X20(c)CP1301, X20CP1381 and X20CP1382

1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 system user's manual
MAEMV	Installation / EMC guide

2 General information

The Compact controller is available with 200 MHz and 400 MHz processor performance. Depending on the variant, up to 256 MB RAM and up to 32 kB nonvolatile RAM are integrated. A permanently installed flash drive with up to 2 GB is available for the application and data storage.

All controllers are equipped with an Ethernet, USB and RS232 interface. In both performance classes, POWERLINK and CAN bus are also available as integrated interfaces. For additional fieldbus connections, each controller can be expanded with an interface module from the X20 standard portfolio. The controllers are fanless and battery-free and thus maintenance-free. 30 different digital inputs and outputs and 2 analog inputs are integrated in the devices. 1 analog input can be used for Pt1000 resistance temperature measurement.

- CPU is Intel x86 200/400 MHz compatible with integrated I/O processor.
- Ethernet, POWERLINK with poll-response chaining and onboard USB
- 1 slot for modular interface expansion
- 30 digital inputs/outputs and 2 analog inputs integrated in the device
- 1/2 GB onboard flash drive
- 128/256 MB DDR3 SDRAM
- Fanless
- No battery
- Backed-up real-time clock

3 Coated modules

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

> **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



4 Order data



Order number	Short description
	Compact PLCs
X20CP1301	X20 PLC, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 Pt1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included
X20cCP1301	X20 PLC coated, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 Pt1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included
X20CP1381	X20 PLC, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 Pt1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included
X20CP1382	X20 PLC, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 Pt1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included

Table 1: Order data

Content of delivery

Order number	Quantity	Short description
-	1	Interface module slot cover
X20AC0SR1	1	X20 end cover plate (right)
X20TB1F	3	X20 terminal block, 16-pin, 24 VDC keyed

Table 2: Content of delivery

5 Technical data

Order number	X20CP1301	X20cCP1301	X20CP1381	X20CP1382
Short description				
Interfaces	1x RS232, 1x Ethernet, 1x USB, 1x X2X Link		1x RS232, 1x Ethernet, 1x POWERLINK, 2x USB, 1x X2X Link, 1x CAN bus	
System module	Controller			
General information				
B&R ID code	0xE35B	0xEB58	0xE35C	0xDABB
Cooling	Fanless			
Status indicators	CPU function, Ethernet, RS232, PLC power supply, I/O power supply, I/O function per channel		CPU function, Ethernet, POWERLINK, RS232, CAN bus, CAN bus terminating resistor, PLC power supply, I/O power supply, I/O function per channel	
Diagnostics				
Outputs	Digital outputs: Yes, using LED status indicator and software (output error status)			
CPU function	Yes, using LED status indicator			
CAN bus data transfer	-		Yes, using LED status indicator	
RS232 data transfer	Yes, using LED status indicator			
Inputs	Analog inputs: Yes, using LED status indicator and software			
Ethernet	Yes, using LED status indicator			
I/O power supply	Yes, using LED status indicator			
POWERLINK	-		Yes, using LED status indicator	
Supply voltage monitoring	Yes, using LED status indicator			
Temperature	Yes, using software register			
Terminating resistor	-		Yes, using LED status indicator	
Support				
Controller redundancy	No			
ACOPOS support	Yes			
reACTION-capable I/O channels	No			
Visual Components support	Yes			
Power consumption without interface module and USB	4.3 W		4.8 W	5.5 W
Power consumption for X2X Link power supply [1]	0.8 W			
Power consumption [1]				
Internal I/O	2.3 W			
Additional power dissipation caused by actuators (resistive) [W]	-			
Type of signal lines	Shielded lines must be used for all high-speed digital inputs/outputs, line length: Max. 20 m			
Certifications				
CE	Yes			
UKCA	Yes			
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X			
UL	cULus E115267 Industrial control equipment			
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5			
DNV	Temperature: **B** (0 - 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)			
LR	ENV1			
KR	Yes			
ABS	Yes			
EAC	Yes			
CPU and X2X Link power supply				
Input voltage	24 VDC -15% / +20%			
Input current	Max. 1 A			
Fuse	Integrated, cannot be replaced			
Reverse polarity protection	Yes			
X2X Link power supply output				
Nominal output power	2 W			
Parallel connection	Yes [2]			
Redundant operation	Yes [3]			
Input I/O power supply				
Input voltage	24 VDC -15% / +20%			
Fuse	Required line fuse: Max. 10 A, slow-blow			
Output I/O power supply				
Nominal output voltage	24 VDC			
Permissible contact load	10 A			

Table 3: Technical data

Order number	X20CP1301	X20cCP1301	X20CP1381	X20CP1382
Controller				
Real-time clock	Retention for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C			
FPU	Yes			
Processor				
Type	Vx86EX			
Clock frequency	200 MHz			400 MHz
L1 cache				
Data code	16 kB			
Program code	16 kB			
L2 cache	128 kB			
Integrated I/O processor	Processes I/O data points in the background			
Modular interface slots	1			
Remanent variables	16 kB FRAM, retention >10 years [4]			32 kB FRAM, retention >10 years [4]
Shortest task class cycle time	2 ms			1 ms
Typical instruction cycle time	0.0419 µs			0.0199 µs
Standard memory				
RAM	128 MB DDR3 SDRAM			256 MB DDR3 SDRAM
Application memory				
Type	1 GB eMMC flash memory			2 GB eMMC flash memory
Data retention	10 years			
Writable data amount				
Guaranteed	40 TB			
Results for 5 years	21.9 GB/day			
Guaranteed erase/write cycles	20,000			
Error-correcting code (ECC)	Yes			
Interfaces				
Interface IF1				
Signal	RS232			
Variant	Connection via 16-pin terminal block X20TB1F			
Max. distance	900 m			
Transfer rate	Max. 115.2 kbit/s			
Interface IF2				
Signal	Ethernet			
Variant	1x RJ45 shielded			
Line length	Max. 100 m between 2 stations (segment length)			
Transfer rate	10/100 Mbit/s			
Transfer				
Physical layer	10BASE-T/100BASE-TX			
Half-duplex	Yes			
Full-duplex	Yes			
Autonegotiation	Yes			
Auto-MDI/MDIX	Yes			
Interface IF3				
Fieldbus	-		POWERLINK managing or controlled node	
Type	-		Type 4 [5]	
Variant	-		1x RJ45 shielded	
Line length	-		Max. 100 m between 2 stations (segment length)	
Transfer rate	-		100 Mbit/s	
Transfer				
Physical layer	-		100BASE-TX	
Half-duplex	-		Yes	
Full-duplex	-		POWERLINK mode: No / Ethernet mode: Yes	
Autonegotiation	-		Yes	
Auto-MDI/MDIX	-		Yes	
Interface IF4				
Type	USB 1.1/2.0			
Variant	Type A			
Max. output current	0.5 A			
Interface IF5				
Type	-		USB 1.1/2.0	
Variant	-		Type A	
Max. output current	-		0.1 A	
Interface IF6				
Fieldbus	X2X Link master			
Interface IF7				
Signal	-		CAN bus	
Variant	-		Connection via 16-pin terminal block X20TB1F	
Max. distance	-		1000 m	
Transfer rate	-		Max. 1 Mbit/s	
Terminating resistor	-		Integrated in module	
Controller	-		SJA 1000	

Table 3: Technical data

Order number	X20CP1301	X20cCP1301	X20CP1381	X20CP1382
Digital inputs				
Quantity	14 standard inputs, 4 high-speed inputs and 4 mixed channels, configuration as input or output using software			
Nominal voltage	24 VDC			
Input voltage	24 VDC -15% / +20%			
Input current at 24 VDC	X1 - Standard inputs: Typ. 3.5 mA X2 - Standard inputs: Typ. 2.68 mA X2 - High-speed inputs: Typ. 3.5 mA X3 - Mixed channels: Typ. 2.68 mA			
Input circuit	Sink			
Input filter				
Hardware	Standard inputs and mixed channels: ≤200 µs High-speed inputs: ≤2 µs, when used as standard inputs: ≤200 µs			
Software	Default 1 ms, configurable between 0 and 25 ms in 0.1 ms increments			
Connection type	1-wire connections			
Input resistance	X1 - Standard inputs: 6.8 kΩ X2 - Standard inputs: 8.9 kΩ X2 - High-speed inputs: 6.8 kΩ X3 - Mixed channels: 8.9 kΩ			
Additional functions	X2 - High-speed digital inputs: 2x 250 kHz event counting, 2x AB counter, ABR incremental encoder, direction/frequency, period measurement, gate measurement, differential time measurement, edge counters, edge times			
Switching threshold				
Low	<5 VDC			
High	>15 VDC			
AB incremental encoder				
Quantity	2			
Encoder inputs	24 V, asymmetrical			
Counter size	32-bit			
Input frequency	Max. 100 kHz			
Evaluation	4x			
Encoder power supply	Module-internal, max. 300 mA			
Overload characteristics of encoder power supply	Short-circuit proof, overload-proof			
ABR incremental encoder				
Quantity	1			
Encoder inputs	24 V, asymmetrical			
Counter size	32-bit			
Input frequency	Max. 100 kHz			
Evaluation	4x			
Encoder power supply	Module-internal, max. 300 mA			
Overload characteristics of encoder power supply	Short-circuit proof, overload-proof			
Event counters				
Quantity	2			
Signal form	Square wave pulse			
Evaluation	1x			
Input frequency	Max. 250 kHz			
Counter frequency	250 kHz			
Counter size	32-bit			
Edge detection / Time measurement				
Possible measurements	Period measurement, gate measurement, differential time measurement, edge counter, edge times			
Measurements per module	Each function up to 2x			
Counter size	32-bit			
Input frequency	Max. 10 kHz			
Timestamp	1 µs resolution			
Signal form	Square wave pulse			
Analog inputs				
Input	±10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections			
Input type	Differential input			
Digital converter resolution				
Voltage	±12-bit			
Current	12-bit			
Conversion time	1 channel enabled: 100 µs 2 channels enabled: 200 µs			
Output format				
Data type	INT			
Voltage	INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV			
Current	INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA			
Input impedance in signal range				
Voltage	20 MΩ			
Current	-			
Load				
Voltage	-			
Current	<300 Ω			

Table 3: Technical data

Order number	X20CP1301	X20cCP1301	X20CP1381	X20CP1382
Input protection	Protection against wiring with supply voltage			
Permissible input signal				
Voltage	Max. ±30 V			
Current	Max. ±50 mA			
Output of digital value during overload	Configurable			
Conversion procedure	SAR			
Input filter	Third-order low-pass filter / Cutoff frequency 1 kHz			
Max. error				
Voltage				
Gain	0.18% (Rev. <C0: 0.37%) [6]			
Offset	0.04% (Rev. <C0: 0.25%) [7]			
Current				
Gain	0 to 20 mA = 0.15% (Rev. <C0: 0.52%) / 4 to 20 mA = 0.25% [6]			
Offset	0 to 20 mA = 0.1% (Rev. <C0: 0.4%) / 4 to 20 mA = 0.15% [8]			
Max. gain drift				
Voltage	0.017 %/°C [6]			
Current	0 to 20 mA = 0.015 %/°C / 4 to 20 mA = 0.023 %/°C [6]			
Max. offset drift				
Voltage	0.008 %/°C [7]			
Current	0 to 20 mA = 0.008 %/°C / 4 to 20 mA = 0.012 %/°C [8]			
Common-mode rejection				
DC	70 dB			
50 Hz	70 dB			
Common-mode range	±12 V			
Crosstalk between channels	<-70 dB			
Nonlinearity				
Voltage	<0.025% [7]			
Current	<0.05% [8]			
Resistance measurement temperature inputs				
Quantity	1			
Input	Resistance measurement with constant current supply for 2-wire connections			
Digital converter resolution	13-bit			
Conversion time	Only temperature input enabled: 200 µs Temperature and analog input enabled: 400 µs			
Conversion procedure	SAR			
Output format	INT or UINT for resistance measurement			
Sensor				
Pt1000	-200 to 850°C			
Resistance measurement range	0.1 to 4000 Ω			
Temperature sensor resolution	1 LSB = 0x0005 = 0.16°C			
Resistance measurement resolution	1 LSB = 0x0005 = 0.49 Ω			
Input filter	First-order low-pass filter / cutoff frequency 7 Hz			
Sensor standard	EN 60751			
Common-mode range	1 V			
Linearization method	Internal			
Measurement current	1 mA			
Permissible input signal	Short-term max. ±30 V			
Max. error at 25°C				
Gain	0.3% (Rev. <C0: 1.93%) [9]			
Offset	0.15% (Rev. <C0: 0.32%) [10]			
Max. gain drift	0.023 %/°C [9]			
Max. offset drift	0.012%/°C [10]			
Nonlinearity	<0.05% [10]			
Standardized range of values for resistance measurement	0.1 to 4000.0 Ω			
Crosstalk between channels	<-70 dB			
Common-mode rejection				
50 Hz	>60 dB			
Temperature sensor normalization				
Pt1000	-200 to 850°C			
Digital outputs				
Quantity	4 standard outputs, 4 high-speed outputs and 4 mixed channels, configuration as input or output using software			
Variant	Standard outputs and mixed channels: Current-sourcing FET High-speed outputs: Push-Pull			
Nominal voltage	24 VDC			
Switching voltage	24 VDC -15% / +20%			
Nominal output current	Standard outputs and mixed channels: 0.5 A High-speed outputs: 0.2 A			
Total nominal current	Standard outputs and mixed channels: 4 A High-speed outputs: 0.8 A			
Connection type	1-wire connections			
Output circuit	Standard outputs and mixed channels: Source High-speed outputs: Sink or source			

Table 3: Technical data

Order number	X20CP1301	X20cCP1301	X20CP1381	X20CP1382
Output protection [11]	Thermal shutdown in the event of overcurrent or short circuit (see value "Short-circuit peak current") Internal freewheeling diode for switching inductive loads (see section "Switching inductive loads")			
Pulse width modulation [12]				
Period duration	5 to 65535 µs corresponds to 200 kHz to 15 Hz			
Pulse duration	0 to 100%, minimum 2.5 µs			
Resolution for pulse duration	0.1% of the configured frequency			
Diagnostic status	Standard outputs and mixed channels: Output monitoring with 10 ms delay High-speed outputs: Output monitoring with 10 µs delay			
Leakage current when the output is switched off	Standard outputs and mixed channels: 5 µA High-speed outputs: 25 µA			
$R_{DS(on)}$	140 mΩ [13]			
Residual voltage	Standard outputs and mixed channels: <0.1 V at nominal current 0.5 A High-speed outputs: <0.9 V at nominal current 0.1 A			
Peak short-circuit current	Standard outputs and mixed channels: <3 A High-speed outputs: <20 A			
Switch-on in the event of overload shutdown or short-circuit shutdown	Standard outputs and mixed channels: Approx. 10 ms (depends on module temperature) High-speed outputs: No switch-on			
Switching delay				
0 → 1	Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs			
1 → 0	Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs			
Switching frequency				
Resistive load [14]	Standard outputs and mixed channels: Max. 500 Hz High-speed outputs: 50 kHz, max. 200 kHz (see section "Switching frequency derating for high-speed digital outputs")			
Inductive load	See section "Switching inductive loads".			
Braking voltage when switching off inductive loads	Standard outputs and mixed channels: Typ. 45 VDC			
Electrical properties				
Electrical isolation	Ethernet (IF2) and X2X (IF6) isolated from each other, from other interfaces and from PLC Channel isolated from bus Channel not isolated from channel or PLC		Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC Channel isolated from bus Channel not isolated from channel or PLC	
Operating conditions				
Mounting orientation				
Horizontal	Yes			
Vertical	Yes			
Installation elevation above sea level				
0 to 2000 m	No limitation			
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m			
Degree of protection per EN 60529	IP20			
Ambient conditions				
Temperature				
Operation				
Horizontal mounting orientation	-25 to 60°C			
Vertical mounting orientation	-25 to 50°C			
Derating	See section "Switching frequency derating for high-speed digital outputs".			
Storage	-40 to 85°C			
Transport	-40 to 85°C			
Relative humidity				
Operation	5 to 95%, non-condensing	Up to 100%, condensing	5 to 95%, non-condensing	
Storage	5 to 95%, non-condensing			
Transport	5 to 95%, non-condensing			
Mechanical properties				
Note	X20 end cover plate (right) included in delivery 3 X20 terminal blocks (16-pin) included in delivery Interface module slot cover included in delivery			
Dimensions				
Width	164 mm			
Height	99 mm			
Depth	75 mm			
Weight	300 g		310 g	

Table 3: Technical data

1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" in the X20 system user's manual.
2) When operated in parallel, the nominal power of 2 W is not permitted to be added to the total power.
3) Up to 2 W bus load.
4) The memory size for remanent variables is configurable in Automation Studio.
5) For additional information, see section "Communication / POWERLINK / General information / Hardware - IF/LS" in Automation Help.
6) Based on the current measured value.
7) Based on the 20 V measurement range.
8) Based on the 20 mA measurement range.
9) Based on the current measured resistance value.
10) Based on the entire resistance measurement range.
11) For the high-speed digital outputs, derating must be taken into account at a switching frequency >50 kHz (see section "Derating for switching frequency of high-speed digital outputs"). Overtemperature protection is not provided.

