and instructions for avoiding malfunctions.

Table 2: Organization of general notices

1 General information

The modules are equipped with 1 safe digital input for measuring the velocity. Velocity information can be acquired from AB signals up to a maximum frequency of 7 kHz.

The safe counter modules are suitable for safely acquiring velocities for safety applications up to PL e or SIL 3.

These modules are designed for X20 12-pin terminal blocks.

- 1 safe digital counter input with up to 7 kHz counter frequency
- For encoder inputs A-A, A-B, A-A/-B-B/
- Sink circuit
- Input filter configurable

1.1 Function

Safe counter function

This safe counter module is suitable for safely acquiring speed information from AB signals up to a maximum frequency of 7 kHz for safety-related applications up to PL e or SIL 3.

openSAFETY

This module uses the protective mechanisms of openSAFETY when transferring data to the various bus systems. Because the data is encapsulated in the openSAFETY container in a fail-safe manner, the components on the network that are involved in the transfer do not require any additional safety-related features. At this point, only the safety-related characteristic values specified for openSAFETY in the technical data are to be consulted. The data in the openSAFETY container undergoes safety-related processing only when received by the remote station; for this reason, only this component is involved from a safety point of view. Read access to the data in the openSAFETY container for applications without safety-related characteristics is permitted at any point in the network without affecting the safety-related characteristics of openSAFETY.

open SAFETY

1.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation.
The modules' electronics are fully compatible with the corresponding X20 modules.

Information:

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, Method 4, exposure 21 days

Contrary to the specifications for X20 system modules without safety certification and despite the tests performed, X20 safety modules are **NOT suited for applications with corrosive gases (EN 60068-2-60)!**

2 Overview

Module	X20SD1207
Counter function	
Number of counter channels	1
Nominal voltage	24 VDC
Input circuit	Sink
Function modes	A-A, A-B, A-A/-B-B/
Input frequency	Max. 7 kHz
Encoder supply	
Nominal voltage	24 VDC
Nominal output current	80 mA

Table 3: Counter and positioning modules

3 Order data

Model number	Short description	Figure
	Counter and positioning modules	
X20SD1207	X20 safe digital counter module, 1 safe digital counter channel, 7 kHz, 24 VDC	
X20cSD1207	X20 safe digital counter module, coated, 1 safe digital counter channel, 7 kHz, 24 VDC	
	Required accessories	
	Bus modules	
X20BM33	X20 bus module, for X20 SafeIO modules, internal I/O power supply continuous	
X20BM36	X20 bus module, for X20 SafeIO modules, with node number switch, internal I/O power supply continuous	
X20cBM33	X20 bus module, coated, for X20 SafeIO modules, internal I/O power supply continuous	
	Terminal blocks	
X20TB52	X20 terminal block, 12-pin, safety-keyed	

Table 4: X20SD1207, X20cSD1207 - Order data

4 Technical data

Model number	X20SD1207	X20cSD1207
Short description		
I/O module	1 safe digital counter channel, 7 kHz, 24 VDC	
General information		
B&R ID code	0xCAC1	0xE1CB
System requirements		
Automation Studio	3.0.90 or later	4.0.16 or later
Automation Runtime	3.00 or later	V3.08 or later
SafeDESIGNER	2.91 or later	3.1.0 or later
Safety Release	1.5 or later	1.7 or later
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	
Blackout mode		
Scope	Module	
Function	Module function	
Standalone mode	No	
Max. I/O cycle time	2 ms	
Power consumption		
Bus	0.25 W	
Internal I/O	0.75 W	
Electrical isolation		
Channel - Bus	Yes	
Channel - Channel	No	
Certifications		
CE	Yes	
EAC	Yes	
UL	cULus E115267 Industrial control equipment	
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5	
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X	
DNV GL	Temperature: **A** (0 - 45°C) Humidity: **B** (up to 100%) Vibration: **A** (0.7 g) EMC: **B** (bridge and open deck)	
Functional safety	cULus FSPC E361559 Energy and industrial systems Certified for functional safety ANSI UL 1998:2013	
Functional safety	IEC 61508:2010, SIL 3 EN 62061:2013, SIL 3 EN ISO 13849-1:2015, Cat. 4 / PL e IEC 61511:2004, SIL 3	
Functional safety	EN 50156-1:2004	
Safety characteristics		
EN ISO 13849-1:2015		
Category	Cat. 4 The special instructions in the "Connection examples" section must be followed. [1)]	
PL	PL e	
DC	>94%	
MTTFD	2500 years	
Mission time	Max. 20 years	
IEC 61508:2010, IEC 61511:2004, EN 62061:2013		
SIL CL	SIL 3	
SFF	>90%	
PFH / PFH_d		
Module	$<1*10^{-10}$	
openSAFETY wired	Negligible	
openSAFETY wireless	$<1*10^{-14}$ * Number of openSAFETY packets per hour	
PFD	$<2*10^{-5}$	
Proof test interval (PT)	20 years	
Encoder power supply		
Output voltage	I/O power supply minus residual voltage	
Nominal output current	80 mA	
Residual voltage	<0.4 VDC	

Table 5: X20SD1207, X20cSD1207 - Technical data

Model number	X20SD1207	X20cSD1207
Protective measures		
Short-circuit proof	Thermal limit determined by PTC	
I/O power supply		
Nominal voltage	24 VDC	
Voltage range	24 VDC -15% / +20%	
Integrated protection	Reverse polarity protection	
Safe digital counter inputs		
Nominal voltage	24 VDC	
Input characteristics per EN 61131-2	Type 1	
Input filter		
Hardware	<10 µs	
Software	Configurable between 0 and 100 s	
Input frequency	Max. 7 kHz	
Input circuit	Sink	
Input voltage	24 VDC -15% / +20%	
Input current at 24 VDC	2.48 mA	
Input resistance	9.68 kΩ	
Isolation voltage between channel and bus	500 V_{eff}	
Switching threshold		
Low	<5 VDC	
High	>15 VDC	
Line length	Max. 30 m shielded	
Operating conditions		
Mounting orientation		
Horizontal	Yes	
Vertical	Yes	
Installation elevation above sea level	0 to 2000 m, no limitation	
Degree of protection per EN 60529	IP20	
Ambient conditions		
Temperature		
Operation		
Horizontal mounting orientation	0 to 60°C	-40 to 60°C [2]
Vertical mounting orientation	0 to 50°C	-40 to 50°C [3]
Derating	See section "Derating".	
Storage	-40 to 85°C	
Transport	-40 to 85°C	
Relative humidity		
Operation	5 to 95%, non-condensing	Up to 100%, condensing
Storage	5 to 95%, non-condensing	
Transport	5 to 95%, non-condensing	
Mechanical properties		
Note	Order 1x safety-keyed terminal block separately. Order 1x safety-keyed bus module separately.	
Spacing	$25^{+0.2}$ mm	

Table 5: X20SD1207, X20cSD1207 - Technical data

1) The related danger warnings in the technical data sheet must also be observed.
2) Up to hardware upgrade <1.10.1.0: -25 to 60°C
3) Up to hardware upgrade <1.10.1.0: -25 to 50°C

Danger!

Operation outside the technical data is not permitted and can result in dangerous states.

Information:

For detailed information about installation, see chapter "Installation notes for X20 modules" on page 34.

Derating

The derating curve refers to standard operation and can be shifted to the right by the specified derating bonus if in a horizontal mounting orientation.

Module	X20SD1207
Derating bonus	
At 24 VDC	+2.5°C
Dummy module to the left	+0°C
Dummy module to the right	+2.5°C
Dummy module to the left and right	+5°C
With double PFH / PFH_d	+0°C

Table 6: Derating bonus

The number of inputs that should be used at the same time depends on the operating temperature and the mounting orientation. The resulting amount can be looked up in the following table.

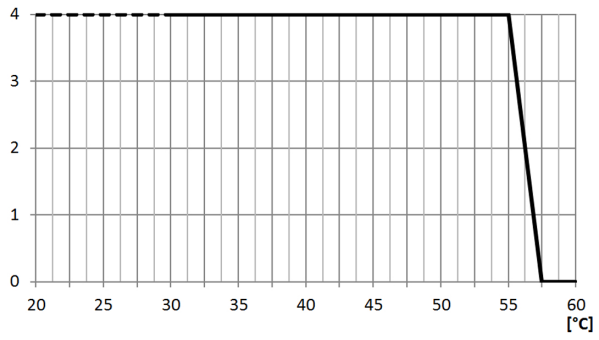
Horizontal (0 to 60°C, coated: -40 to 60°C)	Vertical (0 to 50°C, coated: -40 to 50°C)
	No derating

Table 7: Derating in relation to operating temperature and mounting orientation

Information:

Regardless of the values specified in the derating curve, the module cannot be operated above the values specified in the technical data.

5 LED status indicators

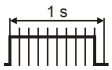
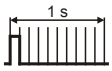
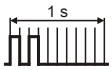
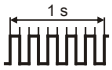
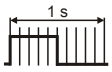
Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	Reset mode
			Double flash	Updating firmware
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	e	Red	Off	No power to module or everything OK
			Pulsating	Boot loader mode
			Triple flash	Updating safety-related firmware
			On	Error or I/O component not provided with voltage
	e + r	Red on / green single flash		Invalid firmware
	A, B, $\overline{A}$, $\overline{B}$	Input state of the corresponding digital input		
		Red	On	Warning/Error on the input channel
			All on	Error on all channels, connection to the SafeLOGIC controller not OK or booting not yet completed
			Off	No warning / No error
		Green	On	Input set
			Off	Input not set
	p	This LED is reserved for future functional expansions.		
	v	Status of speed evaluation		
		Red	On	Warning/Error on evaluation channel, connection to the SafeLOGIC controller not OK or booting not yet completed
		Green	On	Evaluation channel set
	SE	Red	Off	RUN mode or I/O component not provided with voltage
				Boot phase, missing X2X Link or defective processor
				Safety PREOPERATIONAL state Modules that are not used in the SafeDESIGNER application remain in the PREOPERATIONAL state.
				Safe communication channel not OK
				The firmware for this module is a non-certified pilot customer version.
				Boot phase, faulty firmware
			On	Safety state active for the entire module (= "FailSafe" state)
		The "SE" LEDs separately indicate the status of safety processor 1 ("S" LED) and safety processor 2 ("E" LED).		

Table 8: Status display

Danger!

Constantly lit "SE" LEDs indicate a defective module that must be replaced immediately.
It is your responsibility to ensure that all necessary repair measures are initiated after an error occurs since subsequent errors can result in a hazard!