12) The high-speed digital outputs can be used for pulse width modulation.
13) Only for standard outputs and mixed channels.
14) Standard outputs and mixed channels: At loads ≤1 kΩ

6 Operating and connection elements

X20CP1301

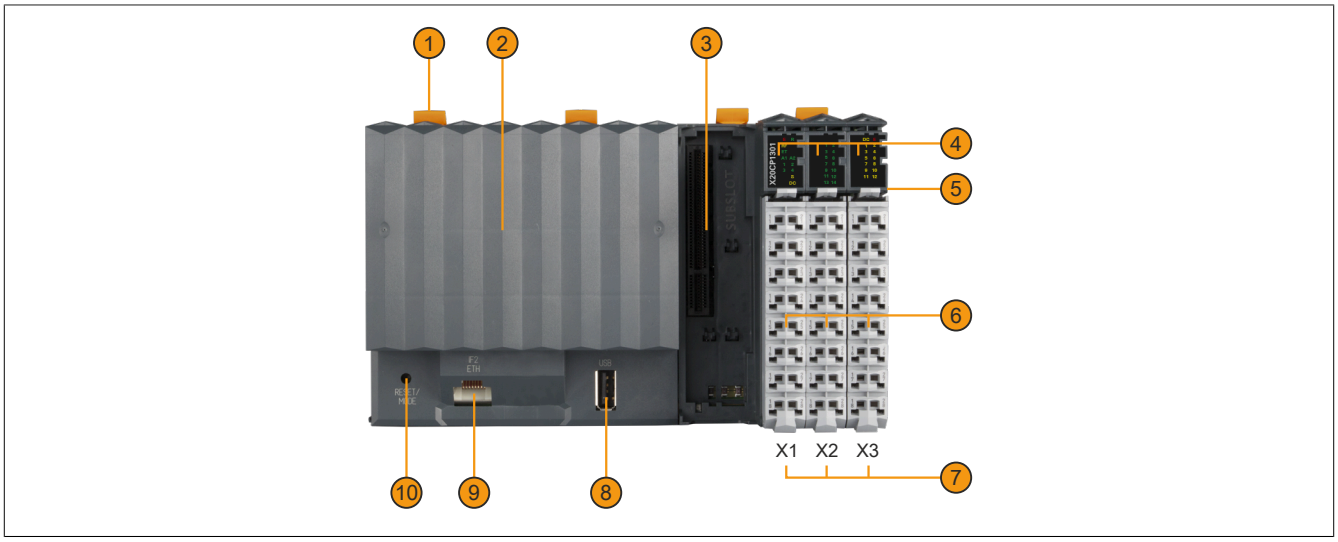


Figure 1: Operating elements for X20CP1301

1	Top-hat rail latch	2	Integrated flash drive
3	Slot for interface modules	4	LED status indicators
5	IF6 - X2X Link	6	Connections for: Power supplies, I/O channels, IF1 - RS232
7	3 integrated I/O slots: X1, X2 and X3	8	IF4 - USB
9	IF2 - Ethernet	10	Button for reset and operating mode

X20CP1381 and X20CP1382

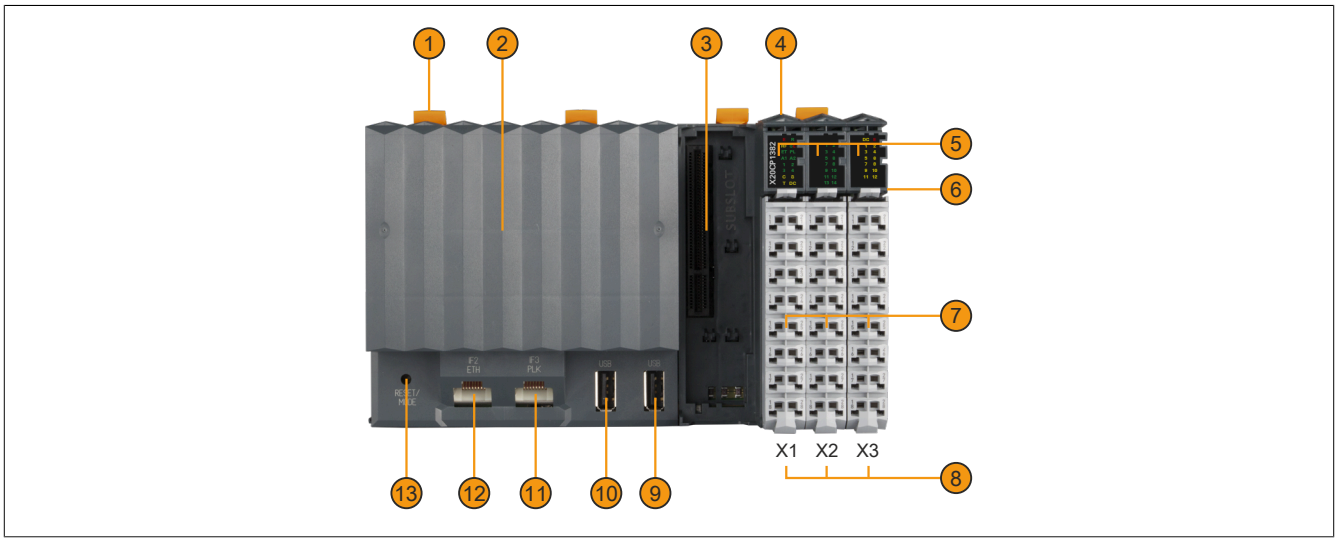


Figure 2: Operating elements for X20CP1381 and X20CP1382

1	Top-hat rail latch	2	Integrated flash drive
3	Slot for interface modules	4	Switch for CAN bus terminating resistor
5	LED status indicators	6	IF6 - X2X Link
7	Connections for: Power supplies, I/O channels, IF1 - RS232, IF7 - CAN bus	8	3 integrated I/O slots: X1, X2 and X3
9	IF5 - USB	10	IF4 - USB
11	IF3 - POWERLINK	12	IF2 - Ethernet
13	Button for reset and operating mode	-	-

6.1 LED status indicators

6.1.1 Slot X1

Figure	LED	Color	Status	Description
	E	Red	On	Operating mode SERVICE[1] or BOOT[1]
			Blinking	The "E" LED blinks red and the "RF" LED blinks yellow when there is a license violation.
			Double flash	Firmware update[2]
	R	Green	On	Application running
			Blinking	System startup: The controller is initializing the application, all bus systems and I/O modules.[2]
		Red	On	During reset
	RF	Yellow	On	Operating mode SERVICE[1] or BOOT[1]
			Blinking	The "RF" LED blinks yellow and the "E" LED blinks red when there is a license violation.
	SE	Green/Red		Status/Error LED. LED states are described in section "LED "S/E" (status/error LED)" on page 10.
	ET	Green	On	A link to the Ethernet remote station has been established.
			Blinking	A link to the Ethernet remote station has been established. The LED blinks when Ethernet activity is taking place on the bus.
	PL	Green	On	A link to the POWERLINK peer station has been established.
			Blinking	A link to the POWERLINK peer station has been established. The LED blinks when Ethernet activity is taking place on the bus.
	A1 - A2	Green	Off	Open circuit or disconnected sensor
			Blinking	Input signal overflow or underflow
			On	Analog/digital converter running, value OK
	1 - 4	Green		Input state of the corresponding digital input
	C	Yellow	On	Controller transmitting or receiving data via the CAN bus interface
	S	Yellow	On	Controller transmitting or receiving data via the RS232 interface
	T	Yellow	On	The terminating resistor integrated in the controller is switched on.
	DC	Yellow	On	Controller power supply unit OK

Table 4: LED status indicators on the integrated X1 I/O slot

1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".
2) The process can take several minutes depending on the configuration.

6.1.1.1 LED "S/E" (status/error LED)

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

6.1.1.1.1 Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

LED "S/E"		
Green	Red	Description
On	Off	The interface is operated as an Ethernet interface.

Table: LED "S/E": Interface in Ethernet mode

6.1.1.1.2 POWERLINK V2 mode

Error message

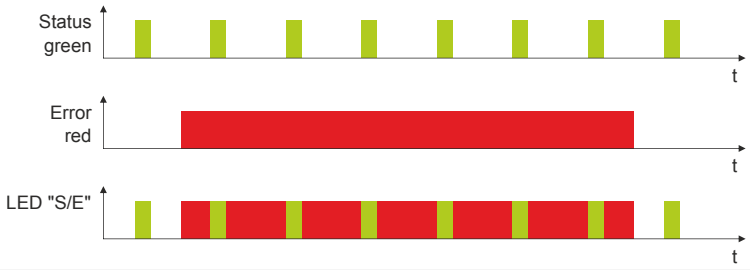
LED "S/E"		
Green	**Red**	**Description**
Off	On	The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however.
Blinking	On	If an error occurs in the following modes, then the green LED blinks over the red LED: • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE 

Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

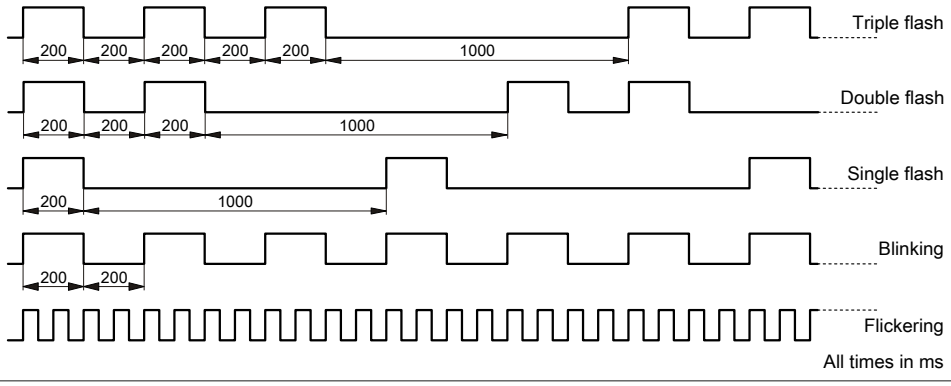
LED "S/E"		
Green	**Red**	**Description**
Off	Off	**Mode:** NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present: • The device is switched off. • The device is in the startup phase. • The interface or device is not configured correctly in Automation Studio. • The interface or device is defective. **Managing node (MN)** The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started. **Controlled node (CN)** The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.
Flickering (approx. 10 Hz)	Off	**Mode:** BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode. **Managing node (MN)** This mode can only be exited by resetting the controller. **Controlled node (CN)** If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.
Single flash (approx. 1 Hz)	Off	**Mode:** PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1. **Managing node (MN)** The MN is in "reduced cycle" mode. The CNs are configured in this mode. Cyclic communication is not yet taking place. **Controlled node (CN)** The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.
	On	**Controlled node (CN)** If the red LED lights up in this mode, this means that the MN has failed.
Double flash (approx. 1 Hz)	Off	**Mode:** PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2. **Managing node (MN)** The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode. **Controlled node (CN)** The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.
	On	**Controlled node (CN)** If the red LED lights up in this mode, this means that the MN has failed.

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

LED "S/E"		
Green	**Red**	**Description**
Triple flash (approx. 1 Hz)	Off	**Mode:** READY_TO_OPERATE The interface is in mode READY_TO_OPERATE. **Managing node (MN)** Cyclic and asynchronous communication. Received PDO data is ignored. **Controlled node (CN)** The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.
	On	**Controlled node (CN)** If the red LED lights up in this mode, this means that the MN has failed.
On	Off	**Mode:** OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.
Blinking (approx. 2.5 Hz)	Off	**Mode:** STOPPED The interface is in mode STOPPED. **Managing node (MN)** This mode does not occur for the MN. **Controlled node (CN)** Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

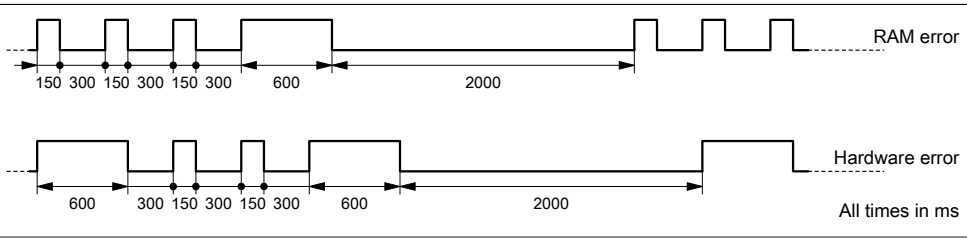
Blink times



6.1.1.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



Error	Error description
RAM error	The device is defective and must be replaced.
Hardware error	The device or a system component is defective and must be replaced.

6.1.2 Slot X2

Figure	LED	Color	Status	Description
	1 - 14	Green		Input state of the corresponding digital input

Table 5: LED status indicators on the integrated X2 I/O slot

6.1.3 Slot X3

Figure	LED	Color	Status	Description
	DC	Yellow	On	I/O power supply OK
	E	Red	Off	Everything OK
			Double flash	No power to module
	1 - 4	Yellow		Output state of the corresponding digital output
	5 - 8	Yellow		Input or output state of the corresponding digital input or output
	9 - 12	Yellow		Output state of the corresponding high-speed digital output

Table 6: LED status indicators on the integrated X3 I/O slot

6.2 Button for reset and operating mode



6.2.1 Reset

The button must be pressed for less than 2 seconds to trigger a reset. This triggers a hardware reset on the controller, which means that:

- All application programs are stopped.
- All outputs are set to zero.

The controller then boots into service mode by default. The startup mode after pressing the reset button can be set in Automation Studio:

- Service mode (default)
- Warm restart
- Cold restart
- Diagnostic mode

6.2.2 Operating mode

3 operating modes can be set using different button sequences:

Operating mode	Button sequence	Description
BOOT[1)]	Boot mode is enabled by the following button sequence: • Press the button for less than 2 s. The button can be released as soon as LED "R" on I/O slot X1 lights up **RED**. • Then press the button within 2 s for longer than 2 s. As soon as LED "R" goes out, the button can be released.	Boot AR is started, and the runtime system can be installed via the online interface (Automation Studio). User flash memory is erased only when the download begins.
SERVICE/RUN[1)]	Press the button for less than 2 s. The button can be released as soon as LED "R" on I/O slot X1 lights up **RED**.	Mode SERVICE/RUN: Triggering and startup behavior correspond to triggering a hardware reset (see "Reset" on page 14).
DIAGNOSE[1)]	Press the button for more than 2 s. LED "R" on I/O slot X1 lights up **RED** and then goes out. As soon as LED "R" goes out, the button can be released.	The controller is starting up in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the controller always boots with a warm restart.

1) The operating states are described in "Real-time operating system - Method of operation - Operating states" in Automation Help.

6.3 Flash drive

This application memory is implemented as an integrated flash drive.

6.4 Project installation

Project installation is described in "Project management - Project installation" in Automation Help.

6.5 RS232 interface (IF1)

The non-electrically isolated RS232 interface is primarily intended to serve as an online interface for communication with the programming device. It is located on the X1 I/O slot.

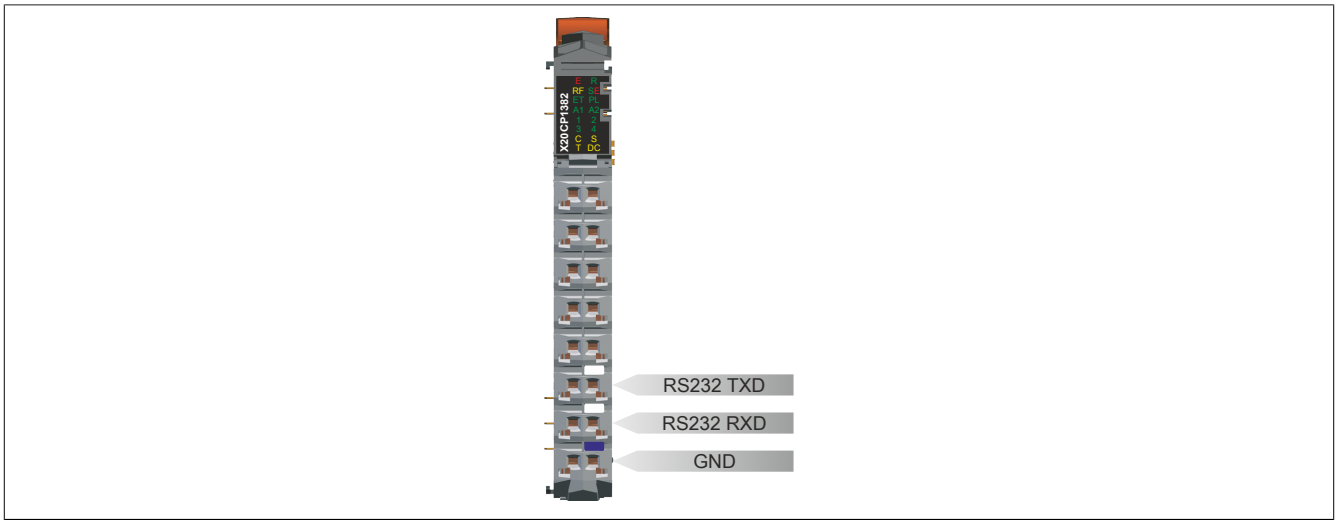
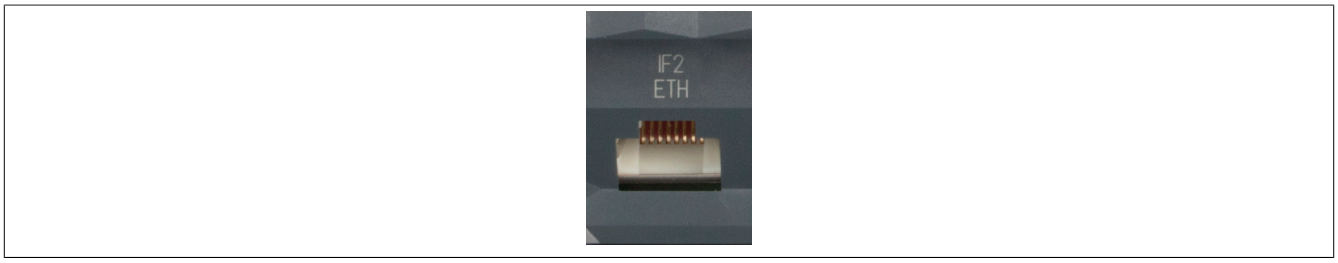


Figure 3: RS232 interface (IF1) on the X1 I/O slot - Pinout

6.6 Ethernet interface (IF2)



IF2 is a 10BASE-T/100BASE-TX Ethernet interface.

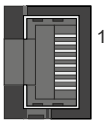
The INA2000 station number is set using the B&R Automation Studio software.

For information about wiring X20 modules with an Ethernet interface, see section "Mechanical and electrical configuration - Wiring guidelines for X20 modules with Ethernet cables" in the X20 user's manual.

Information:

The Ethernet interface is not suitable for POWERLINK.

When using the POWERLINK interface, the Ethernet interface is not permitted to be operated with an IP address from the POWERLINK address range.
POWERLINK address range: 192.168.100.x

Interface	Pinout		
	Pin	Ethernet	
 Shielded RJ45	1	RXD	Receive data
	2	RXD\	Receive data\
	3	TXD	Transmit data
	4	Termination	
	5	Termination	
	6	TXD\	Transmit data\
	7	Termination	
	8	Termination	

6.7 POWERLINK interface (IF3)

Compact controllers X20CP1381 and X20CP1382 are equipped with a POWERLINK V2 interface.

POWERLINK

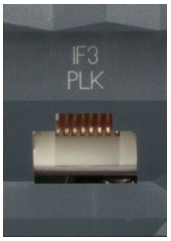
By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

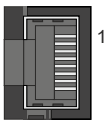
Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the Automation Studio software.

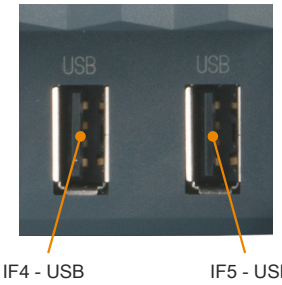
Pinout



For information about wiring X20 modules with an Ethernet interface, see section "Mechanical and electrical configuration - Wiring guidelines for X20 modules with Ethernet cables" in the X20 user's manual.

Interface	Pinout		
	Pin	Ethernet	
 Shielded RJ45	1	RXD	Receive data
	2	RXD\	Receive data\
	3	TXD	Transmit data
	4	Termination	
	5	Termination	
	6	TXD\	Transmit data\
	7	Termination	
	8	Termination	

6.8 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-galvanically isolated USB interfaces. The abbreviation USB stands for "Universal Serial Bus". Both USB interfaces support the USB 1.1 and 2.0 standards.

Information:

USB peripheral devices can be connected to the USB interfaces. Automation Runtime supports a selection of USB peripheral devices. For the supported USB classes, see the AR help documentation.

Information:

The following must be taken into account when using a USB peripheral device and grounded controller power supply (PELV):

- **Only USB peripheral devices with no connection between GND and ground are permitted to be connected. This is the case, e.g. with the USB dongle from B&R.**

Only interface IF4 is connected to the entry-level controller.

6.9 CAN bus interface (IF7)

With the exception of the entry-level controller, the Compact controllers are equipped with a non-galvanically isolated CAN bus interface. It is located on the integrated X1 I/O slot.

6.9.1 Pinout

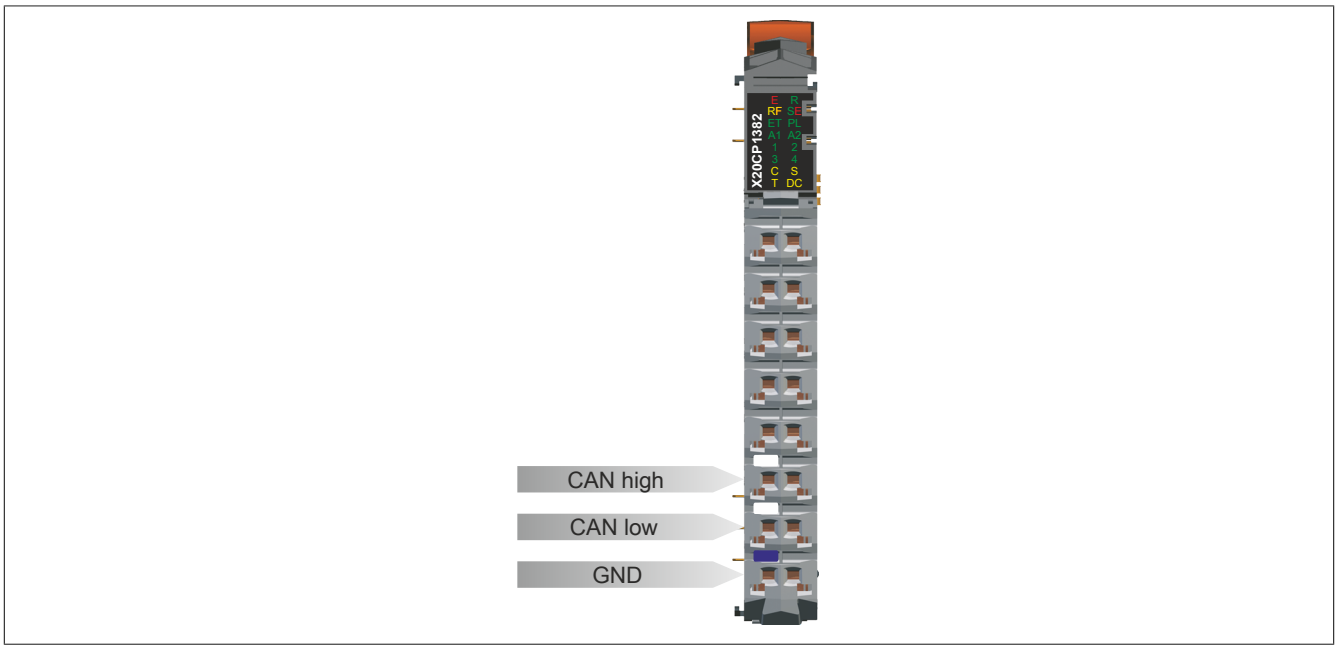


Figure 4: CAN bus interface (IF7) on the X1 I/O slot - Pinout

6.9.2 Terminating resistor

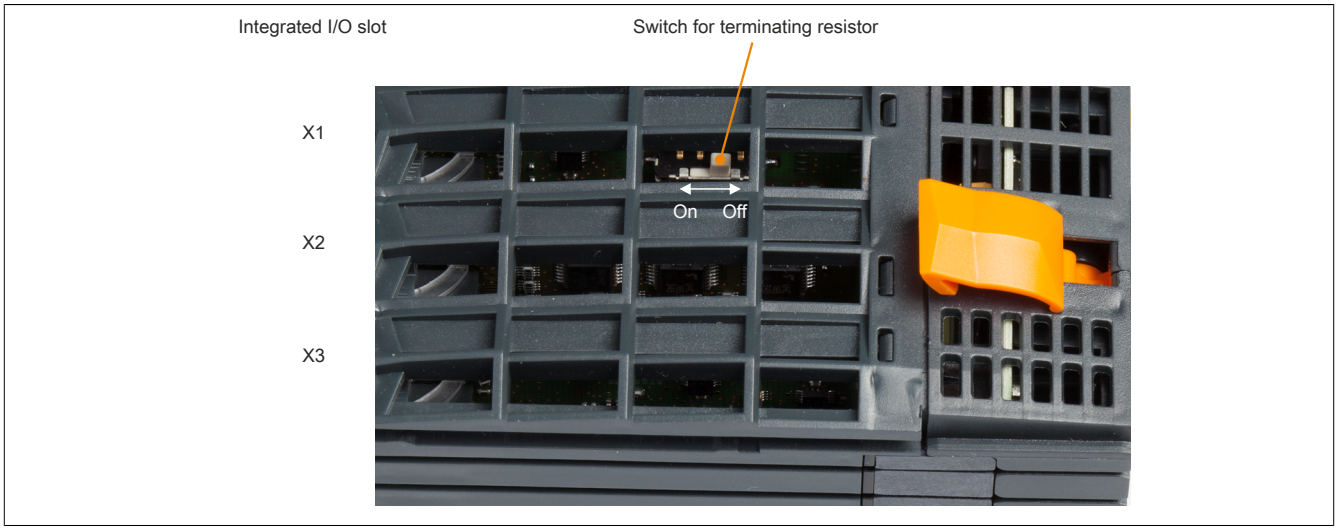


Figure 5: Switch positions for the CAN bus terminating resistor

A terminating resistor is already installed on the X1 I/O slot. The terminating resistor is switched on or off with a switch on the top of the housing. An enabled terminating resistor is indicated by LED "T".

6.10 Slot for interface modules

These controllers are equipped with one slot for interface modules.

Different bus or network systems can be flexibly integrated into the X20 system by selecting the appropriate interface module.

6.11 Data and real-time clock retention

The controllers do not use a battery. This makes them completely maintenance-free. Eliminating the backup battery was made possible by the following measures:

Data and real-time clock retention	Backup type	Note
Remanent variables	FRAM	This FRAM stores its contents ferroelectrically. Unlike normal SRAM, this does not require a battery.
Real-time clock	Gold foil capacitor	The real-time clock is backed up for approx. 1000 hours by a gold foil capacitor. The gold foil capacitor is completely charged after 3 continuous hours of operation.

7 Controller power supply

A power supply unit is integrated in these Compact controllers. It is equipped with a supply for the controller, X2X Link and the internal I/O power supply. The supply is galvanically isolated from X2X Link.

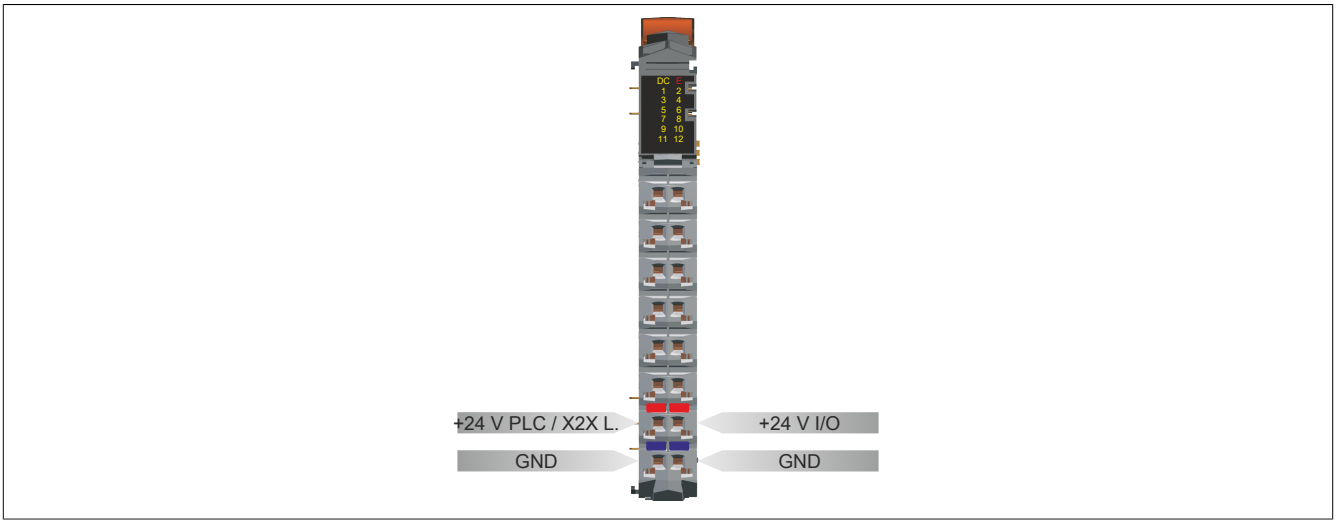
The connections are located on the X3 I/O slot.