6 Pinout

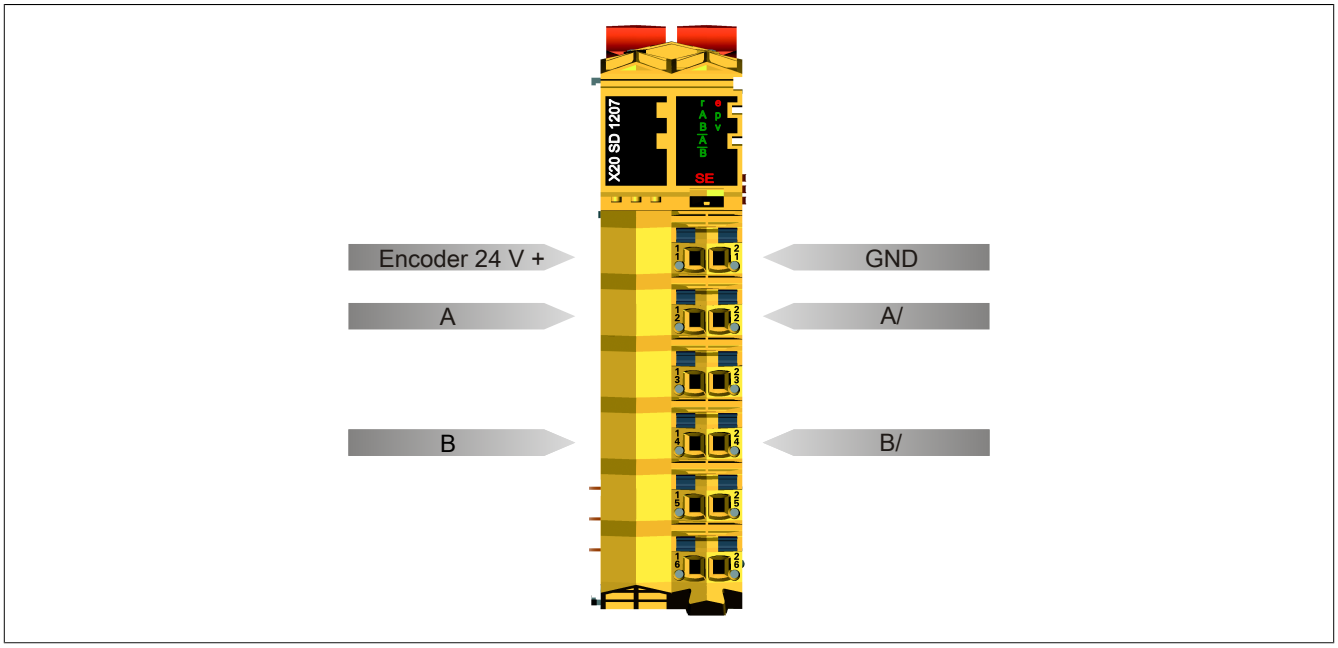


Figure 1: X20SD1207 - Pinout

7 Connection examples

The typical connection examples in this section only represent a selection of the different wiring methods. The user must take error detection into consideration in each case.

7.1 Function mode A-A - Single-channel encoder

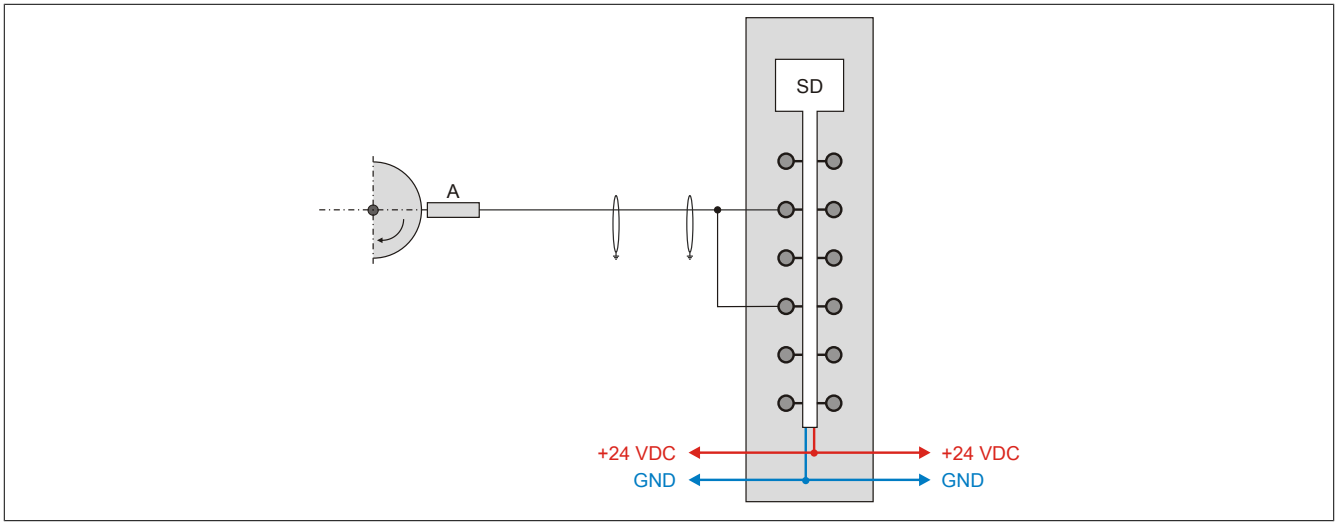


Figure 2: X20SD1207 - Function mode A-A - Single-channel encoder

Signal form A-A

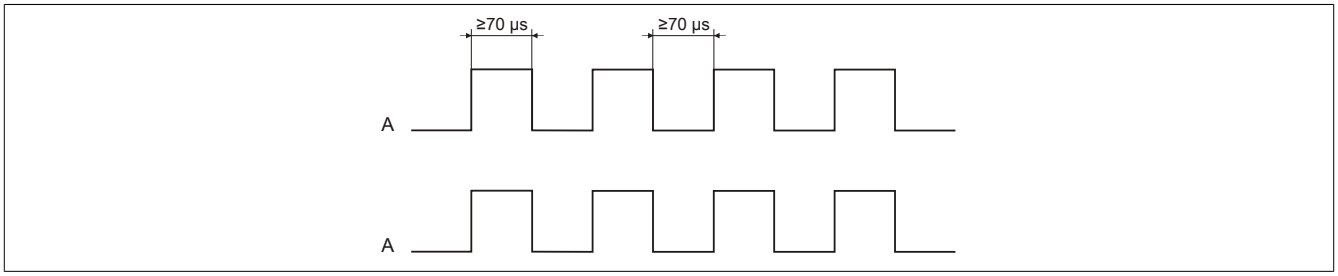


Figure 3: Signal form A-A

Function mode	A-A - Single-channel encoder
Category in accordance with EN ISO 13849-1:2015 (module and encoder)	CAT 2
Safe recording of the rotary speed	Yes, if rotary speed >0
Safe recording of the direction of rotation	No
Safe stall detection	No
Encoder wiring instructions	
• Shielded cables should be used for encoder wiring. • Cable length - Max. 30 m	
Information regarding the encoder	
• The encoder must be taken into consideration when assessing and validating the safety chain. • Encoders with output signal test pulses (OSSD) are not permitted to be used because the test pulses would result in incorrect measurement results on the counter channel. • The encoder signal levels must be compatible with the input channels. Here, the characteristic values listed in the technical data must be taken into account.	
Information regarding the encoder supply	
• The design of the encoder supply must ensure proper operation and the correct signal level (<5 VDC low, >15 VDC high).	

7.2 Function mode A-A - Two-channel encoder

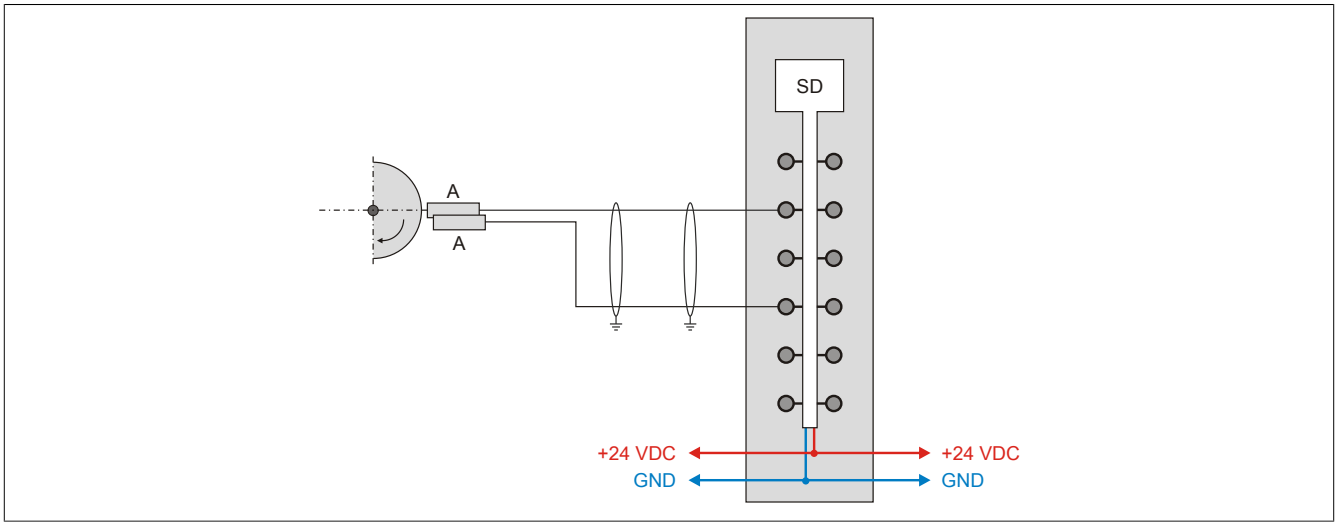


Figure 4: X20SD1207 - Function mode A-A - Two-channel encoder

Signal form A-A

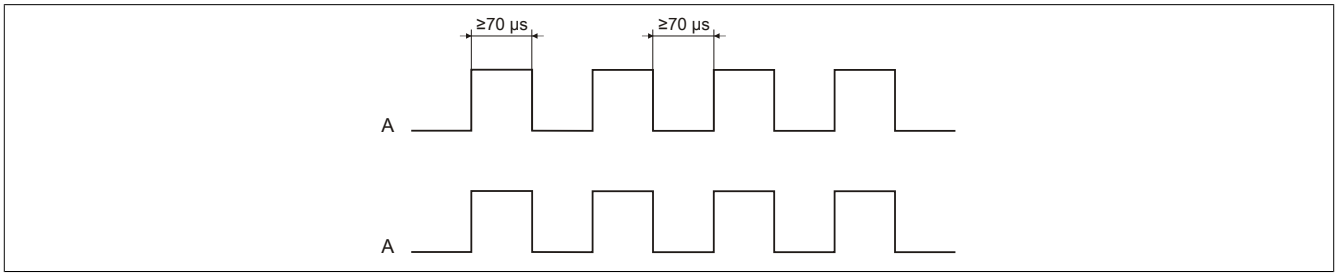


Figure 5: Signal form A-A

Function mode	A-A - Two-channel encoder
Category in accordance with EN ISO 13849-1:2015 (module and encoder)	CAT 4
Safe recording of the rotary speed	Yes, if rotary speed >0
Safe recording of the direction of rotation	No
Safe stall detection	No
Encoder wiring instructions	
• Two separate and shielded lines must be used to wire both encoders.	
Information regarding the encoder	
• The encoder must be taken into consideration when assessing and validating the safety chain. • Encoders with output signal test pulses (OSSD) are not permitted to be used because the test pulses would result in incorrect measurement results on the counter channel. • The encoder signal levels must be compatible with the input channels. Here, the characteristic values listed in the technical data must be taken into account. • The two "A" signals must be generated by independent encoders.	
Information regarding the encoder supply	
• The design of the encoder supply must ensure proper operation and the correct signal level (<5 VDC low, >15 VDC high).	

7.3 Function mode A-B

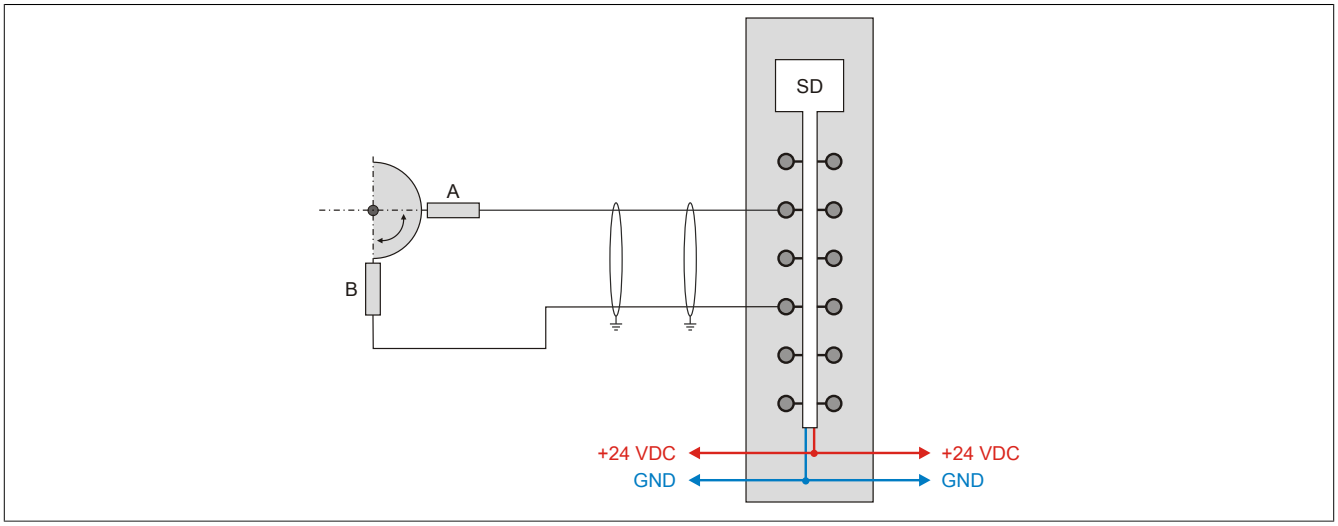


Figure 6: X20SD1207 - Function mode A-B

Signal form A-B

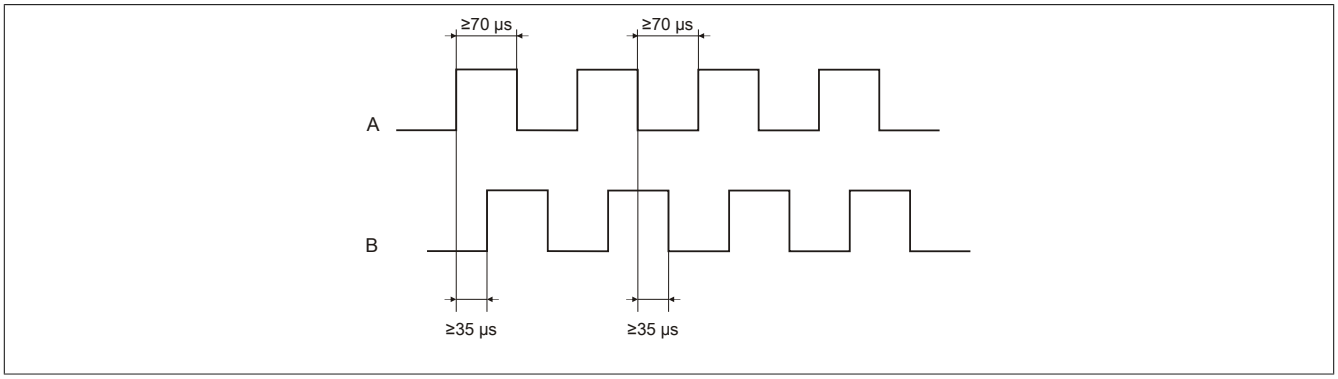


Figure 7: Signal form A-B

Function mode	A-B
Category in accordance with EN ISO 13849-1:2015 (module and encoder)	CAT 4
Safe recording of the rotary speed	Yes, if rotary speed >0
Safe recording of the direction of rotation	No
Safe stall detection	No
Encoder wiring instructions	
• Shielded cables should be used for encoder wiring. • Cable length - Max. 30 m	
Information regarding the encoder	
• The encoder must be taken into consideration when assessing and validating the safety chain. • Encoders with output signal test pulses (OSSD) are not permitted to be used because the test pulses would result in incorrect measurement results on the counter channel. • The encoder signal levels must be compatible with the input channels. Here, the characteristic values listed in the technical data must be taken into account. • The "A" and "B" signals must be generated by independent encoders. If "AB" encoders are used, it is necessary to ensure that the "A" signal is generated in the encoder independent of the "B" signal.	
Information regarding the encoder supply	
• The design of the encoder supply must ensure proper operation and the correct signal level (<5 VDC low, >15 VDC high).	

7.4 Function mode A-A/-B-B/

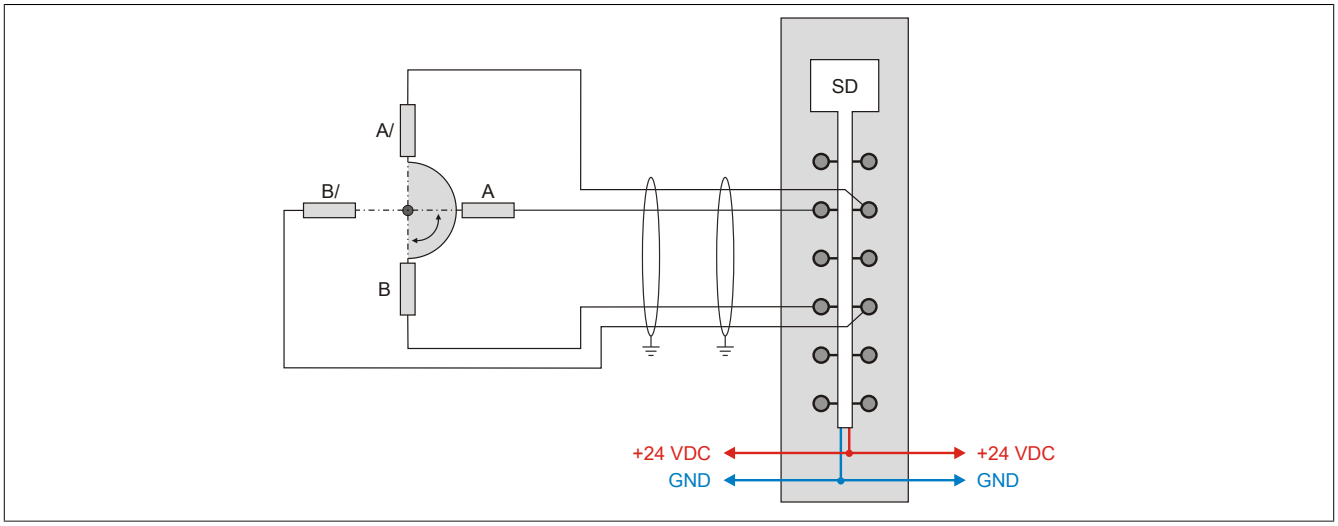


Figure 8: X20SD1207 - Function mode A-A/-B-B/

Signal form A-A/-B-B/

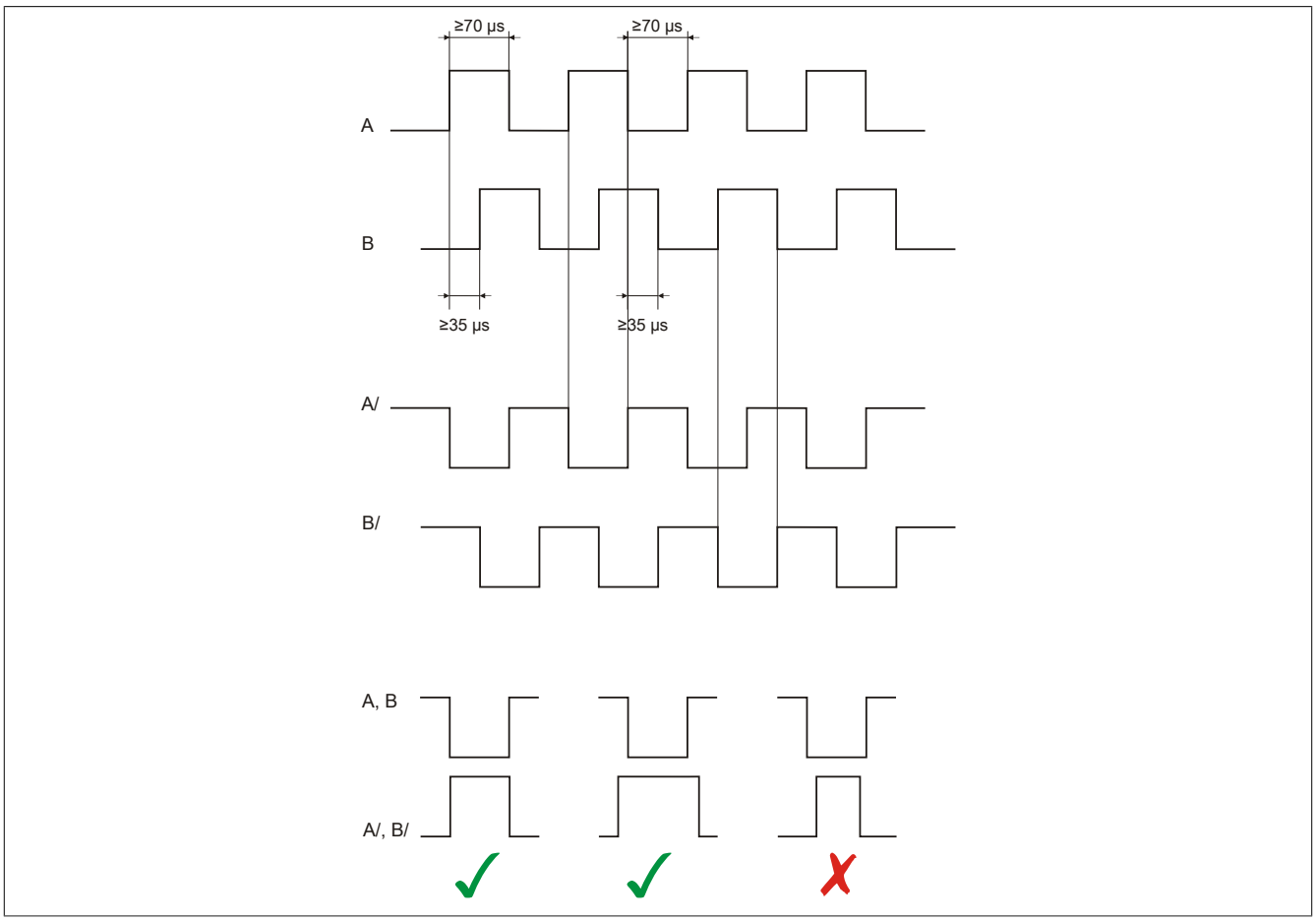


Figure 9: Signal form A-A/-B-B/

Function mode	A-A/-B-B/
Category in accordance with EN ISO 13849-1:2015 (module and encoder)	CAT 4
Safe recording of the rotary speed	Yes, if rotary speed >0
Safe recording of the direction of rotation	Yes
Safe stall detection	Yes

Encoder wiring instructions

- Shielded cables should be used for encoder wiring.
- Cable length - Max. 30 m

Information regarding the encoder

- The encoder must be taken into consideration when assessing and validating the safety chain.
- Encoders with output signal test pulses (OSSD) are not permitted to be used because the test pulses would result in incorrect measurement results on the counter channel.
- The encoder signal levels must be compatible with the input channels. Here, the characteristic values listed in the technical data must be taken into account.
- The "A", "A/", "B" and "B/" signals must be generated by independent encoders. If "AA/BB/" encoders are used, it is necessary to ensure that all signals are generated in the encoder independent of the others.