Power supply concept of Compact controllers

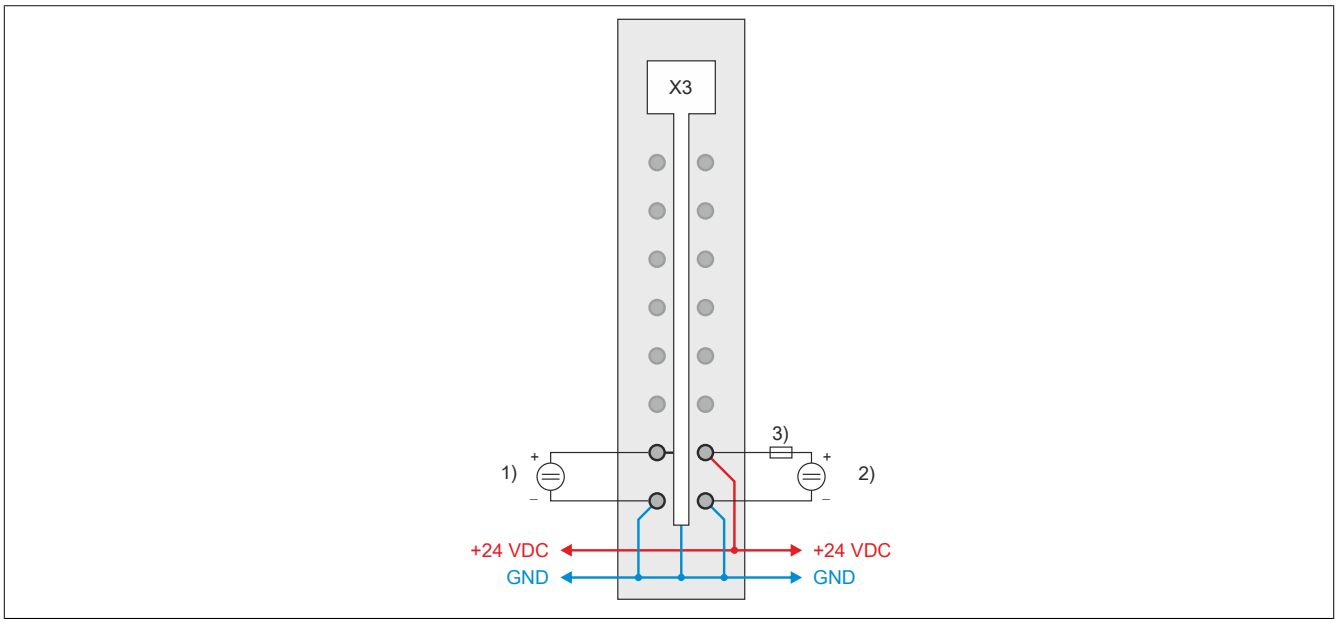
To ensure proper operation of the Compact controllers, the following points must be observed:

Power supply concept	Description
PLC and I/O GND	The GND contact is provided 5 times on the terminal blocks of the integrated I/O slots. All GND contacts are connected to one another. The GND contacts of the controller and I/O power supply therefore use the same electric potential.
Connectable X20 I/O modules	Power supply of X20 I/O modules that are connected to the Compact controller: • X2X Link: Power supply via the controller power supply • I/O channels: Supplied by the I/O power supply
Integrated X1 I/O slot	All digital and analog signals as well as the RS232 and CAN bus interface are supplied by the controller power supply. Their operation is therefore guaranteed even if there is no I/O power supply.
Integrated X2 I/O slot	• All digital signals are supplied by the controller power supply. Their operation is therefore guaranteed even if there is no I/O power supply. • The encoder power supply is supplied by the I/O power supply. If the encoder should not be included in the EMERGENCY STOP chain, it must be connected to an external power supply or it will be supplied by the controller's power supply unit.
Integrated X3 I/O slot	• All 12 digital signals are supplied by the I/O power supply. • The status messages for each channel also work without an I/O power supply. This guarantees that status messages will continue to be transferred during an emergency stop. • The state of the I/O power supply is indicated by a separate status message. **Caution!** **Channels 5 to 8 are designed as mixed channels. If one of these channels is being used, it is absolutely essential to ensure that there is no external voltage present on the I/O channel when the I/O power supply is cut off. Otherwise, power will be regenerated back to the plus terminal of the I/O power supply via the I/O channel. This will result in defective components.** **The following solutions are available for preventing power regeneration from occurring:** • **The I/O power supply of the controller is not permitted to be switched off, which allows the reference potential to be maintained.** • **If the I/O power supply is switched off anyway (e.g. as part of the emergency stop chain), then the sensor/actuator power supplies must also be switched off. This prevents potential power regeneration and protects components from being destroyed.**

Pinout



Connection example



1) Supply for the PLC / X2X Link power supply
2) Supply for the I/O power supply
3) Fuse, 10 A slow-blow

8 Overtemperature shutdown

To prevent damage, a shutdown – reset state – of the controller takes place at 95°C board temperature.

The following errors are entered in the logbook in the event of shutdown:

Error number	Short error text
9204	PLC restart triggered by the PLC CPU's temperature monitoring.
9210	Warning: Halt/Service after watchdog or manual reset.

9 Local I/O channels

Compact controllers are equipped with 3 integrated I/O slots. These devices have 30 digital inputs/outputs and 2 analog inputs.

The functions of high-speed digital inputs and outputs are described in section "Functions of the high-speed digital inputs/outputs" on page 27.

The following overviews show the assignment of connections to the I/O channels and their properties.

Digital inputs/outputs

Connection	Terminal connection	Channel	Description
X1	14	DI 1	24 VDC, sink, ≤200 µs, configurable software filter
	24	DI 2	24 VDC, sink, ≤200 µs, configurable software filter
	15	DI 3	24 VDC, sink, ≤200 µs, configurable software filter
	25	DI 4	24 VDC, sink, ≤200 µs, configurable software filter
X2	11	DI 1	24 VDC, sink, ≤200 µs, configurable software filter
	21	DI 2	24 VDC, sink, ≤200 µs, configurable software filter
	...	...	...
	25	DI 10	24 VDC, sink, ≤200 µs, configurable software filter
	16	DI 11	24 VDC, sink, ≤2 µs, configurable software filter
	26	DI 12	24 VDC, sink, ≤2 µs, configurable software filter
	17	DI 13	24 VDC, sink, ≤2 µs, configurable software filter
	27	DI 14	24 VDC, sink, ≤2 µs, configurable software filter
X3	11	DO 1	24 VDC, 0.5 A, source, <300 µs
	21	DO 2	24 VDC, 0.5 A, source, <300 µs
	12	DO 3	24 VDC, 0.5 A, source, <300 µs
	22	DO 4	24 VDC, 0.5 A, source, <300 µs
	13	DI 5 / DO 5	DI: 24 VDC, sink, ≤200 µs, configurable software filter DO: 24 VDC, 0.5 A, source, <300 µs
	23	DI 6 / DO 6	DI: 24 VDC, sink, ≤200 µs, configurable software filter DO: 24 VDC, 0.5 A, source, <300 µs
	14	DI 7 / DO 7	DI: 24 VDC, sink, ≤200 µs, configurable software filter DO: 24 VDC, 0.5 A, source, <300 µs
	24	DI 8 / DO 8	DI: 24 VDC, sink, ≤200 µs, configurable software filter DO: 24 VDC, 0.5 A, source, <300 µs
	15	DO 9	24 VDC, 0.2 A, push-pull, <3 µs
	25	DO 10	24 VDC, 0.2 A, push-pull, <3 µs
	16	DO 11	24 VDC, 0.2 A, push-pull, <3 µs
	26	DO 12	24 VDC, 0.2 A, push-pull, <3 µs

Analog inputs

Connection	Terminal connection	Channel	Description
X1	11, 12, 13	AI 1	±10 V / 0 to 20 mA or 4 to 20 mA, 12-bit, 1 ms
	21, 22, 23	AI 2	±10 V / 0 to 20 mA or 4 to 20 mA, 12-bit, 1 ms

Analog input 1 can also be used for PT1000 resistance temperature measurement.

Connection	Terminal connection	Channel	Description
X1	11, 12, 13	AI 1	PT1000 resistance temperature measurement: Measurement takes place using analog input A1.

10 Pinouts

Slot X1

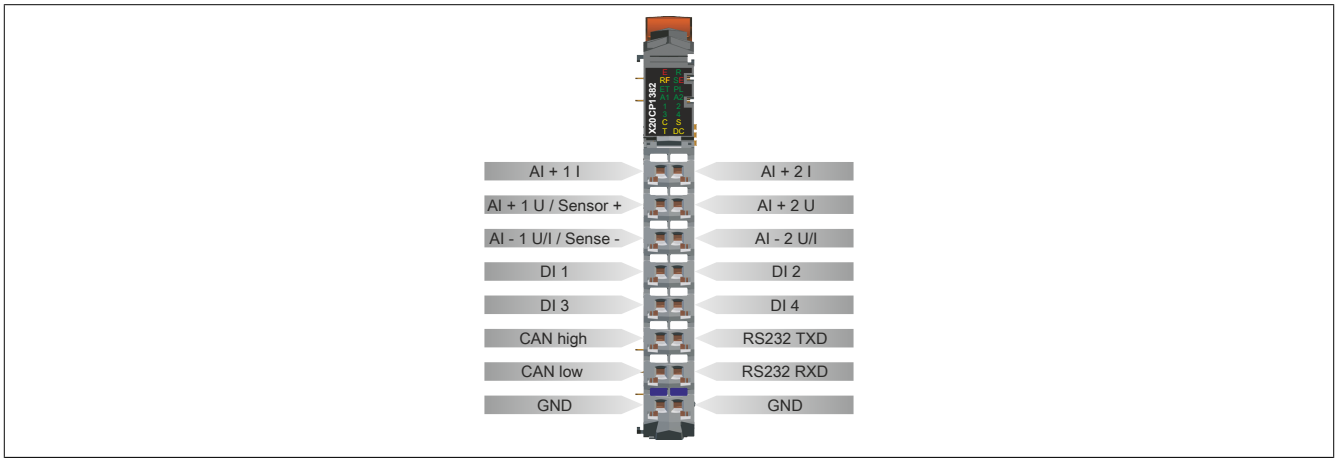


Figure 6: Pinout of the integrated X1 I/O slot

Slot X2

To prevent crosstalk, each signal line of the high-speed digital inputs should be shielded individually. The maximum cable length is 20 m.

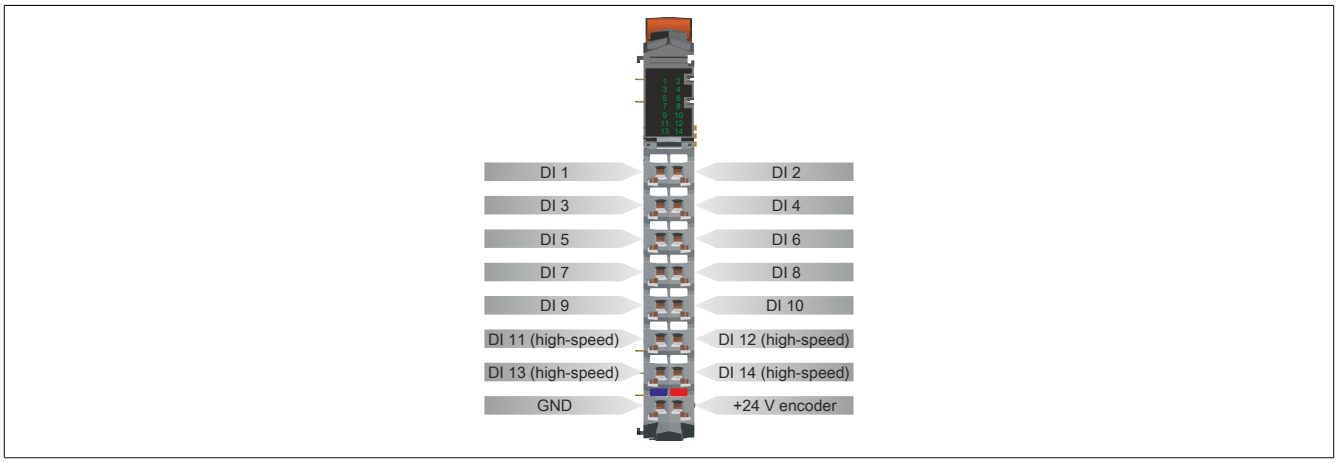


Figure 7: Pinout of the integrated X2 I/O slot

Slot X3

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section "Power supply concept of Compact controllers" on page 19.

To prevent crosstalk, each signal line of the high-speed digital outputs should be shielded individually. The maximum cable length is 20 m.

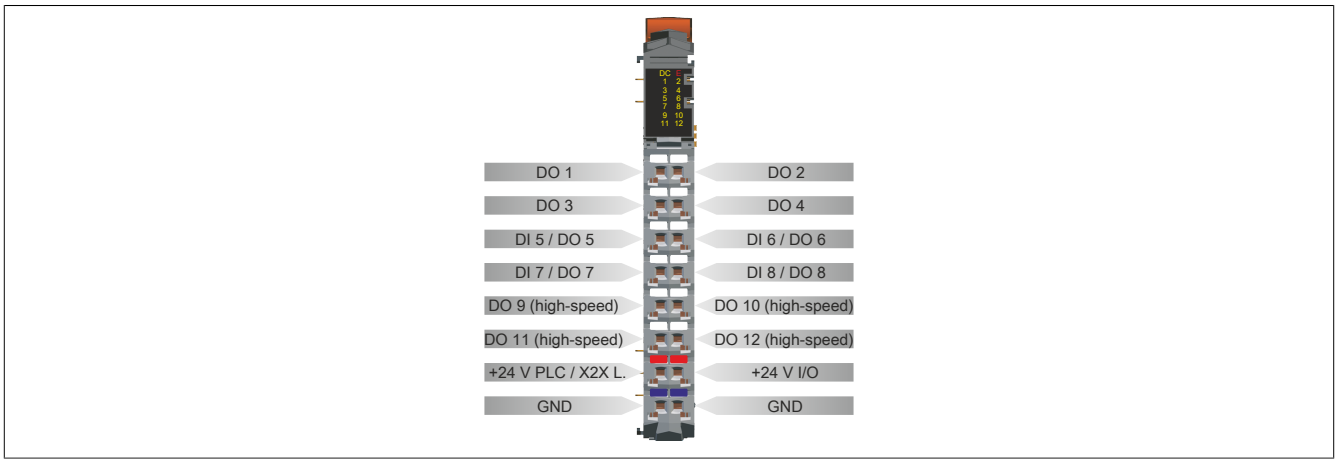


Figure 8: Pinout of the integrated X3 I/O slot

11 Connection examples

11.1 Slot X1

Voltage/Current measurement, digital inputs and CAN bus

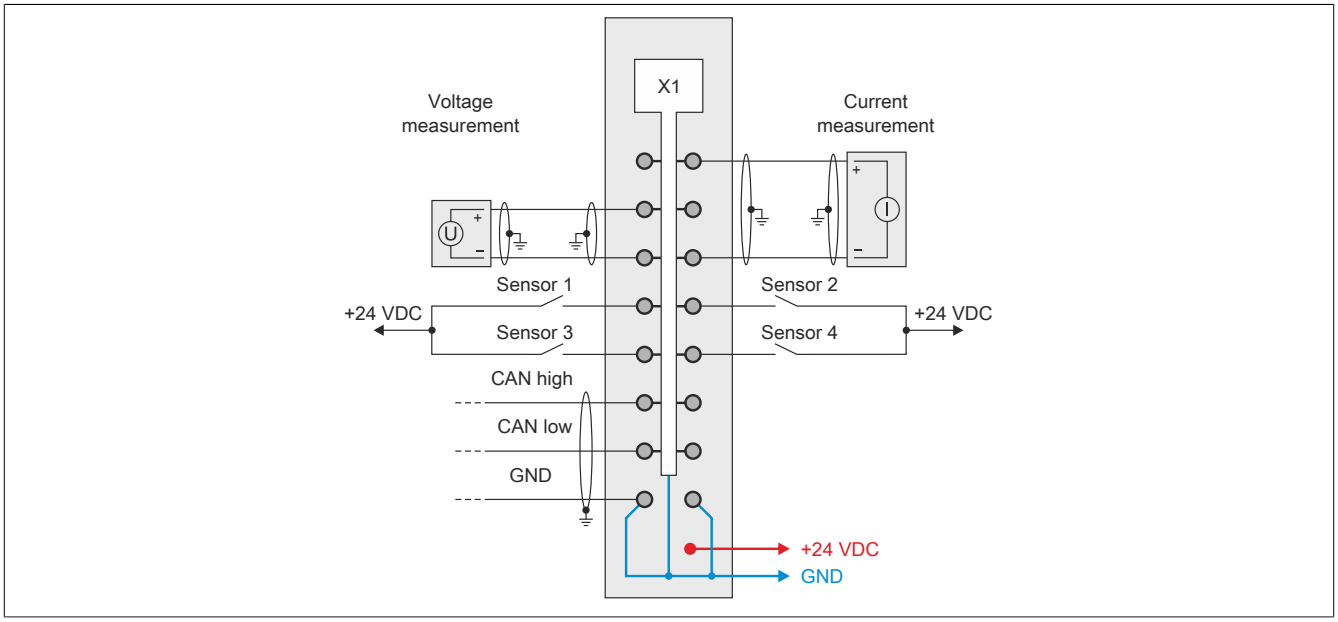


Figure 9: Connection example 1 for integrated I/O slot X1

PT1000 resistance temperature measurement, voltage measurement, digital inputs and RS232