Information regarding the encoder supply

- The design of the encoder supply must ensure proper operation and the correct signal level (<5 VDC low, >15 VDC high).

8 Error detection

8.1 Internal module errors

The red "SE" LED makes it possible to evaluate the following error states:

- Module error, e.g. defective RAM, defective CPU, etc.
- Overtemperature/Undertemperature
- Overvoltage/Undervoltage
- Incompatible firmware version

Errors that occur within the module are detected according to the requirements of the standards listed in the certificate and within the minimum safety response time specified in the technical data. After this occurs, the module enters a safe state.

The internal module tests needed for this are only performed, however, if the module's firmware has been booted and the module is in either the PREOPERATIONAL state or the OPERATIONAL state. If this state is not achieved (for example, because the module has not been configured in the application), then the module will remain in the boot state.

BOOT mode on a module is clearly indicated by a slowly blinking SE LED (2 Hz or 1 Hz).

The error detection time specified in the technical data is relevant only for detecting external errors (i.e. wiring errors) in single-channel structures.

Danger!

Operating the safety module in BOOT mode is not permitted.

Danger!

A safety-related output channel is only permitted to be switched off for a maximum of 24 hours. The channel must be switched on by the end of this period so that the module's internal channel test can be performed.

8.2 Wiring errors

The wiring errors described in section "Error detection" are indicated by the red channel LED according to the application.

If a module detects an error, then:

- The channel LED is lit constantly red.
- Status signal (e.g. (Safe)ChannelOK, (Safe)InputOK, (Safe)OutputOK, etc.) is set to (SAFE)FALSE.
- Signal "SafeDigitalInputxx" or "SafeDigitalOutputxx" is set to SAFEFALSE.
- An entry is generated in the logbook.

Danger!

Recognizable errors (see the following chapters) are detected by the module within the error detection time. Errors not recognized by the module (or not recognized on time) that can lead to safety-critical states must be detected using additional measures.

Danger!

It is your responsibility to ensure that all necessary repair measures are initiated after an error occurs since subsequent errors can result in a hazard!

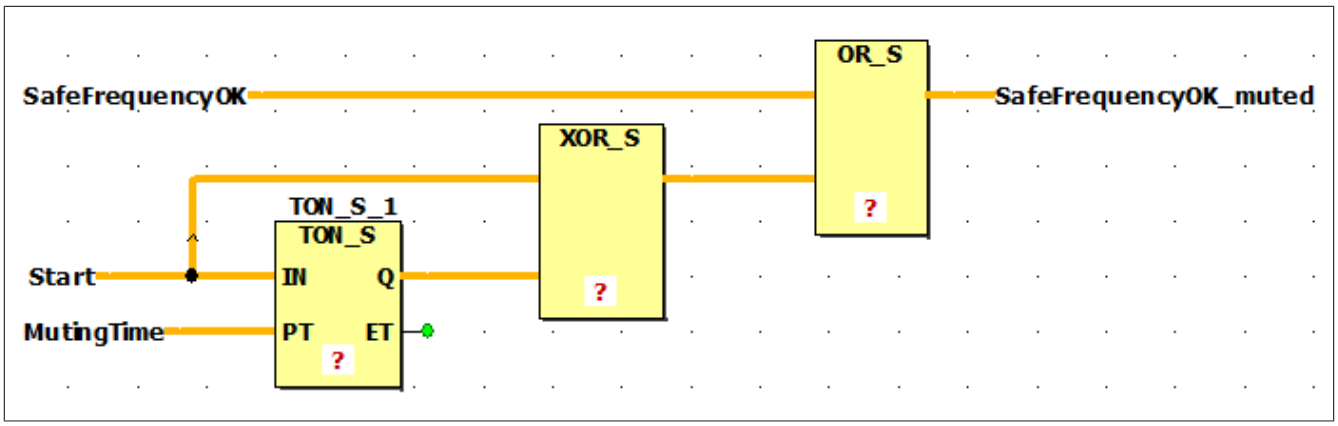
8.2.1 Function mode A-A and A-B

In these modes, the module identifies a safe frequency signal ("SafeFrequency").
Detecting wiring errors only functions properly with dynamic signals and not when in a stationary state. Thus, signal "SafeFrequency" is not permitted to be evaluated when in a stationary state.
This situation is indicated by the "SafeFrequencyOK" status signal.

Status signal "SafeFrequencyOK" is determined as follows:

- SAFETRUE, if pulses are detected on the counter channel within the time specified for "Timebase"
- SAFEFALSE, if no pulses are detected on the counter channel within the time specified for "Timebase", or a different problem is found on the module

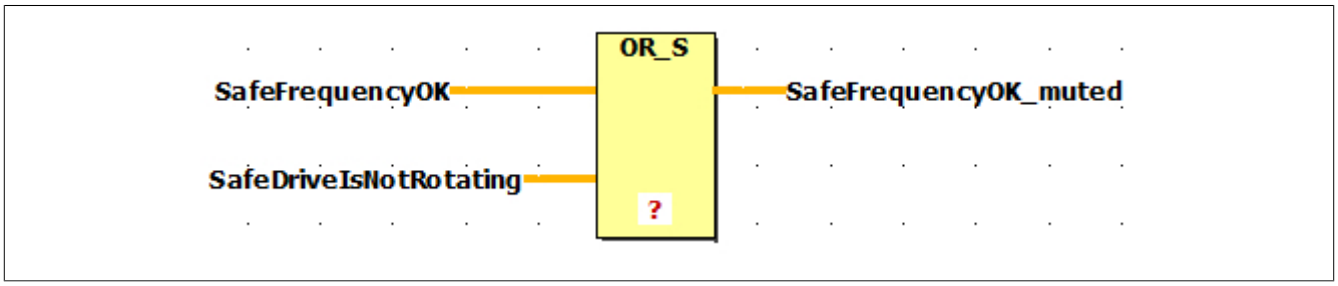
Because "SafeFrequency" is not permitted to be evaluated when in a stationary state, a deadlock situation can occur, for example in an application that monitors the max. speed when starting up the drive (drive cannot start because signal "SafeFrequencyOK" is not SAFETRUE, and signal "SafeFrequencyOK" cannot become SAFETRUE because the drive does not start).
The following SafeDESIGNER code snippet could be used, for example, to solve this problem:



Variable	Type	Source	Description
SafeFrequencyOK	SAFEBOOL	X20SD1207	This status signal indicates the validity of signal "SafeFrequency".
Start	SAFEBOOL	Applications	A rising edge on this signal indicates that a start request has been sent for the rotary movement.
MutingTime	SAFETIME	Applications	This signal defines the max. time the drive needs to detect pulses on the counter channel. The "Timebase" parameter must also be taken into consideration during this time. **Important:** **Monitoring functions are not active during this time. Therefore, this time must be as short as possible. Alternate methods must be used to ensure that no dangerous states can occur within this time.**
SafeFrequencyOK_muted	SAFEBOOL	-	This signal can now be used to further evaluate the rotary movement.

Table 9: Code snippet: Timed muting of signal "SafeFrequencyOK"

As soon as a safe signal for determining the rotary movement is available, the following SafeDESIGNER code snippet can be used:



Variable	Type	Source	Description
SafeFrequencyOK	SAFEBOOL	X20SD1207	This status signal indicates the validity of signal "SafeFrequency".
SafeDriveIsNotRotating	SAFEBOOL	Applications	This signal indicates if a rotary movement is taking place or not.
SafeFrequencyOK_muted	SAFEBOOL	-	This signal can now be used to further evaluate the rotary movement.

Table 10: Code snippet: Muting signal "SafeFrequencyOK" using an additional signal

8.2.2 Function mode A-A/-B-B/

In mode "A-A/-B-B/", wiring error detection is always available regardless if in a stationary state or not. In this mode, it is also permitted to evaluate signal "SafeFrequency" when in a stationary state and to implement safe stall detection.

9 Input circuit diagram

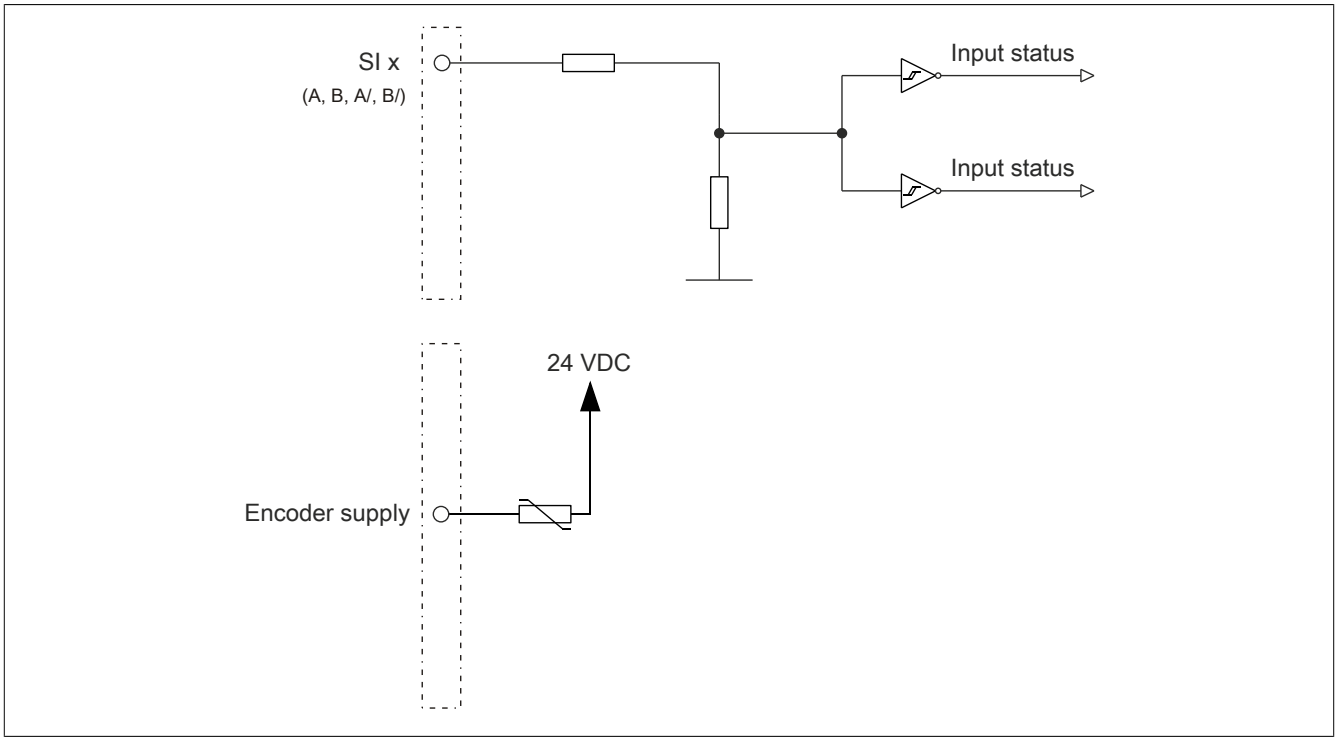


Figure 10: Input circuit diagram

10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.

Minimum cycle time
200 µs

11 I/O update time

The time needed by the module to generate a sample is specified by the I/O update time. This depends on the "Timebase" configured in SafeDESIGNER.

Timebase	I/O update time	Maximum I/O update time
10 ms	2 ms	12 ms
50 ms	2 ms	52 ms
100 ms	2 ms	102 ms
500 ms	5 ms	505 ms
1000 ms	10 ms	1010 ms
5000 ms	50 ms	5050 ms
10 s	0.1 s	10.1 s
50 s	0.5 s	50.5 s
100 s	1 s	101 s

Danger!