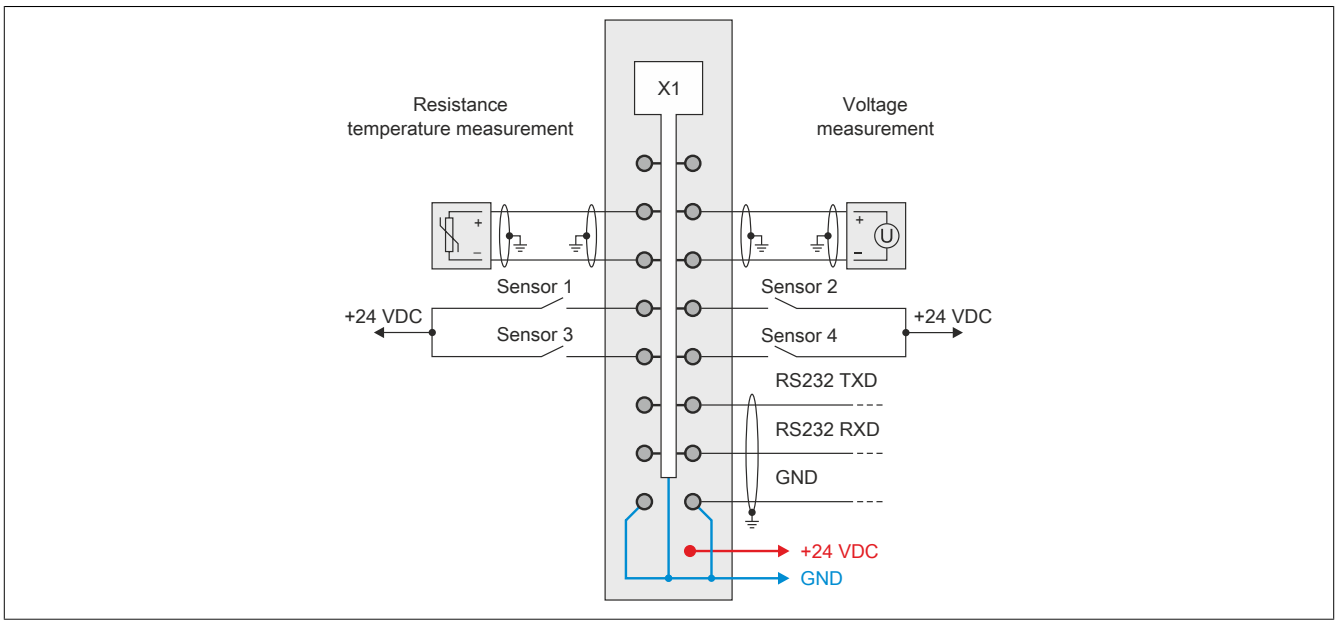


Figure 10: Connection example 2 for integrated I/O slot X1

11.2 Slot X2

Digital inputs and ABR incremental encoder

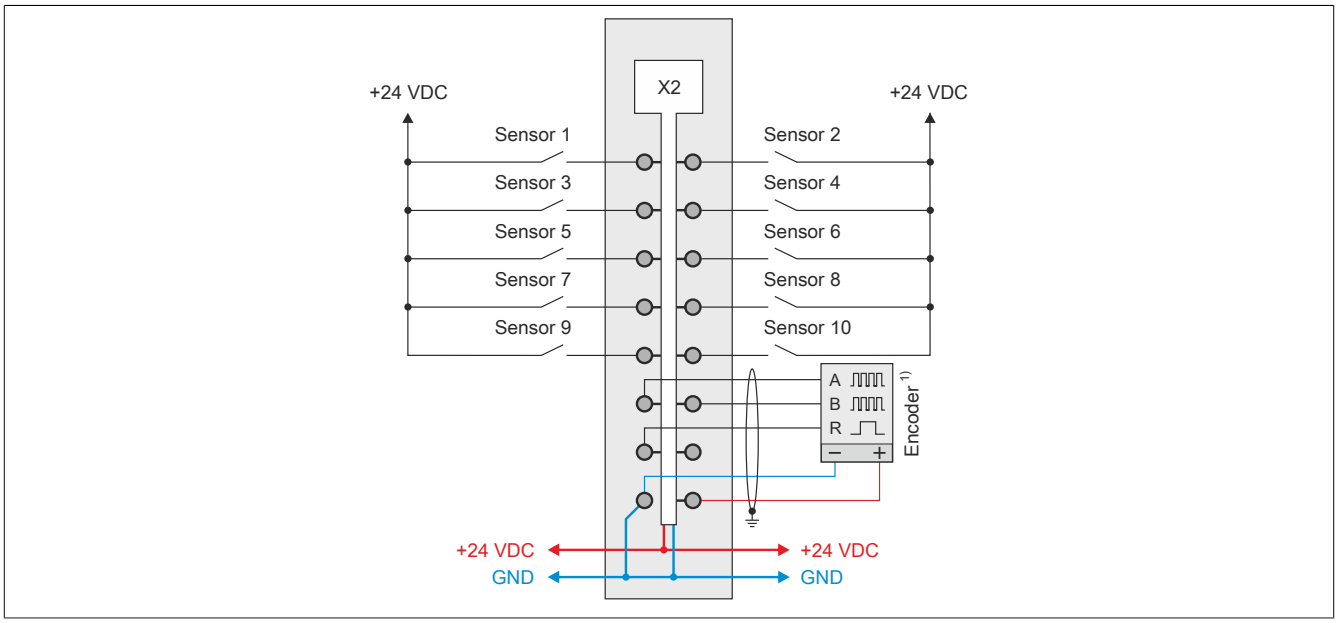


Figure 11: Connection example 1 for integrated I/O slot X2

1) Observe the cabling guidelines from the encoder manufacturer.

DI11 to DI14 are used as high-speed digital inputs.

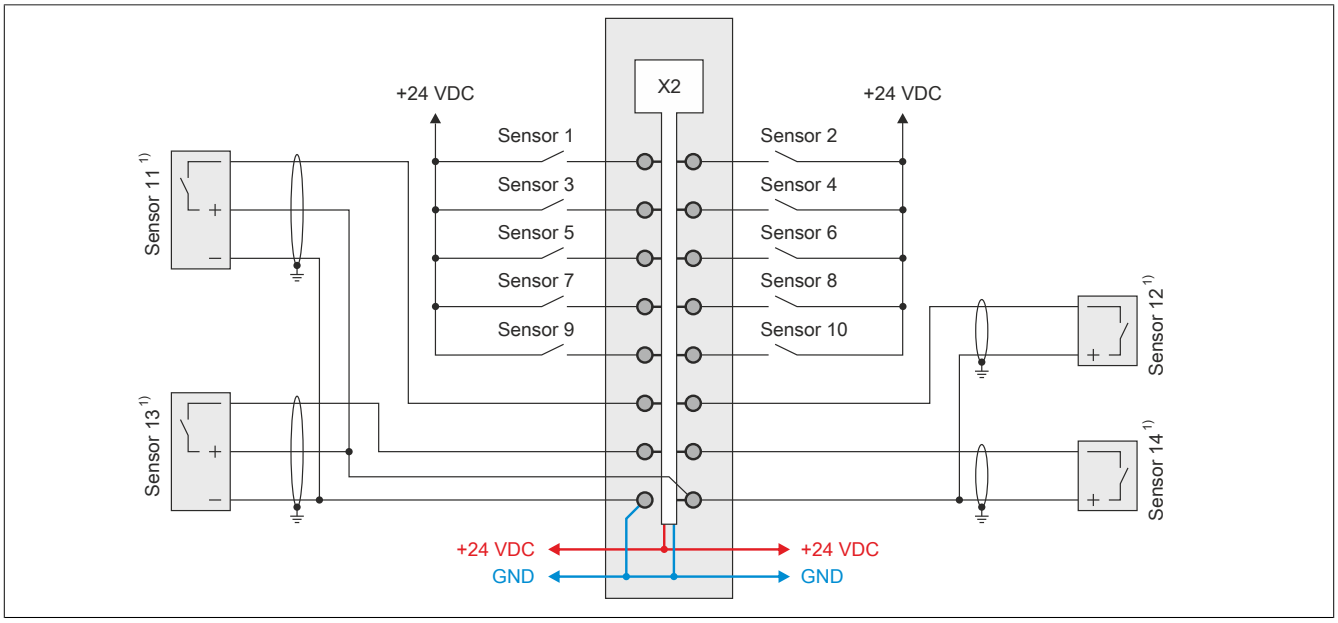


Figure 12: Connection example 2 for integrated I/O slot X2

1) Observe the cabling guidelines from the sensor manufacturer.

11.3 Slot X3

Digital inputs/outputs, direction/frequency (DF), PWM, PLC / X2X Link power supply and I/O power supply

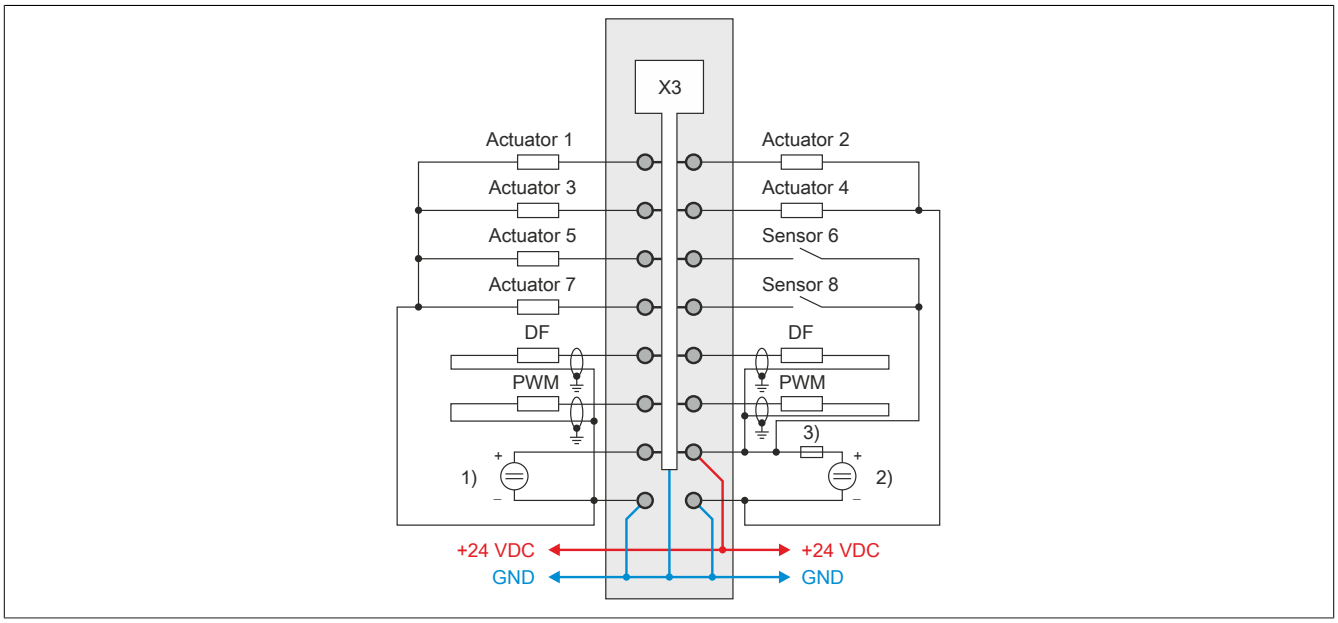


Figure 13: Connection example for integrated I/O slot X3

1) PLC / X2X Link power supply
2) I/O power supply
3) Fuse, 10 A slow-blow

12 Functions of the high-speed digital inputs/outputs

12.1 Functions of the high-speed digital inputs

Possible functions

The high-speed digital inputs DI 11 to DI 14 can be configured for the following functions. It is important to note that maximum 2 functions of the same type are possible with edge detection.

Channel	Counter function				Edge detection[1]	
DI 11	Event counter 1	A	A	D - Direction	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times
DI 12		B	B	F - Frequency	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times
DI 13	Event counter 2	A	R	R	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times
DI 14		B	E - Reference enable	E - Reference enable	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times

Table 7: Possible functions of the high-speed digital inputs DI 11 to DI 14

1) Maximum 2 functions of the same type can be configured.

Please note

The following points must be taken into account to correctly configure the high-speed digital inputs:

- The counter functions are mutually exclusive. Only one type of counter function can be selected at a time. It is not possible to select 2 event counters (DI 11 and DI 13) at the same time together with an AB or DF counter (each on DI 13 and DI 14)!
- It is possible to select a counter function and edge detection at the same time.
- A position or counter latch is possible when configuring the high-speed inputs as a 2x event counter, ABR incremental encoder or DF function.