Configuring parameter "Timebase" lengthens the safety response time!

12 Precision

The precision of the frequency value measured by the module is determined by the module's resolution and basic accuracy. In firmware version 300 and later, measurement precision has been significantly improved.

12.1 Precision in firmware version 297

Timebase	Resolution in mode "A-A"			Resolution in mode "A-B" and "A-A/-B-B/"			Basic accuracy
	Inc/s	Inc/min	Inc/h	Inc/s	Inc/min	Inc/h	
10 ms	±60 Inc/s	±60 Inc/s	±60 Inc/s	±30 Inc/s	±30 Inc/s	±30 Inc/s	±5% of measured value
50 ms	±12 Inc/s	±12 Inc/s	±12 Inc/s	±6 Inc/s	±6 Inc/s	±6 Inc/s	±5% of measured value
100 ms	±6 Inc/s	±6 Inc/s	±6 Inc/s	±3 Inc/s	±3 Inc/s	±3 Inc/s	±5% of measured value
500 ms	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value
1 s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value
5 s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value
10 s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value
50 s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value
100 s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±1 Inc/s	±5% of measured value

Table 11: Precision in firmware version 297

Danger!

The safe precision of the safe counter module is the result of adding the resolution and the basic accuracy (see table above).

12.2 Precision in firmware version 300 and later

Configuring the "Unit" parameter			Basic accuracy
Inc/s	Inc/min	Inc/h	
±1 Inc/s	±1 Inc/min	±1 Inc/h	±3% of measured value

Table 12: Precision in firmware version 300 and later

Danger!

The safe precision of the safe counter module is the result of adding the resolution and the basic accuracy (see table above).

13 Restart behavior

Each digital input channel is not equipped with an internal restart interlock, which means that the associated channel data reverts back to the proper state automatically after an error situation on the module and/or network.
It is the responsibility of the user to connect the channel data of the safe input channels correctly and to provide them with a restart interlock. The restart interlocks of PLCopen function blocks can be used here, for example.
Using input channels without a correctly connected restart interlock can result in an automatic restart.

Each output channel is equipped with an internal restart interlock, which means that the following sequence must be followed in order to switch on a channel after an error situation on the module/network and/or after ending the safety function:

- Correct all module, channel or communication errors.
- Enable the safety-related signal for this channel (SafeOutput, etc.).
- Pause to ensure that the safety-related signal has been processed on the module (min. 1 network cycle).
- Positive edge on the release channel

For switching the release signal, the notes for manual reset function in EN ISO 13849-1:2015 must be observed.

The restart interlock functions independently of the enabling principle, which means that the behavior described above is not influenced by the parameter settings for the enabling principle or by the chronological position of the functional switching signal.

An automatic restart of the module can be configured by setting parameters. With this function, the output channel can be enabled using safety technology without an additional signal edge on the release channel. This function remains active as long as the release signal is TRUE and there is no error situation on the module/network.

Regardless of this parameter, a positive edge is required on the release channel for enabling the output channel in the following situations:

- After switching on
- After correcting an error on the safe communication channel
- After correcting a channel error
- After the release signal drops out

The automatic restart is configured in SafeDESIGNER using the channel parameters. If using an automatic restart, note the information in EN ISO 13849-1:2015.

Danger!

Configuring an automatic restart can result in critical safety conditions. Take additional measures to ensure proper safety-related functionality.

14 Register description

14.1 Parameters in the I/O configuration

Group: Function model

Parameter	Description	Default value	Unit
Function model	This parameter is reserved for future functional expansions.	Default	-

Table 13: I/O configuration parameters: Function model

Group: General

Parameter	Description	Default value	Unit
Module supervised	System behavior when a module is missing	On	-
	Parameter value / **Description** On: A missing module triggers service mode. Off: A missing module is ignored.		
Module information (up to AS 3.0.90)	This parameter enables/disables the module-specific information in the I/O mapping: • SerialNumber • ModuleID • HardwareVariant • FirmwareVersion	Off	-
Blackout mode (hardware upgrade 1.10.0.6 or later)	This parameter enables blackout mode (see section Blackout mode in Automation Help under: Hardware → X20 system → Additional information → Blackout mode).	Off	-
	Parameter value / **Description** On: Blackout mode is enabled. Off: Blackout mode is disabled.		
SafeLOGIC ID	In applications with multiple SafeLOGIC controllers, this parameter defines the module's association with a particular SafeLOGIC controller. • Permissible values: 1 to 1024	Assigned automatically	-
SafeMODULE ID	Unique safety address of the module • Permissible values: 2 to 1023	Assigned automatically	-

Table 14: I/O configuration parameters: General

14.2 Parameters in SafeDESIGNER - up to Release 1.9

Group: Basic

<table>
<tr><th>Parameter</th><th>Description</th><th>Default value</th><th>Unit</th></tr>
<tr><td>Min_required_FW_Rev</td><td>This parameter is reserved for future functional expansions.</td><td>Basic Release</td><td>-</td></tr>
<tr><td>Optional</td><td>This parameter can be used to configure the module as "optional". Optional modules do not have to be present, i.e. the SafeLOGIC controller will not indicate that these modules are not present. However, this parameter does not influence the module's signal or status data.

<table><tr><th>Parameter value</th><th>Description</th></tr><tr><td>No</td><td>This module is mandatory for the application.

The module must be in OPERATIONAL mode after startup, and safe communication to the SafeLOGIC controller must be established without errors (SafeModuleOK = SAFETRUE). Processing of the safety application on the SafeLOGIC controller is delayed after startup until this state is achieved for all modules with "Optional = No".

After startup, module problems are indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is also made in the logbook.</td></tr><tr><td>Yes</td><td>The module is not required for the application.

The module is not taken into account during startup, which means the safety application is started regardless of whether the modules with "Optional = Yes" are in OPERATIONAL mode or if safe communication is properly established between these modules and the SafeLOGIC controller.

After startup, module problems are NOT indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is NOT made in the logbook.</td></tr><tr><td>Startup</td><td>This module is optional. The system determines how the module will proceed during startup.

If it is determined that the module is physically present during startup (regardless of whether it is in OPERATIONAL mode or not), then the module behaves as if "Optional = No" is set.

If it is determined that the module is not physically present during startup, then the module behaves as if "Optional = Yes" is set.</td></tr><tr><td>Not_Present
(Release 1.9 and later)</td><td>The module is not required for the application.

The module is ignored during startup, which means the safety application is started regardless of whether the modules with "Optional = Not_Present" are physically present.

Unlike when "Optional = Yes" is configured, the module is not started with "Optional = Not_Present", which optimizes system startup behavior.

After startup, module problems are NOT indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is NOT made in the logbook.</td></tr></table></td><td>No</td><td>-</td></tr>
<tr><td>External_UDID</td><td>This parameter enables the option on the module for the expected UDID to be specified externally by the CPU.

<table><tr><th>Parameter value</th><th>Description</th></tr><tr><td>Yes-ATTENTION</td><td>The UDID is determined by the CPU. The SafeLOGIC controller must be restarted if the UDID is changed.</td></tr><tr><td>No</td><td>The UDID is specified by a teach-in procedure during startup.</td></tr></table></td><td>No</td><td>-</td></tr>
<tr><td>Function mode</td><td>This parameter can be used to select the mode for input signal evaluation.</td><td>A-A</td><td>-</td></tr>
</table>

Table 15: SafeDESIGNER parameters: Basic

<table>
<tr><th>Parameter</th><th>Description</th><th>Default value</th><th>Unit</th></tr>
<tr><td></td><td><table>
<tr><th>Parameter value</th><th>Description</th></tr>
<tr><td>Mode A-A</td><td>In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations.
The frequency setting can only accept positive values in this mode.</td></tr>
<tr><td>Mode A-B</td><td>In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations.
The frequency setting can only accept positive values in this mode.</td></tr>
<tr><td>Mode A-Ai-B-Bi</td><td>In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations.
The combination of the inputs can be used to differentiate between a positive and negative direction.
The frequency setting can accept positive and negative values in this mode.</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>Unit</td><td>This parameter can be used to set the unit that should be used when the module transfers the frequency.</td><td>Increment / s</td><td>-</td></tr>
<tr><td></td><td><table>
<tr><th>Parameter value</th><th>Description</th></tr>
<tr><td>Increment / s</td><td>The frequency that has been determined will be shown in increments per second.</td></tr>
<tr><td>Increment / min</td><td>The frequency that has been determined will be shown in increments per minute.</td></tr>
<tr><td>Increment / h</td><td>The frequency that has been determined will be shown in increments per hour.</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>Timebase</td><td>This parameter specifies the time for calculating the average value of the frequency.
• Permissible values: 10 ms, 50 ms, 100 ms, 500 ms, 1 s, 5 s, 10 s, 50 s, 100 s</td><td>10</td><td>ms</td></tr>
</table>

Table 15: SafeDESIGNER parameters: Basic

Danger!

If function "External_UDID = Yes-ATTENTION" is used, incorrect specifications from the CPU can lead to safety-critical situations.
Perform an FMEA (Failure Mode and Effects Analysis) in order to detect these situations and implement additional safety measures to handle them.

Danger!

Configuring parameter "Timebase" lengthens the safety response time!

Group: Safety_Response_Time

<table>
<tr><th>Parameter</th><th>Description</th><th>Default value</th><th>Unit</th></tr>
<tr><td>Manual_Configuration</td><td>This parameter makes it possible to manually and individually configure the safety response time for the module.

The parameters for the safety response time are generally set in the same way for all stations involved in the application. For this reason, these parameters are configured for the SafeLOGIC controller in SafeDESIGNER. For application situations in which individual safety functions require optimal response time behavior, the parameters for the safety response time can be configured individually on the respective module.</td><td>No</td><td>-</td></tr>
<tr><td></td><td colspan="3"><table>
<tr><th>Parameter value</th><th>Description</th></tr>
<tr><td>Yes</td><td>Data from the module's "Safety_Response_Time" group is used to calculate the safety response time for the module's signals.</td></tr>
<tr><td>No</td><td>The parameters for the safety response time are taken from the "Safety_Response_Time" group on the SafeLOGIC controller.</td></tr>
</table></td></tr>
<tr><td>Synchronous_Network_Only</td><td>This parameter describes the synchronization characteristics of the network being used. They are defined in Automation Studio / Automation Runtime.</td><td>Yes</td><td>-</td></tr>
<tr><td></td><td colspan="3"><table>
<tr><th>Parameter value</th><th>Description</th></tr>
<tr><td>Yes</td><td>In order to calculate the safety response time, networks must be synchronous and their cycle times must either be the same or an integer ratio of the cycle times.</td></tr>
<tr><td>No</td><td>No requirement for synchronization of the networks</td></tr>
</table></td></tr>
<tr><td>Max_X2X_CycleTime_us</td><td>This parameter specifies the maximum X2X cycle time used to calculate the safety response time.
• Permissible values: 200 to 25,000 µs (corresponds to 0.2 to 25 ms)</td><td>5000</td><td>µs</td></tr>
<tr><td>Max_Powerlink_CycleTime_us</td><td>This parameter specifies the maximum POWERLINK cycle time used to calculate the safety response time.
• Permissible values: 200 to 25,000 µs (corresponds to 0.2 to 25 ms)</td><td>5000</td><td>µs</td></tr>
<tr><td>Max_CPU_CrossLinkTask_
CycleTime_us</td><td>This parameter specifies the maximum cycle time for the copy task on the CPU used to calculate the safety response time. The value 0 indicates that a copy task is not included for the response time.
• Permissible values: 0 to 25,000 µs (corresponds to 0 to 25 ms)</td><td>5000</td><td>µs</td></tr>
<tr><td>Min_X2X_CycleTime_us</td><td>This parameter specifies the minimum X2X cycle time used to calculate the safety response time.
• Permissible values: 200 to 25,000 µs (corresponds to 0.2 to 25 ms)</td><td>200</td><td>µs</td></tr>
<tr><td>Min_Powerlink_CycleTime_us</td><td>This parameter specifies the minimum POWERLINK cycle time used to calculate the safety response time.
• Permissible values: 200 to 25,000 µs (corresponds to 0.2 to 25 ms)</td><td>200</td><td>µs</td></tr>
<tr><td>Min_CPU_CrossLinkTask_
CycleTime_us</td><td>This parameter specifies the minimum cycle time for the copy task on the CPU used to calculate the safety response time. The value 0 indicates that configurations without a copy task are also included for the response time.
• Permissible values: 0 to 25,000 µs (corresponds to 0 to 25 ms)</td><td>0</td><td>µs</td></tr>
<tr><td>Worst_Case_Response_Time_us</td><td>This parameter specifies the limit value for monitoring the safety response time.
• Permissible values: 3000 to 5,000,000 µs (corresponds to 3 ms to 5 s)</td><td>50000</td><td>µs</td></tr>
<tr><td>Node_Guarding_Lifetime</td><td>This parameter specifies the maximum number of attempts to be made during the time set with parameter "Node_Guarding_Timeout_s". The purpose of these attempts is to ensure that the module is available.
• Permissible values: 1 to 255
Note
• The larger the configured value, the greater the amount of asynchronous data traffic.
• This setting is not critical to safety functionality. The time for safely cutting off actuators is determined independently using parameter "Worst_Case_Response_Time_us".</td><td>5</td><td>-</td></tr>
</table>