Examples of possible configurations

Channel	Configuration 1	Configuration 2	Configuration 3	Configuration 4
DI 11	Event counter 1	• Edge counter • Edge times	A	D
DI 12	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times	B	F
DI 13	Event counter 2	A	R	R
DI 14	• Period measurement • Gate measurement • Differential time measurement	B	E - Reference enable	E - Reference enable

Channel	Configuration 5	Configuration 6	Configuration 7	Configuration 8
DI 11	Event counter 1	A	• Period measurement • Gate measurement • Differential time measurement	D - Direction
DI 12	• Edge counter • Edge times	B	• Period measurement • Gate measurement • Differential time measurement	F - Frequency
DI 13	Event counter 2	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times	• Edge counter • Edge times
DI 14	• Period measurement • Gate measurement • Differential time measurement	• Edge counter • Edge times	• Edge counter • Edge times	• Period measurement • Gate measurement • Differential time measurement

12.2 Functions of the high-speed digital outputs

Possible functions

High-speed digital outputs DO 9 to DO 12 can be configured for the following functions:

Channel	Function	
DO 9	PWM - Pulse width modulation	D - Direction
DO 10	PWM - Pulse width modulation	F - Frequency
DO 11	PWM - Pulse width modulation	D - Direction
DO 12	PWM - Pulse width modulation	F - Frequency

Table 8: Possible functions of high-speed digital outputs DO 9 to DO 12

Examples of possible configurations

Channel	Configuration 1	Configuration 2	Configuration 3	Configuration 4
DO 9	PWM - Pulse width modulation	D - Direction	PWM - Pulse width modulation	D - Direction
DO 10	PWM - Pulse width modulation	F - Frequency	PWM - Pulse width modulation	F - Frequency
DO 11	D - Direction	PWM - Pulse width modulation	PWM - Pulse width modulation	D - Direction
DO 12	F - Frequency	PWM - Pulse width modulation	PWM - Pulse width modulation	F - Frequency

13 Input/Output circuit diagram

13.1 Digital inputs (X1) and high-speed digital inputs (X2)

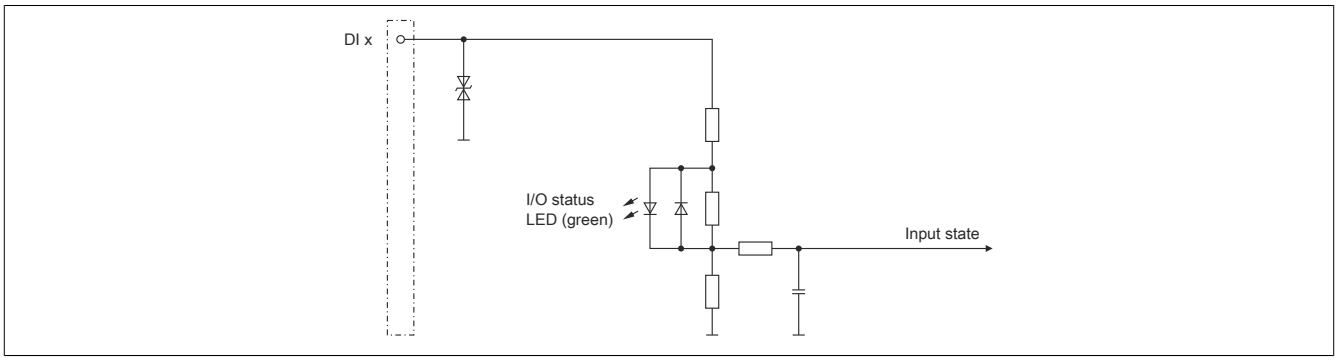


Figure 14: Input circuit diagram of the digital inputs on the integrated X1 I/O slot and the high-speed digital inputs on the integrated X2 I/O slot

13.2 Digital inputs (X2)

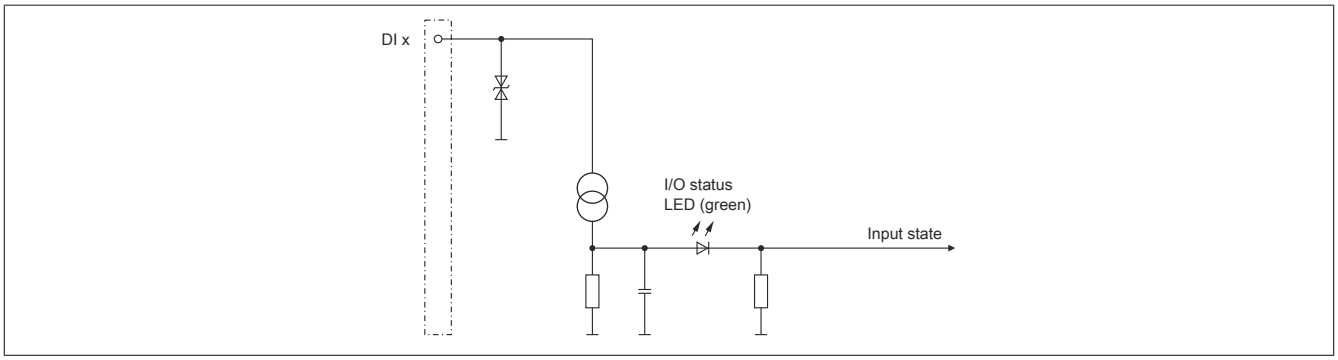


Figure 15: Input circuit diagram of the digital inputs on the integrated X2 I/O slot

13.3 Digital outputs (X3)

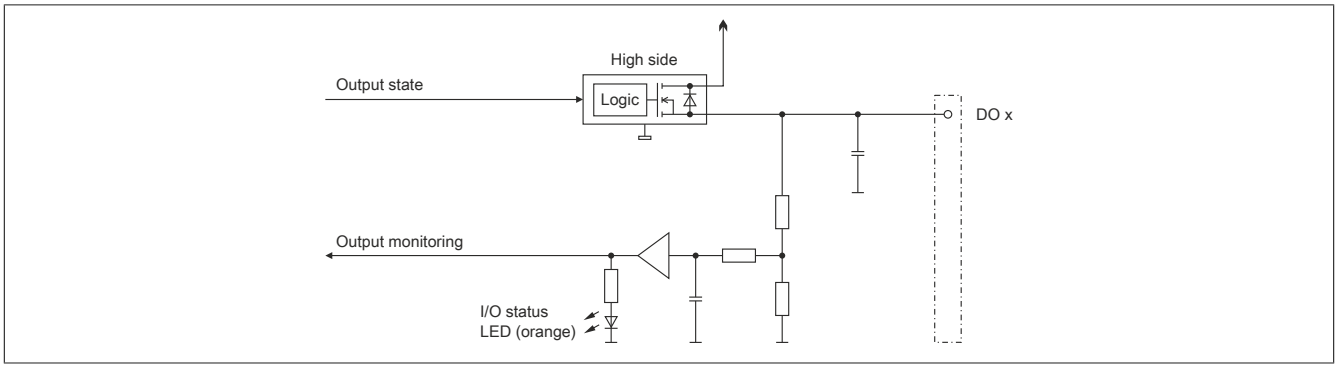


Figure 16: Output circuit diagram of the digital outputs on the integrated X3 I/O slot

13.4 High-speed digital outputs (X3)

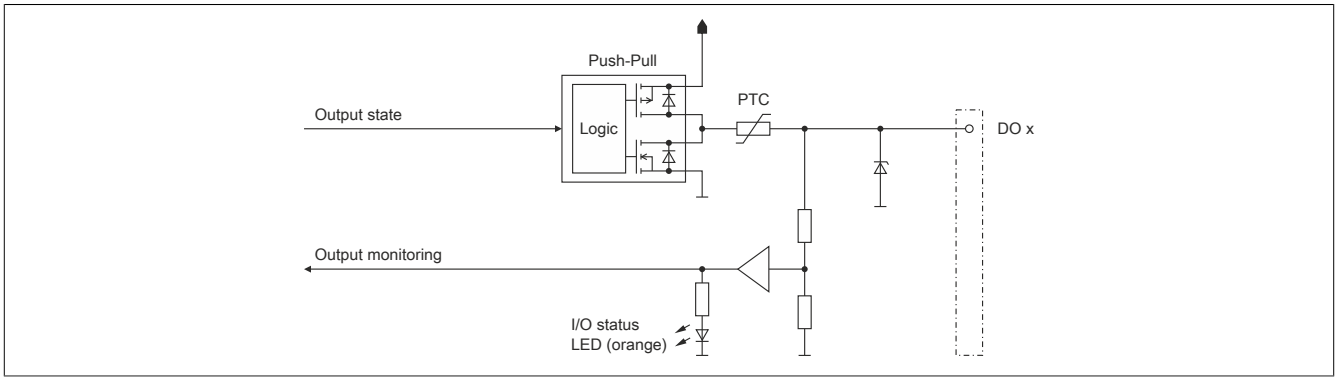


Figure 17: Output circuit diagram of the high-speed digital outputs on the integrated X3 I/O slot

13.5 Digital inputs/outputs (X3)

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section "Power supply concept of Compact controllers" on page 19.

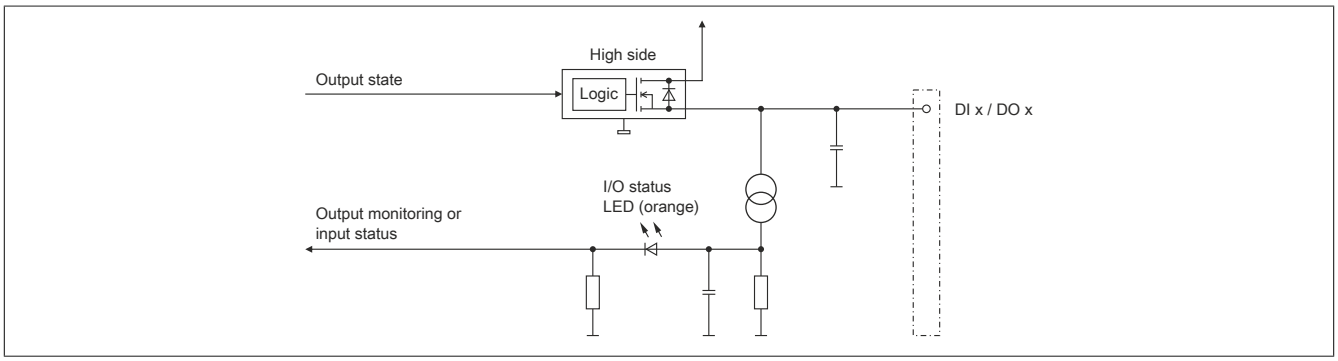


Figure 18: Input/Output circuit diagram of the digital mixed channels on the integrated X3 I/O slot

13.6 Analog inputs (X1)

A PT1000 resistance temperature sensor can be connected to analog input AI 1 and used for temperature measurement.

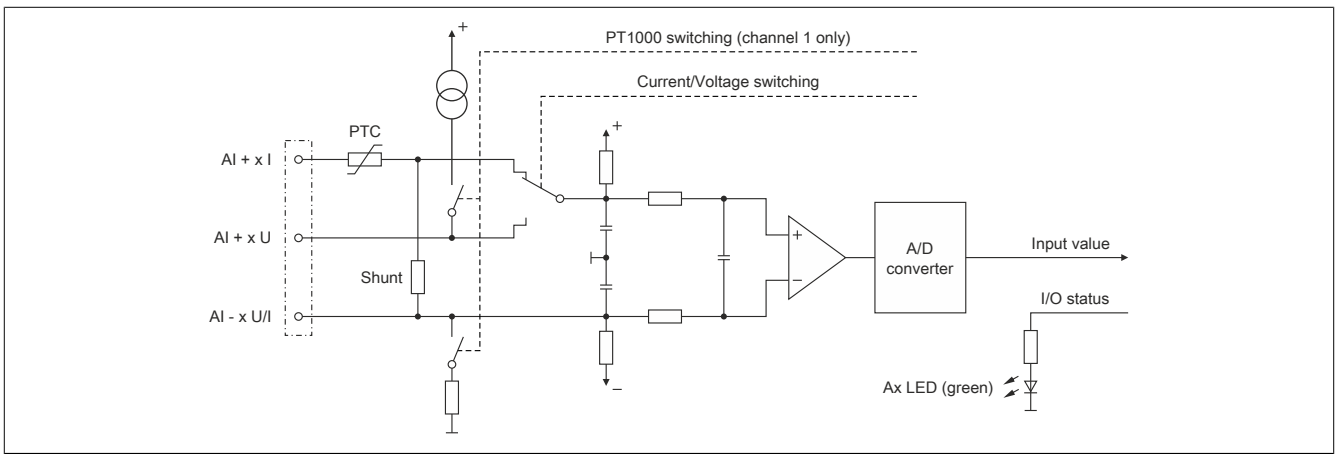


Figure 19: Input circuit diagram of the analog inputs and temperature input on the integrated X1 I/O slot

13.7 Encoder power supply (X2)

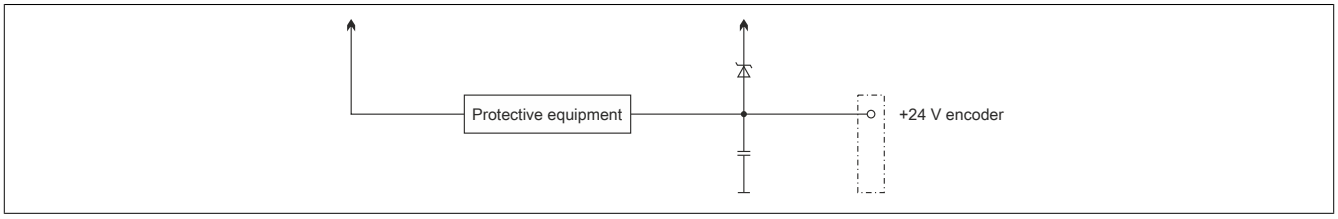


Figure 20: Circuit diagram of the encoder power supply on the integrated X2 I/O slot

13.8 Controller, X2X Link and I/O power supply (X3)

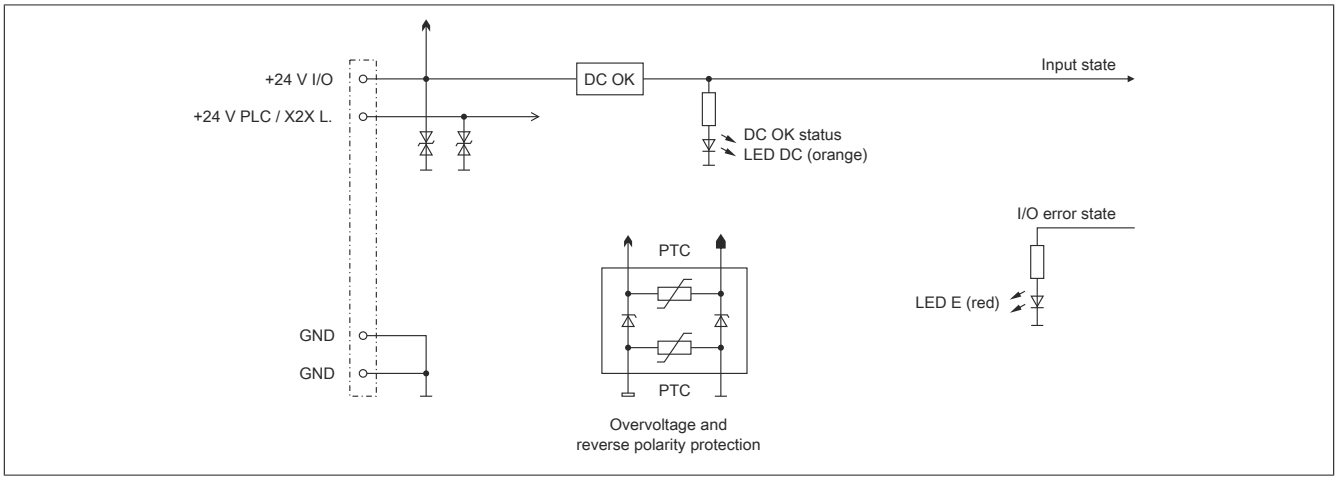


Figure 21: Circuit diagram of the PLC / X2X Link and I/O power supply on the integrated X3 I/O slot

14 Switching frequency derating for high-speed digital outputs

The high-speed digital outputs can be switched with a frequency of max. 200 kHz. Derating must be taken into account depending on the mounting orientation and operating temperature.