Table 16: SafeDESIGNER parameters: Safety_Response_Time

14.3 Parameters in SafeDESIGNER - Release 1.10 and higher

Group: Basic

Parameter	Description	Default value	Unit
Min required FW Rev	This parameter is reserved for future functional expansions.	Basic Release	-
Optional	This parameter can be used to configure the module as "optional". Optional modules do not have to be present, i.e. the SafeLOGIC controller will not indicate that these modules are not present. However, this parameter does not influence the module's signal or status data.	No	-

Parameter value	Description
No	This module is absolutely necessary for the application. The module must be in OPERATIONAL mode after startup, and safe communication to the SafeLOGIC controller must be established without errors (SafeModuleOK = SAFETRUE). Processing of the safety application on the SafeLOGIC controller is delayed after startup until this state is achieved for all modules with "Optional = No". After startup, module problems are indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is also made in the logbook.
Yes	This module is not necessary for the application. The module is not taken into account during startup, which means the safety application is started regardless of whether the modules with "Optional = Yes" are in OPERATIONAL mode or if safe communication is properly established between these modules and the SafeLOGIC controller. After startup, module problems are NOT indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is NOT made in the logbook.
Startup	This module is optional. The system determines how the module will proceed during startup. If it is determined that the module is physically present during startup (regardless of whether it is in OPERATIONAL mode or not), then the module behaves as if "Optional = No" is set. If it is determined that the module is not physically present during startup, then the module behaves as if "Optional = Yes" is set.
NotPresent	This module is not necessary for the application. The module is ignored during startup, which means the safety application is started regardless of whether the modules with "Optional = NotPresent" are physically present. Unlike when "Optional = Yes" is configured, the module is not started with "Optional = NotPresent", which optimizes system startup behavior. After startup, module problems are NOT indicated by a quickly blinking "MXCHG" LED on the SafeLOGIC controller. An entry is NOT made in the logbook.

External UDID	This parameter enables the option on the module for the expected UDID to be specified externally by the CPU.	No	-

Parameter value	Description
Yes-ATTENTION	The UDID is determined by the CPU. The SafeLOGIC controller must be restarted if the UDID is changed.
No	The UDID is specified by a teach-in procedure during startup.

Table 17: SafeDESIGNER parameters: Basic

Danger!

If function "External UDID = Yes-ATTENTION" is used, incorrect specifications from the CPU can lead to safety-critical situations.
Perform an FMEA (Failure Mode and Effects Analysis) in order to detect these situations and implement additional safety measures to handle them.

Group: Safety Response Time

Parameter	Description	Default value	Unit
Manual Configuration	This parameter makes it possible to manually and individually configure the safety response time for the module. The parameters for the safety response time are generally set in the same way for all stations involved in the application. For this reason, these parameters are configured for the SafeLOGIC controller in SafeDESIGNER. For application situations in which individual safety functions require optimal response time behavior, the parameters for the safety response time can be configured individually on the respective module.	No	-
	Parameter value / **Description** Yes: Data from the module's "Safety Response Time" group is used to calculate the safety response time for the module's signals. No: The parameters for the safety response time are taken from the "Safety Response Time" group on the SafeLOGIC controller.		
Safe Data Duration	This parameter specifies the maximum permissible data transmission time between the SafeLOGIC controller and SafeIO module. For more information about the actual data transmission time, see section Diagnostics and service → Diagnostics tools → Network analyzer → Editor → Calculation of safety runtime of Automation Help. The cycle time of the safety application must also be added. • Permissible values: 2000 to 10,000,000 µs (corresponds to 2 ms to 10 s)	20000	µs
Additional Tolerated Packet Loss	This parameter specifies the number of additional tolerated lost packets during data transfer. • Permissible values: 0 to 10	0	Packets
Packets per Node Guarding	This parameter specifies the maximum number of packets used for node guarding. • Permissible values: 1 to 255 **Note** • The larger the configured value, the greater the amount of asynchronous data traffic. • This setting is not critical to safety functionality. The time for safely cutting off actuators is determined independently of this.	5	Packets

Table 18: SafeDESIGNER parameters: Safety Response Time

Group: Module Configuration

Parameter	Description	Default value	Unit
Function Mode	This parameter can be used to select the mode for input signal evaluation.	Mode A-B	-
	Parameter value / **Description** Mode A-A: In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations. The frequency setting can only accept positive values in this mode. Mode A-B: In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations. The frequency setting can only accept positive values in this mode. Mode A-Ai-B-Bi: In this mode, the frequency of the pulses on the inputs is determined. The frequencies of the relevant inputs are checked to see if they are the same, and a channel error is triggered if there are any deviations. The combination of the inputs can be used to differentiate between a positive and negative direction. The frequency setting can accept positive and negative values in this mode.		
Unit	This parameter can be used to set the unit that should be used when the module transfers the frequency.	Increment / s	-
	Parameter value / **Description** Increment / s: The frequency that has been determined will be shown in increments per second. Increment / min: The frequency that has been determined will be shown in increments per minute. Increment / h: The frequency that has been determined will be shown in increments per hour.		
Timebase	This parameter specifies the time for calculating the average value of the frequency. • Permissible values: 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1,000 ms, 2,000 ms, 5,000 ms, 10,000 ms, 20,000 ms, 50,000 ms, 100,000 ms	10	ms

Table 19: SafeDESIGNER parameters: Module Configuration

Danger!

Configuring the "Timebase" parameter lengthens the safety response time!

14.4 Channel list

<table>
<tr><th>Channel name</th><th>Access via Automation Studio</th><th>Access via SafeDESIGNER</th><th>Data type</th><th>Description</th></tr>
<tr><td>ModuleOk</td><td>Read</td><td>-</td><td>BOOL</td><td>Indicates if the module is OK</td></tr>
<tr><td>SerialNumber</td><td>Read</td><td>-</td><td>UDINT</td><td>Module serial number</td></tr>
<tr><td>ModuleID</td><td>Read</td><td>-</td><td>UINT</td><td>Module ID</td></tr>
<tr><td>HardwareVariant</td><td>Read</td><td>-</td><td>UINT</td><td>Hardware variant</td></tr>
<tr><td>FirmwareVersion</td><td>Read</td><td>-</td><td>UINT</td><td>Firmware version of the module</td></tr>
<tr><td>UDID_low</td><td>(Read) 1)</td><td>-</td><td>UDINT</td><td>UDID, lower 4 bytes</td></tr>
<tr><td>UDID_high</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>UDID, upper 2 bytes</td></tr>
<tr><td>SafetyFWversion1</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>Firmware version - Safety processor 1</td></tr>
<tr><td>SafetyFWversion2</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>Firmware version - Safety processor 2</td></tr>
<tr><td>SafetyFWcrc1
(hardware upgrade 1.10.1.0 or later)</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>CRC of firmware header on safety processor 1</td></tr>
<tr><td>SafetyFWcrc2
(hardware upgrade 1.10.1.0 or later)</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>CRC of firmware header on safety processor 2</td></tr>
<tr><td>Bootstate
(hardware upgrade 1.10.1.0 or later)</td><td>(Read) 1)</td><td>-</td><td>UINT</td><td>Startup state of the module.
Notes:
Some of the boot states do not occur during normal startup or are cycled through so quickly that they are not visible externally.
The boot states usually cycle through in ascending order. There are cases, however, in which a previous value is captured.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x0003</td><td>Startup communication processor OK, no communication to the safety processors (check 24 V supply voltage!)</td></tr>
<tr><td>0x0010</td><td>FAILSAFE. At least one of the safety processors is in the safe state.</td></tr>
<tr><td>0x0020</td><td>Internal communication to safety processors started</td></tr>
<tr><td>0x0024</td><td>Firmware update of safety processors</td></tr>
<tr><td>0x0040</td><td>Firmware of safety processors started</td></tr>
<tr><td>0x0440</td><td>Firmware of safety processors running</td></tr>
<tr><td>0x0840</td><td>Waiting for openSAFETY "Operational" (loading SafeDESIGNER application or no valid application exists, waiting on acknowledgments such as module exchange)</td></tr>
<tr><td>0x1040</td><td>Evaluating the configuration according to the SafeDESIGNER application</td></tr>
<tr><td>0x3440</td><td>Stabilizing cyclic openSAFETY data exchange.
Note:
If the boot state remains here, check SafeDESIGNER parameters "(Default) Safe Data Duration", "(Default) Additional Tolerated Packet Loss".</td></tr>
<tr><td>0x4040</td><td>RUN. Final state, startup completed.</td></tr>
</table></td></tr>
<tr><td>Diag1_Temp</td><td>(Read) 1)</td><td>-</td><td>INT</td><td>Module temperature in °C</td></tr>
<tr><td>SafeModuleOK</td><td>-</td><td>Read</td><td>SAFEBOOL</td><td>Indicates if the safe communication channel is OK</td></tr>
<tr><td>SafeChannelOK</td><td>Read</td><td>Read</td><td>SAFEBOOL</td><td>No errors in frequency evaluation</td></tr>
<tr><td>SafeFrequency</td><td>Read</td><td>Read</td><td>SAFEINT</td><td>Current frequency</td></tr>
<tr><td>SafeFrequencyOK</td><td>Read</td><td>Read</td><td>SAFEBOOL</td><td>Indicates if the frequency being output is OK</td></tr>
<tr><td>Reset</td><td>-</td><td>Write</td><td>BOOL</td><td>Release signal</td></tr>
</table>

Table 20: Channel list

1) This data is accessed in Automation Studio using the ASIOACC library.

Danger!

The validity of analog signals is represented by the associated status signals. These binary status signals (data type SAFEBOOL) must also be evaluated each time the analog signals are used. A binary status signal with the status FALSE indicates an invalid value in the analog signal. When this happens, the analog signal is no longer permitted to be used for safety-related assessments.

15 Safety response time

The safety response time is the time between the arrival of the signal on the input channel and the output of the cutoff signal on the output.

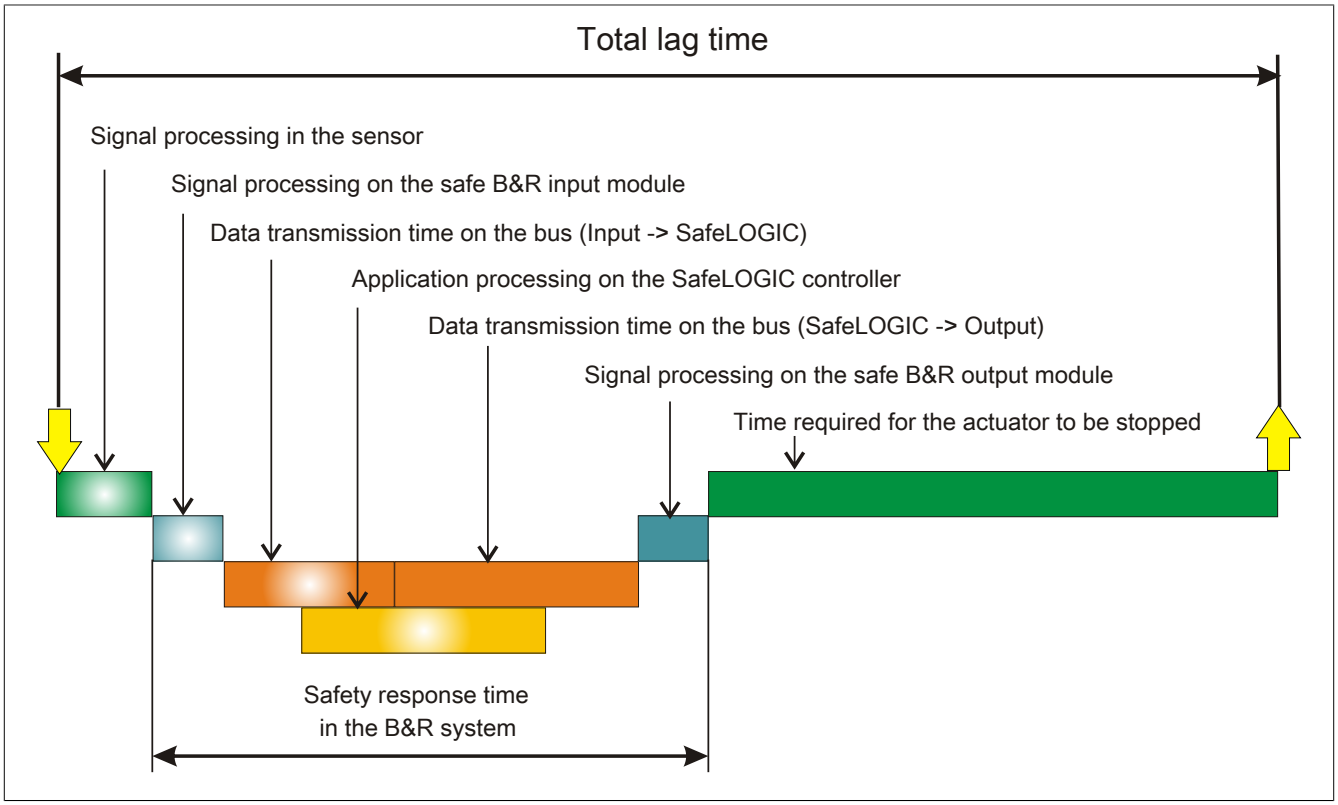


Figure 11: Total lag time

As illustrated in the figure, the safety response time in the B&R system is composed of the following partial response times:

- Signal processing on the safe B&R input module
- Data transmission time on the bus (Input -> SafeLOGIC)
- Data transmission time on the bus (SafeLOGIC -> Output)
- Signal processing on the safe B&R output module

Danger!

The following sections are dedicated exclusively to the safety response time in the B&R system. When assessing the complete safety response time, the user must include signal processing in the sensor as well as the time until the actuator is stopped.

Be sure to validate the total lag time on the system!

Information:

The safety response time in B&R products already contains all delays caused by sampling input data (sampling theorem).

15.1 Signal processing on the safe B&R input module

The maximum I/O update time in the "I/O update time" chapter for the respective module must be taken into account when processing signals in the safe B&R input module.

15.2 Data transmission time on the bus

The following relationship must be taken into consideration for the data transmission time on the bus:

- The time needed to transfer data from the input to the SafeLOGIC controller or to the output depends on the sum of the cycle times and CPU copy times in effect on the transfer line.
- POWERLINK MN (managing node, standard CPU) settings are important for the actual timing on the bus, but they cannot be used from a safety point of view since the values can be changed at any time in the course of modifications made outside of the safety application.
- In the SafeLOGIC controller, data transmission times are monitored on the bus using openSAFETY services. The time needed to process the application on the SafeLOGIC controller is taken into account in this test (system-dependent). Monitoring is defined in SafeDESIGNER using the parameters in parameter group "Safety Response Time".

Information:

The safety components located in this network segment could be cut off by the SafeLOGIC controller if modified parameters on the POWERLINK MN alter the data transmission times on the bus so that they lie outside of the SafeDESIGNER parameters defined in parameter group "Safety Response Time".

Information:

The safety components located in this network segment could be cut off by the SafeLOGIC controller if EMC disturbances cause data failures that fall outside of the SafeDESIGNER parameters defined in parameter group "Safety Response Time".

Calculating the maximum data transmission time - up to Release 1.9:

- The total max. data transmission time on the bus is calculated by adding parameter "Worst_Case_Response_Time_us" for the safe input module and parameter "Worst_Case_Response_Time_us" for the safe output module. When doing this, be sure to check parameter "Manual_Configuration". If parameter "Manual_Configuration" is set to "No", the value specified for parameter "Default_Worst_Case_Response_Time_us" is used.
- **Special case: Local inputs on the X20SLX module:**
  The total max. data transmission time on the bus is calculated by adding parameter "Cycle_Time_max_us" + 2000 µs and parameter "Worst_Case_Response_Time_us" for the safe output module. When doing this, be sure to check parameter "Manual_Configuration". If parameter "Manual_Configuration" is set to "No", the value specified for parameter "Default_Worst_Case_Response_Time_us" is used.

Calculating the maximum data transmission time - Release 1.10 and later:

The following parameters are relevant for calculating the data transmission time between the safe input module and safe output module; parameter "Manual Configuration" deserves special attention.

- Relevant parameters for "Manual Configuration = No":
  - "PacketLoss1": Parameter "Default Additional Tolerated Packet Loss" of group "Safety Response Time Defaults" of the SafeLOGIC controller
  - "DataDuration1": Parameter "Default Safe Data Duration" of group "Safety Response Time Defaults" of the SafeLOGIC controller
  - "NetworkSyncCompensation1": 12 ms
  - "PacketLoss2": Same as "PacketLoss1"
  - "DataDuration2": Same as "DataDuration1"
  - "NetworkSyncCompensation2": Same as "NetworkSyncCompensation1"
- Relevant parameters for "Manual Configuration = Yes":
  - "PacketLoss1": Parameter "Additional Tolerated Packet Loss" of group "Safety Response Time" of the safe input module
  - "DataDuration1": Parameter "Safe Data Duration" of group "Safety Response Time" of the safe input module
  - "NetworkSyncCompensation1": 12 ms
  - "PacketLoss2": Parameter "Additional Tolerated Packet Loss" of group "Safety Response Time" of the safe output module
  - "DataDuration2": Parameter "Safe Data Duration" of group "Safety Response Time" of the safe output module
  - "NetworkSyncCompensation2": Same as "NetworkSyncCompensation1"
- **Special case: Local inputs on the X20SLX module:**
  - "PacketLoss1": 0
  - "DataDuration1": Parameter "Cycle Time max" of group "Module Configuration" of the X20SLX + 2000 µs
  - "NetworkSyncCompensation1": 0 ms
- **Special case: Local outputs on the X20SLX module:**
  - "PacketLoss2": 0
  - "DataDuration2": Parameter "Cycle Time max" of group "Module Configuration" of the X20SLX + 2000 µs
  - "NetworkSyncCompensation2": 0 ms
- **Special case: Linking local inputs with local outputs on the X20SRT module:**
  - "PacketLoss1": 0
  - "PacketLoss2": 0
  - "DataDuration1": Parameter "Cycle time" of group "General"
  - "DataDuration2": Parameter "Cycle time" of group "General"
  - "NetworkSyncCompensation1": 0 ms
  - "NetworkSyncCompensation2": 0 ms

The following equation is used to calculate the maximum data transmission time between the safe input module and safe output module:

Maximum data transmission time = (PacketLoss1+1)* DataDuration1 + NetworkSyncCompensation1 + (Packet-Loss2+1)* DataDuration2 + NetworkSyncCompensation2

Information:

In addition to the data transmission time on the bus, the time for signal processing in the safe B&R input and output module must be taken into account (see section 15 "Safety response time").

Information:

For more information about the actual data transmission time, see Automation Help, section Diagnostics and service → Diagnostics tools → Network analyzer → Editor → Calculation of safety runtime. The cycle time of the safety application must also be added.

15.3 Signal processing on the safe B&R output module

The maximum I/O update time in the "I/O update time" chapter for the respective module must be taken into account when processing signals in the safe B&R output module.

15.4 Minimum signal lengths

The parameters in group "Safety Response Time" in SafeDESIGNER influence the maximum number of data packets that are permitted to fail without triggering a safety response. These parameters therefore act like a switch-off filter. If several data packets are lost within the tolerated amount, safety signals may not be detected if their low phase is shorter than the determined data transmission time.

Danger!

Lost signals can result in serious safety errors. Check all signals to determine the smallest possible pulse length and make sure that it is larger than the determined data transmission time.

Suggested solution:

- The switch-on filter can be used to extend the low phase of a signal on the input module.
- Low phases of signals from the SafeLOGIC controller can be lengthened with restart interlock functions or timer function blocks.

16 Intended use

Danger!

Danger from incorrect use of safety-related products/functions

Proper functionality is only ensured if the products/functions are used in accordance with their intended use by qualified personnel and the provided safety information is taken into account. The aforementioned conditions must be observed or covered by supplementary measures on your own responsibility in order to ensure the specified protective functions.

16.1 Qualified personnel

Use of safety-related products is restricted to the following persons:

- Qualified personnel who are familiar with relevant safety concepts for automation technology as well as applicable standards and regulations
- Qualified personnel who plan, develop, install and commission safety equipment in machines and systems

Qualified personnel in the context of this manual's safety guidelines are those who, because of their training, experience and instruction combined with their knowledge of relevant standards, regulations, accident prevention guidelines and operating conditions, are qualified to carry out essential tasks and recognize and avoid potentially dangerous situations.
In this regard, sufficient language skills are also required in order to be able to properly understand this manual.

16.2 Application range

The safety-related B&R control components described in this manual were designed, developed and manufactured for special applications for machine and personnel protection. They are not suitable for any use involving serious risks or hazards that could lead to the injury or death of several people or serious environmental impact without the implementation of exceptionally stringent safety precautions. In particular, this includes the use of these devices to monitor nuclear reactions in nuclear power plants, flight control systems, air traffic control, the control of mass transport vehicles, medical life support systems and the control of weapon systems.

When using safety-oriented control components, the safety precautions applying to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives or light curtains.

The safety guidelines, information about connection conditions (nameplate and documentation) and limit values specified in the technical data must be read carefully before installation and commissioning and must be strictly observed.