Switching frequency derating for horizontal mounting orientations

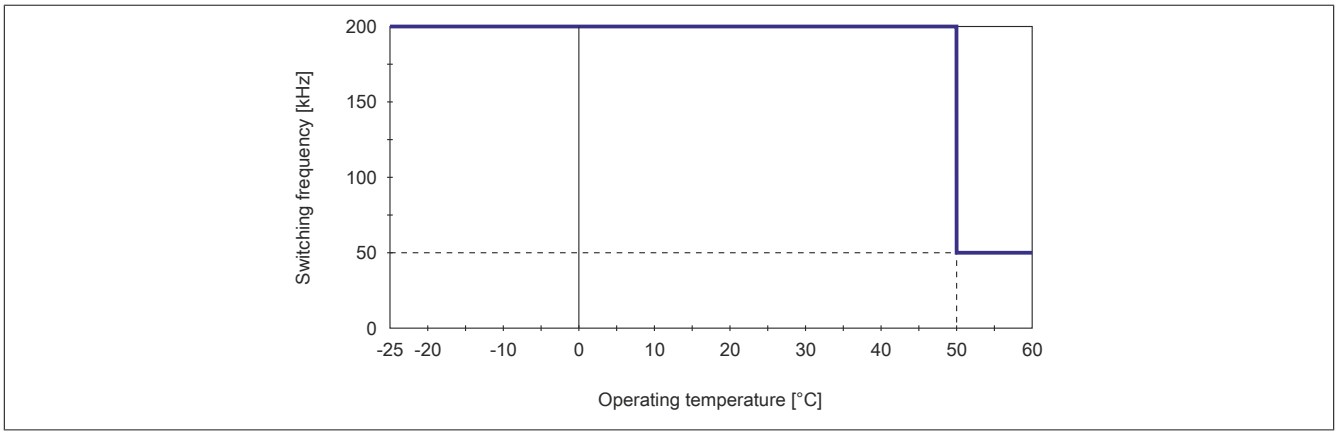


Figure 22: Switching frequency derating for high-speed digital outputs with horizontal mounting orientations

Switching frequency derating for vertical mounting orientations

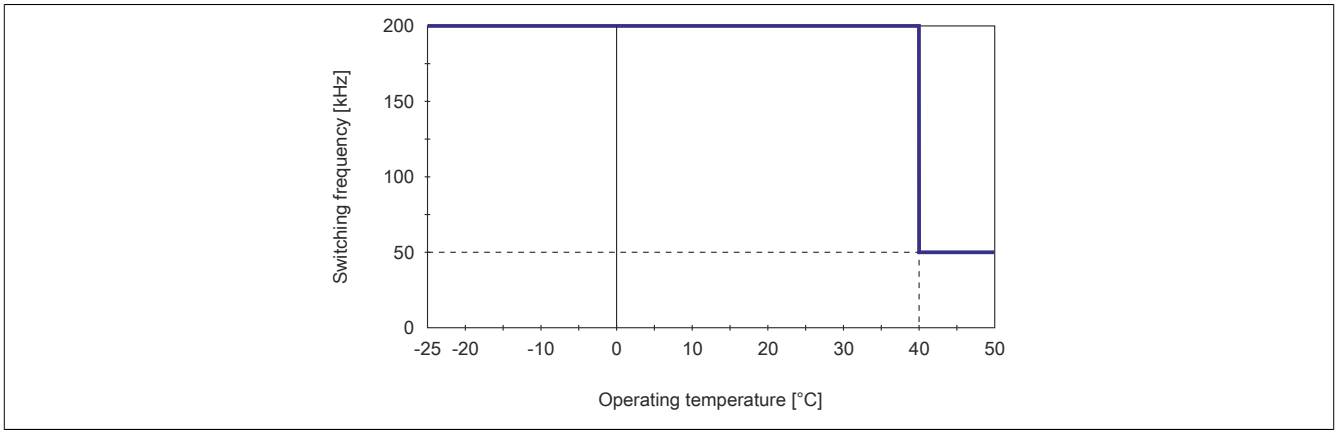
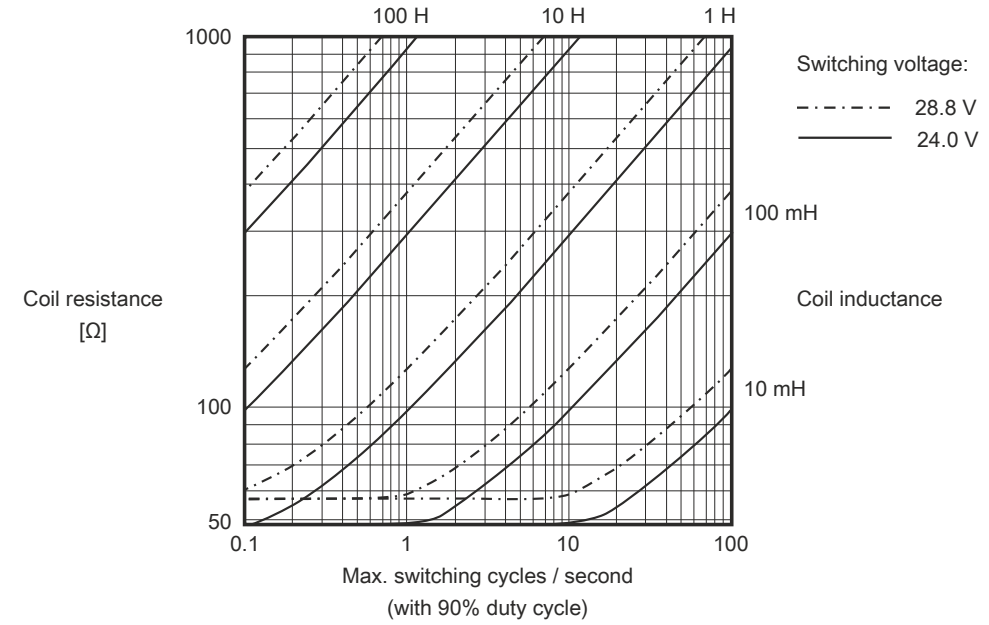


Figure 23: Switching frequency derating for high-speed digital outputs with vertical mounting orientations

15 Switching inductive loads



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

16 Register description

16.1 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.1.4.96
- Automation Runtime M4.10 for X20cCP1301
- Automation Runtime D4.09 for all other variants

16.2 General data points

This controller is equipped with general data points. These are not controller-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section "Additional information - General controller data points" in the X20 system user's manual.

16.3 Register overview of the I/O data points on the integrated X1 I/O slot

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
X1 - Configuration						
2048	X1CfO_DI_Filter	USINT				•
2128	X1CfO_AI_Mode	USINT				•
2112	X1CfO_AI1_Filter	USINT				•
2116	X1CfO_AI1_LowerLim	INT				•
2118	X1CfO_AI1_UpperLim	INT				•
2120	X1CfO_AI2_Filter	USINT				•
2124	X1CfO_AI2_LowerLim	INT				•
2126	X1CfO_AI2_UpperLim	INT				•
X1 - Communication						
0	Digital inputs	USINT	•			
	DigitalInput01	Bit 0				
	DigitalInput02	Bit 1				
	DigitalInput03	Bit 2				
	DigitalInput04	Bit 3				
64	AnalogInput01	INT	•			
		UINT	•			
66	AnalogInput02	INT	•			
80	StatusInput01	USINT	•			

16.3.1 Digital inputs

Unfiltered

The input state is recorded in a 100 µs cycle.

Filtered

The filtered state is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

16.3.1.1 Digital input filter

Name:
X1CfO_DI_Filter

The filter value for all digital inputs can be configured in this register.

The filter value can be configured in steps of 100 µs.

Data type	Values	Filter
USINT	0	No software filter
	1	0.1 ms
	...	...
	250	25 ms - Higher values are limited to this value.

16.3.1.2 Input state of digital inputs 1 to 4

Name:
DigitalInput01 to DigitalInput04

This register contains the input state of digital inputs 1 to 4.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Name	Value	Information
0	DigitalInput01	0 or 1	Input status of digital input 1
...		...	
3	DigitalInput04	0 or 1	Input status of digital input 4

16.3.2 Analog inputs

Analog input values are recorded in a fixed interval. The time required for conversion/updating depends on the number of analog inputs and on the input signal:

Input signal	Time required for conversion/updating
1 current/voltage input	100 µs
1 temperature/resistance input	200 µs
2 current/voltage inputs	200 µs
1 current/voltage input and 1 temperature/resistance input	400 µs

16.3.2.1 Input values of analog inputs

Name:
AnalogInput01

This register contains the analog input value depending on the configured operating mode.

Data type	Values	Input signal
INT	-32768 to 32767	Voltage signal -10 to 10 VDC
	0 to 32767	Current signal 0 to 20 mA (with 0 to 20 mA configuration)
	-8192 to 32767	Current signal 0 to 20 mA (with 4 to 20 mA configuration)
	-2000 to 8500	PT1000 signal -200.0 to 850.0°C
UINT	0 to 40000	Resistance signal 0 to 4000.0 Ω

Name:
AnalogInput02

This register contains the analog input value depending on the configured operating mode.

Data type	Values	Input signal
INT	-32768 to 32767	Voltage signal -10 to 10 VDC
	0 to 32767	Current signal 0 to 20 mA (with 0 to 20 mA configuration)
	-8192 to 32767	Current signal 0 to 20 mA (with 4 to 20 mA configuration)

16.3.2.2 Status of the inputs

Name:
StatusInput01

This register holds the status of the analog inputs. A change in the monitoring status is actively transmitted as an error message. The following states are monitored depending on the settings:

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 1	Channel 1	00	No error
		01	Lower limit value undershot
		10	Upper limit value overshot
		11	Open circuit
2 - 3	Channel 2	00	No error
		01	Lower limit value undershot
		10	Upper limit value overshot
		11	Open circuit
4 - 7	Reserved	0	

Limiting the analog value

In addition to the status information, the analog value is fixed to the specified limit values by default in the error state (see "Limit values" on page 41). The analog value is limited to the new values if the limit values were changed.

16.3.2.3 Input filter

The analog inputs are equipped with a configurable input filter.