16.3 Security concept

B&R products communicate via a network interface and were developed for integration into a secure network. The network and B&R products are affected by the following hazards (not a complete list):

- Unauthorized access
- Digital intrusion
- Data leakage
- Data theft
- A variety of other types of IT security breaches

It is the responsibility of the operator to provide and maintain a secure connection between B&R products and the internal network as well as other networks, such as the Internet, if necessary. The following measures and security solutions are suitable for this purpose:

- Segmentation of the network (e.g. separation of the IT and OT networks)
- Firewalls for the secure connection of network segments
- Implementation of a security-optimized user account and password concept
- Intrusion prevention and authentication systems
- Endpoint security solutions with modules for anti-malware, data leakage prevention, etc.
- Data encryption

It is the responsibility of the operator to take appropriate measures and to implement effective security solutions.

B&R Industrial Automation GmbH and its subsidiaries are not liable for damages and/or losses resulting from, for example, IT security breaches, unauthorized access, digital intrusion, data leakage and/or data theft.

Before B&R releases products or updates, they are subjected to appropriate functional testing. Independently of this, the development of customized test processes is recommended in order to be able to check the effects of changes in advance. Such changes include, for example:

- Installation of product updates
- Notable system modifications such as configuration changes
- Import of updates or patches for third-party software (non-B&R software)
- Hardware replacement

These tests should ensure that implemented security measures remain effective and that systems behave as expected.

16.4 Safety technology disclaimer

The proper use of all B&R products must be guaranteed by the customer through the implementation of suitable training, instruction and documentation measures. The guidelines set forth in system user's manuals must be taken into consideration here as well. B&R has no obligation to provide verification or warnings with regard to the customer's purpose of using the delivered product.

Changes to the devices are not permitted when using safety-related components. Only certified products are permitted to be used. Currently valid product versions in each case are listed in the corresponding certificates. Current certificates are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product. The use of non-certified products or product versions is not permitted.

All relevant information regarding these safety products must be read in the latest version of the related data sheet and the corresponding safety notices observed before the safety products are permitted to be operated. Certified data sheets are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product.

B&R and its employees are not liable for any damages or loss resulting from the incorrect use of these products. The same applies to misuse that may result from specifications or statements made by B&R in connection with sales, support or application activities. It is the sole responsibility of the user to check all specifications and statements made by B&R for proper application as it pertains to safety-related applications. In addition, the user assumes sole responsibility for the proper design of the safety function as it pertains to safety-related applications.

16.5 X20 system characteristics

Because all X20 safety products are seamlessly integrated into the B&R base system, the same system characteristics and user notices from the X20 system user's manual also apply to X20 safety products.

Warning!

Possible failure of safety function

Malfunction of module due to unspecified operating conditions
The notes for installation and operation of the modules provided in the applicable documents must be observed.

In this regard, this means the content and user notices in the following applicable documentation must be observed for X20 safety products:

- X20 system user's manual
- Installation / EMC guide

16.6 Installation notes for X20 modules

Products must be protected against impermissible dirt and contaminants. Products are protected from dirt and contaminants up to pollution degree II as specified in the IEC 60664 standard.

Pollution degree II can usually be achieved in an enclosure with IP54 protection, but uncoated modules are NOT permitted to be operated in condensing relative humidity and temperatures under 0°C.

The operation of coated modules is allowed in condensing relative humidity.

Danger!

Pollution levels higher than specified by pollution degree II in standard IEC 60664 can result in dangerous failures. It is extremely important that you ensure a proper operating environment.

Danger!

In order to guarantee a specific voltage supply, a SELV power supply that conforms to IEC 60204 must be used to supply the bus, SafeIO and SafeLOGIC controller. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

The power supply of X20 potential groups must generally be protected using a fuse with a maximum of 10 A.
For more information, see chapter "Mechanical and electrical configuration" of the X20 or X67 user's manual.

16.7 Safe state

If an error is detected by the module (internal or wiring error), the modules enable the safe state. The safe state is structurally designed as a low state or cutoff and cannot be modified.

Danger!

Applications in which the safe state must actively switch on an actuator cannot be implemented with this module. In these cases, other measures must be taken to meet this safety-related requirement (e.g. mechanical brakes for hanging load that engage on power failure).

16.8 Mission time

All safety modules are designed to be maintenance-free. Repairs are not permitted to be carried out on safety modules.

All safety modules have a maximum mission time of 20 years.

This means that all safety modules must be taken out of service one week (at the latest) before the expiration of this 20-year time span (starting from B&R's delivery date).

Danger!

Operating safety modules beyond the specified mission time is not permitted! The user must ensure that all safety modules are replaced by new safety modules or removed from operation before their mission time expires.

17 Release information

A manual version always describes the respective range of functions for a given product set release. The following table shows the relationship between manual versions and releases.

<table>
<tr><th>Manual version</th><th>Valid for</th></tr>
<tr><td>V1.141
V1.140
V1.131
V1.130
V1.123
V1.122
V1.121
V1.120
V1.111
V1.110
V1.103
V1.102
V1.101
V1.100
V1.92
V1.91
V1.90
V1.80
V1.71
V1.70
V1.64
V1.63.2
V1.63.1
V1.63
V1.62
V1.61
V1.60
V1.52.1
V1.52
V1.51
V1.50.1
V1.50
V1.42
V1.41
V1.40
V1.20
V1.10</td><td>
<table>
<tr><th>Version</th><th>Starting with</th><th>Up to</th></tr>
<tr><td>Product set</td><td>Release 1.2</td><td>Release 1.10</td></tr>
<tr><td>SafeDESIGNER</td><td>2.70</td><td>4.9</td></tr>
<tr><td>Firmware</td><td>270</td><td>399</td></tr>
<tr><td>Upgrades</td><td>1.2.0.0</td><td>1.10.999.999</td></tr>
</table>
</td></tr>
<tr><td>V1.02
V1.01
V1.00</td><td>
<table>
<tr><th>Version</th><th>Starting with</th><th>Up to</th></tr>
<tr><td>Product set</td><td>Release 1.0</td><td>Release 1.1</td></tr>
<tr><td>SafeDESIGNER</td><td>2.58</td><td>2.69</td></tr>
<tr><td>Firmware</td><td>256</td><td>269</td></tr>
<tr><td>Upgrades</td><td>1.0.0.0</td><td>1.1.999.999</td></tr>
</table>
</td></tr>
</table>

Table 21: Release information

18 Version history

Version	Date	Comment
1.141	April 2019	• Chapter 4 "Technical data": Updated standards. • Updated chapter 16.3 "Security concept". • Updated chapter 16.6 "Installation notes for X20 modules". • Editorial changes.
1.140	February 2019	• Chapter 4 "Technical data": Limited installation elevation to 2000 m. • Chapter 14.1 "Parameters in the I/O configuration": Added parameter "Blackout mode". • Chapter 15.2 "Data transmission time on the bus": Updated calculation of maximum data transmission time. • Chapter 16 "Intended use": Added danger notice. • Added chapter "Security notes". • Chapter 16.5 "X20 system characteristics": Added warning notice. • Updated standards. • Editorial changes.
1.120	January 2018	• Chapter 4 "Technical data": – Updated standards and safety characteristics. – Added input characteristics per EN 61131-2. – Coated module: Extended temperature range. – Added information. – Updated derating. • Chapter 13 "Restart behavior": Updated description. • Chapter 14.3 "Parameters in SafeDESIGNER - Release 1.10 and higher": Group "Safety Response Time": Removed parameter "Synchronous Network Only" and updated parameter "Safe Data Duration". • Chapter 14.4 "Channel list": Added new channels. • Chapter 15.2 "Data transmission time on the bus": Updated description and added information. • Chapter 16.6 "Installation notes for X20 modules": Updated danger notice. • Chapter 16.7 "Safe state": Updated danger notice. • Updated standards. • Editorial changes.
1.101	March 2016	• Chapter 15 "Safety response time": Added information.
1.100	January 2016	Merged coated/uncoated modules. • Chapter 1 "General information": Added. • Chapter 4 "Technical data": – Updated standards. – Updated temperature range. – Updated technical data. • Revised chapter 11 "I/O update time". • Chapter 14.3 "Parameters in SafeDESIGNER - Release 1.10 and higher": Added. • Chapter 15.1 "Signal processing on the safe B&R input module": Updated description. • Chapter 15.2 "Data transmission time on the bus": Updated description with "Release 1.10 and later". • Chapter 15.3 "Signal processing on the safe B&R output module": Updated description. • Chapter 15.4 "Minimum signal lengths": Updated description. • Revised chapter 16.4 "Safety technology disclaimer". • Chapter 17 "Release information": Updated.
1.90	October 2014	• Updated chapter 17 "Release information". • Editorial changes.
1.80	July 2014	• Chapter 3 "Order data": Added bus module X20BM36. • Chapter 4 "Technical data": – "Short description": "I/O module": Adapted text to order data. – "System requirements": Added "Automation Runtime". – Added "Safety-related characteristic values" and deleted chapter "Safety-related characteristic values". – "Temperature": "Operation": Added "Derating bonus at 24 VDC". – "Temperature": "Operation": Added "Derating bonus with dummy modules". – Added "Derating" section. • Chapter 13 "Restart behavior": Updated description. • Chapter 14.2 "Parameters in SafeDESIGNER - up to Release 1.9": Group "Basic": Added value "Not_Present" for "Optional" and changed descriptions of individual modes under "Function mode". • Chapter 14.2 "Parameters in SafeDESIGNER - up to Release 1.9": Group "Safety_Response_Time": Added parameter "Node_Guarding_Lifetime". • Chapter 15.2 "Data transmission time on the bus": Updated description. • Updated chapter 17 "Release information".

Table 22: Version history

Version	Date	Comment
1.64	March 2014	• Chapter 12 "Precision": Differentiation between firmware version 297 (chapter 12.1 "Precision in firmware version 297") and firmware version 300 (chapter 12.2 "Precision in firmware version 300 and later"). • Chapter 16.6 "Installation notes for X20 modules": Removed figure "Protecting various potential groups" and updated description.
1.63	November 2013	• Updated standards. • Chapter 4 "Technical data": Added danger notice. • Chapter 8.1 "Internal module errors": Updated description. • Added chapter 8.2 "Wiring errors". • Added chapter 13 "Restart behavior". • Chapter 14.4 "Channel list": Added danger notice. • Updated chapter 17 "Release information". • Editorial changes.
1.62	August 2013	• Chapter 4 "Technical data": General information: Updated system requirements. • Chapter 7 "Connection examples": Added section 7.2 "Function mode A-A - Two-channel encoder". • Chapter 7 "Connection examples": Section 7.4 "Function mode A-A/-B-B/": Corrected figure "X20SD1207 - Function mode A-A/-B-B/". • Updated standards.
1.61	December 2012	First edition as a product-specific manual

Table 22: Version history

19 EC declaration of conformity

This document was originally written in the German language. The German edition therefore represents the original documentation in accordance with the 2006/42/EC Machinery Directive. Documents in other languages are to be interpreted as translations of the original documentation.

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The place of jurisdiction, in accordance with article 17 of the European Convention on Courts of Jurisdiction and Enforcement, is A-4910

Ried im Innkreis, Austria, commercial register court: Ried im Innkreis, Austria

Commercial register number: FN 111651 v.

The place of fulfillment in accordance with article 5 of the European Convention on Courts of Jurisdiction and Enforcement is A-5142 Eggelsberg, Austria

VATIN: ATU62367156

The EC declarations of conformity for B&R products can be downloaded from the B&R website www.br-automation.com.