16.3.2.3.1 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

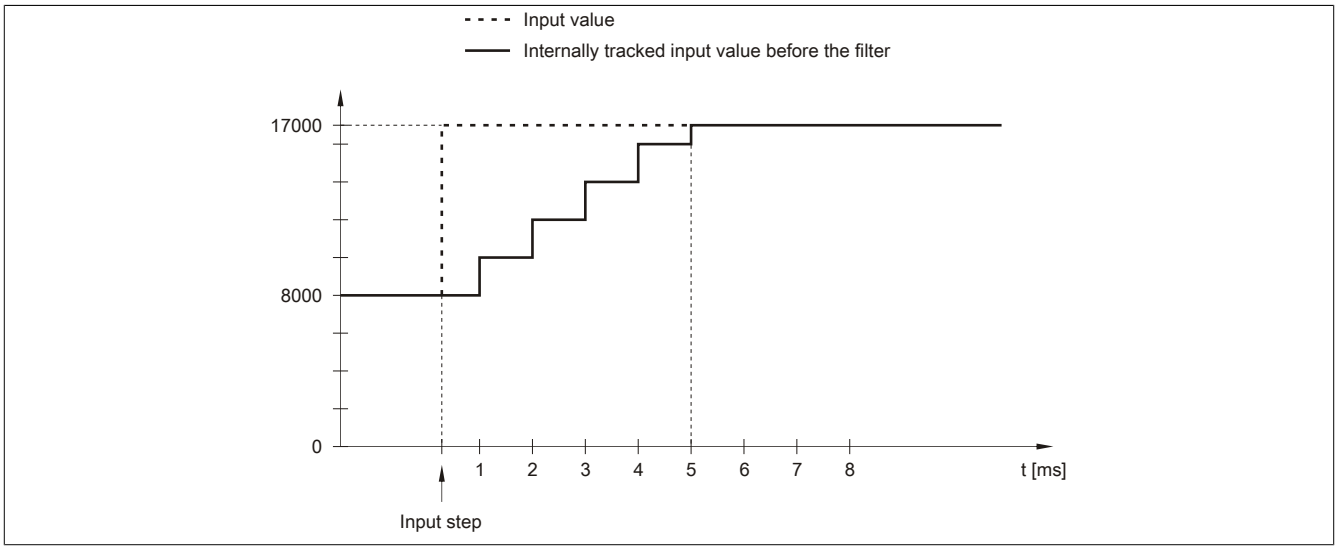


Figure 24: Tracked input value for input step

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

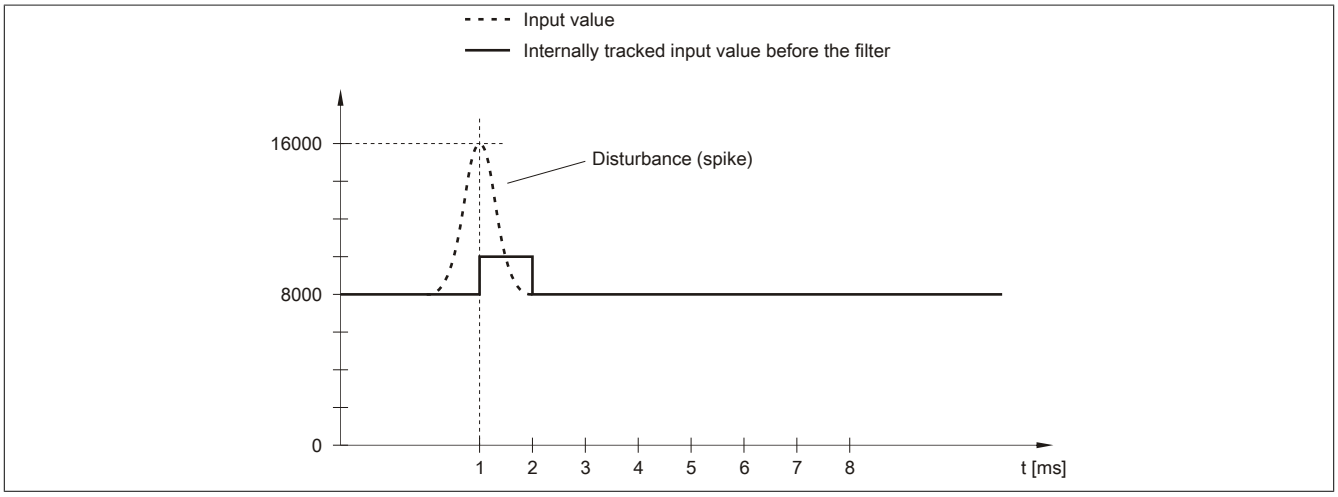


Figure 25: Tracked input value for disturbance

16.3.2.3.2 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

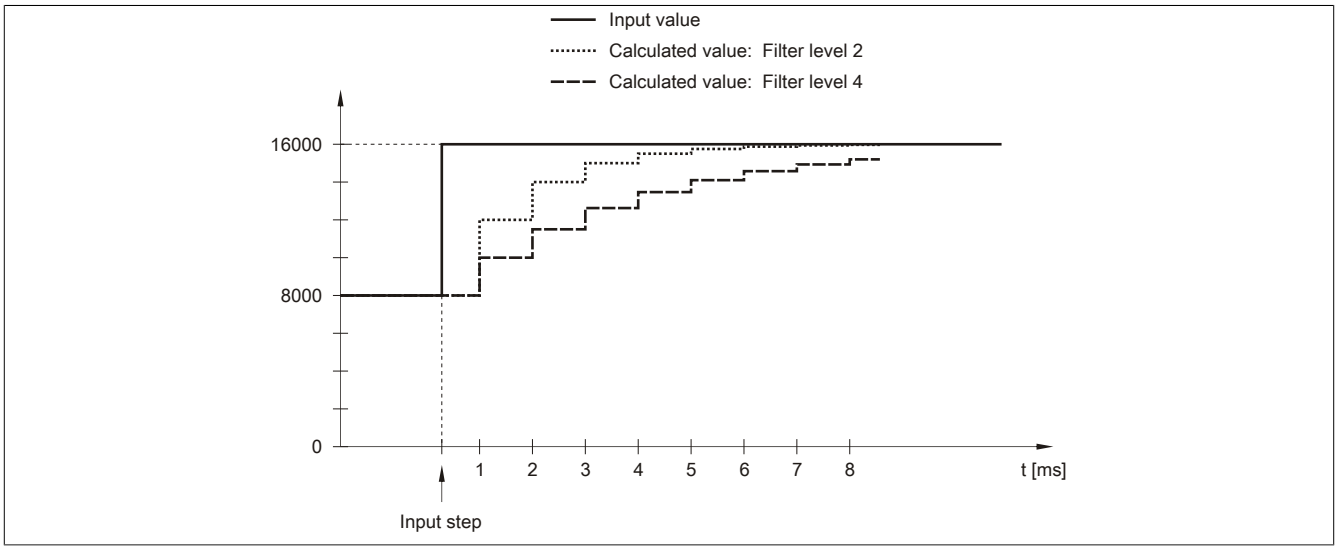


Figure 26: Calculated value during input step

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

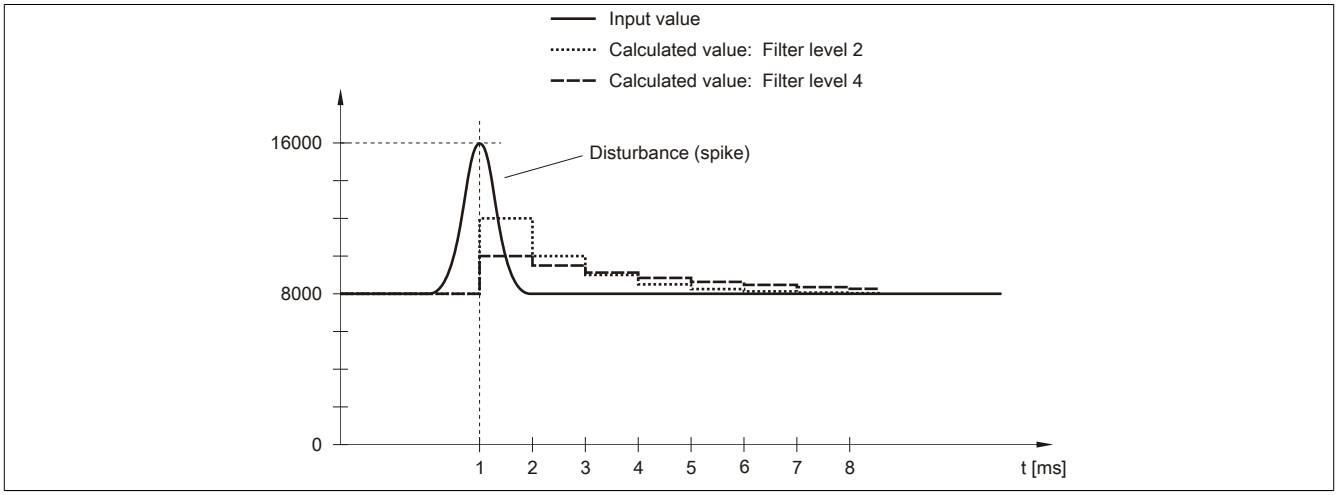


Figure 27: Calculated value during disturbance

16.3.2.3.3 Configuring the input filter

Name:
X1CfO_AI1_Filter
X1CfO_AI2_Filter

The filter level and input ramp limiting of the input filter are set in this register.

Data type	Values
USINT	See the bit structure.

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	

16.3.2.4 Channel type

Name:
X1CfO_AI_Mode

The type and range of signal measurement can be set in this register.

The individual channels are designed for current, voltage and resistance signals. This differentiation is made using different terminal connections and an integrated switch. The switch is automatically activated depending on the specified configuration. The following input signals can be set:

Input signal	On channel
±10 V voltage signal (default)	1 and 2
0 to 20 mA current signal	1 and 2
4 to 20 mA current signal	1 and 2
PT1000 measurement	1
Resistance measurement	1

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Analog input - Channel 1	000	Channel switched off
		001	±10 V voltage signal
		010	0 to 20 mA current signal
		011	4 to 20 mA current signal
		100	PT1000 measurement
		101	Resistance measurement
3	Reserved	0	
4 - 5	Analog input - Channel 2	00	Channel switched off
		01	±10 V voltage signal
		10	0 to 20 mA current signal
		11	4 to 20 mA current signal
6 - 7	Reserved	0	

16.3.2.5 Limit values

The input signal is monitored at the upper and lower limit values. By default, the following limits are set for each operating mode:

Limit value (default)	Voltage signal ±10 V		Current signal 0 to 20 mA		Current signal 4 to 20 mA	
Upper maximum limit value	10 V	32767 (0x7FFF)	20 mA	32767 (0x7FFF)	20 mA	32767 (0x7FFF)
Lower minimum limit value	-10 V	-32767 (0x8001)	0 mA	0[1)]	4 mA	0[2)]

Table 9: Limit values for voltage and current signals

1) The analog value is limited down to 0.
2) Due to the default limit value, the analog value is limited to a minimum of 0 at currents <4 mA.

Limit value (default)	Temperature measurement		Resistance measurement	
Upper maximum limit value	800.0°C	8000 (0x1F40)	4000.0 Ω	32767 (0x7FFF)
Lower minimum limit value	-200.0°C	-2000 (0xF830)	0 Ω	0

Table 10: Limit values for temperature and resistance measurement

Other limit values can be defined if necessary. These are activated automatically by writing the limit value register (see "Lower limit value" on page 41 and "Upper limit value" on page 41). From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register (see "Status of the inputs" on page 36).

Application example of setting limit values

If values <4 mA should be measured for a current signal with 4 to 20 mA, a negative limit value must be set: 0 mA corresponds to value -8192 (0xE000).

16.3.2.5.1 Lower limit value

Name:
X1CfO_AI1_LowerLim
X1CfO_AI2_LowerLim

These registers can be used to configure the lower limit value for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set (see "Status of the inputs" on page 36).

Data type	Values
INT	-32768 to 32767
UINT	0 to 65535

> **Information:**
>
> **For a 4 to 20 mA configuration, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.**

16.3.2.5.2 Upper limit value

Name:
X1CfO_AI1_UpperLim
X1CfO_AI2_UpperLim

These registers can be used to configure the upper limit value for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set (see "Status of the inputs" on page 36).

Data type	Values
INT	0 to 32767
UINT	0 to 65535

16.4 Register overview of the I/O data points on the integrated X2 I/O slot

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
X2 - Configuration						
7168	X2CfO_EdgeDetectUnit01Mode	USINT				•
7169	X2CfO_EdgeDetectUnit01Master	USINT				•
7170	X2CfO_EdgeDetectUnit01Slave	USINT				•
7184	X2CfO_EdgeDetectUnit02Mode	USINT				•
7185	X2CfO_EdgeDetectUnit02Master	USINT				•
7186	X2CfO_EdgeDetectUnit02Slave	USINT				•
6144	X2CfO_DI_Filter	USINT				•
6528	X2CfO_CounterMode	USINT				•
6400	X2CfO_Latch01Mode	USINT				•
6401	X2CfO_Latch01Comparator	USINT				•
6416	X2CfO_Latch02Mode	USINT				•
6417	X2CfO_Latch02Comparator	USINT				•
X2 - Communication						
4096	Digital inputs	USINT	•			
	DigitalInput01	Bit 0				
	DigitalInput02	Bit 1				
	DigitalInput03	Bit 2				
	DigitalInput04	Bit 3				
	DigitalInput05	Bit 4				
	DigitalInput06	Bit 5				
	DigitalInput07	Bit 6				
	DigitalInput08	Bit 7				
4097	Digital inputs	USINT	•			
	DigitalInput09	Bit 0				
	DigitalInput10	Bit 1				
	DigitalInput11	Bit 2				
	DigitalInput12	Bit 3				
	DigitalInput13	Bit 4				
	DigitalInput14	Bit 5				
5120	EdgeDetect01Mastertime	DINT	•			
5124	EdgeDetect01Difference	DINT	•			
5128	EdgeDetect01Mastercount	INT	•			
5136	EdgeDetect02Mastertime	DINT	•			
5140	EdgeDetect02Difference	DINT	•			
5144	EdgeDetect02Mastercount	INT	•			
4384	Counter 1	USINT			•	
	Counter01Reset	Bit 0				
	Latch01Enable	Bit 1				
4352	Counter01Value	DINT	•			
4356	Counter01Latch	DINT	•			
4360	Counter01TimeChanged	DINT	•			
4364	Counter01TimeValid	DINT	•			
4368	Latch01Count	SINT	•			
4448	Counter 2	USINT			•	
	Counter02Reset	Bit 0				
	Latch02Enable	Bit 1				
4416	Counter02Value	DINT	•			
4420	Counter02Latch	DINT	•			
4424	Counter02TimeChanged	DINT	•			
4428	Counter02TimeValid	DINT	•			
4432	Latch02Count	SINT	•			

16.4.1 Digital inputs

Unfiltered

The input state is recorded in a 100 µs cycle.

Filtered

The filtered state is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

16.4.1.1 Digital input filter

Name:
X2CfO_DI_Filter

The filter value for all digital inputs can be configured in this register.

The filter value can be configured in steps of 100 µs.

Data type	Values	Filter
USINT	0	No software filter
	1	0.1 ms
	...	...
	250	25 ms - Higher values are limited to this value.

16.4.1.2 Input state of digital inputs 1 to 14

Name:
DigitalInput01 to DigitalInput14

These registers contain the input state of digital inputs 1 to 14.

Data type	Values
USINT	See the bit structure.

Bit structure of register 4096:

Bit	Name	Value	Information
0	DigitalInput01	0 or 1	Input status of digital input 1
...		...	
7	DigitalInput08	0 or 1	Input status of digital input 8

Bit structure of register 4097:

Bit	Name	Value	Information
0	DigitalInput09	0 or 1	Input status of digital input 9
...		...	
5	DigitalInput14	0 or 1	Input status of digital input 14

16.4.2 Edge detection

Digital inputs 11 to 14 can be used for high-speed edge detection. This runs parallel to all other functions such as counters, etc. This function does not use the digital input filter.

The edge detection function allows edges to be measured with microsecond precision. 2 units are available. A master and a slave edge can be configured for each unit. At each master edge, the timestamp of the master edge and the differential time to the previous slave edge (if present) are logged. A "master count" can always be used to determine how many edges have been detected since the last task class cycle. The timestamp is based on the system time of the controller.

The combination of rising/falling edges of the channels can be used to configure the following functions for each unit:

Function	Description
Edge time	Measure an edge time
Period duration	Measure the master and differential time
Gate time	Measure the master and differential time
Time offset	Measure the master and differential time of edges on different channels

16.4.2.1 Edge detection unit - Mode settings

The edge detection unit must be configured according to the desired function:

Function	Description
Basic timestamp, master edge mode	The current system time is saved as the master time at the time of the edge.
Timestamp and/or differential time, master and slave edge mode	The slave edge starts the measurement and the system time is saved temporarily. When the master edge occurs, the current system time is saved as the master time and the difference between the master and slave edges is calculated.

Name:
X2CfO_EdgeDetectUnit01Mode
X2CfO_EdgeDetectUnit02Mode

These registers are used to configure the master edge basic function or the master edge with slave edge basic function:

Data type	Values	Information
USINT	0x00	Edge detection disabled on Unit0x: Time measurement not possible
	0x80	Edge detection enabled on Unit0x: Reaction only possible for master edge, no differential measurement possible
	0xC0	Edge detection enabled on Unit0x: Reaction possible for configured master and slave edges

16.4.2.2 Edge detection unit - Selection of master edge

Name:
X2CfO_EdgeDetectUnit01Master
X2CfO_EdgeDetectUnit02Master

These registers are used to select the source of the master edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

Data type	Values	Information
USINT	0	Digital input channel 11: Rising edge
	2	Digital input channel 12: Rising edge
	4	Digital input channel 13: Rising edge
	6	Digital input channel 14: Rising edge
	1	Digital input channel 11: Falling edge
	3	Digital input channel 12: Falling edge
	5	Digital input channel 13: Falling edge
	7	Digital input channel 14: Falling edge

16.4.2.3 Edge detection unit - Selection of slave edge

Name:
X2CfO_EdgeDetectUnit01Slave
X2CfO_EdgeDetectUnit02Slave

These registers define the source of the slave edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

Data type	Values	Information
USINT	0	Digital input channel 11: Rising edge
	2	Digital input channel 12: Rising edge
	4	Digital input channel 13: Rising edge
	6	Digital input channel 14: Rising edge
	1	Digital input channel 11: Falling edge
	3	Digital input channel 12: Falling edge
	5	Digital input channel 13: Falling edge
	7	Digital input channel 14: Falling edge

16.4.2.4 Edge detection unit - Master edge counter

Name:
EdgeDetect01Mastercount
EdgeDetect02Mastercount

The counter value of detected master edges is stored in these registers. The counter value is used to detect new measurements.

Data type	Values	Information
INT	-32768 to 32767	Running counter: Number of detected master edges

16.4.2.5 Edge detection unit - Master edge timestamp

Name:
EdgeDetect01Mastertime
EdgeDetect02Mastertime

The exact controller system time of the respective unit is saved to these registers when a master edge occurs. When multiple edges occur within a sampling cycle (task class), then the time of the last edge in each case is shown.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Controller system time of master edge [µs]

16.4.2.6 Edge detection unit - Time difference

Name:
EdgeDetect01Difference
EdgeDetect02Difference

The difference between the master edge and the slave edge of the respective unit is saved to these registers. When several measurement periods are completed within a sampling cycle (task class), then the time difference from the last measurement period is shown.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Time difference between master edge and slave edge [µs]

16.4.3 Counter functions

High-speed digital inputs 11 to 14 can be used for counter functions. This function does not use the digital input filter. The following functions are available. Only one of these basic configurations can be active at a time:

- 2x event counter with latch function
- 2x AB incremental counter without latch function
- DF counter function
- ABR counter function

16.4.3.1 Configuring the counter function

The following counter functions can be configured:

Counter function	Description
2x event counter with latch function	Input 11 for event counter 1 and input 13 for event counter 2 can be used simultaneously as event counters. Both rising and falling edges are counted. The latch function of all 4 inputs can be used.
2x AB incremental counter without latch function	Inputs 11 and 12 as AB counter 1 and inputs 13 and 14 as AB counter 2. Since no more high-speed inputs are available, the latch function is not available.
DF counter: Direction/Frequency with latch function	The D, F and R signals are linked to inputs 11, 12 and 13. Signal D defines the positive (Level = 0) or negative (Level = 1) counting direction. The latch function of all 4 inputs can be used.
ABR counter with latch function	The A, B and R signals are linked to inputs 11, 12 and 13. The latch function of all 4 inputs can be used.

Name:
X2CfO_CounterMode

This register configures the counter function:

Data type	Values	Information
USINT	0	2x event counter with latch function
	1	2x AB incremental counter without latch function
	2	DF counter with latch function
	3	ABR counter with latch function

16.4.3.2 Configuring the mode of the latch function

Name:
X2CfO_Latch01Mode
X2CfO_Latch02Mode

This register sets the mode of the latch function. The following latch functions can be configured:

Latch function	Description
Single shot latch mode	The latch function must be enabled/set. After a successful latch procedure the function must first be reset. Then it can be enabled again.
Continuous latch mode	The latch function must only be enabled/set as long as latching is desired.

A changed counter value on "LatchCount" indicates that the latch procedure has been performed (see "Counter value of latch events" on page 48). The counter value is stored in the latch register (see "Latched counter value" on page 48).

Data type	Values	Information
USINT	0	Single shot latch mode
	1	Continuous latch mode

16.4.3.3 Configuring the latch signals

Name:
X2CfO_Latch01Comparator
X2CfO_Latch02Comparator

This register defines the inputs and their level for triggering the latch procedure.

- This defines which inputs are linked to generate the latch event. All 4 digital input signals can be used for the "AND" operator.
- The "active voltage level" needed for the latch procedure can be defined to adjust for the physical signals. Configuring a high level and low level at the same time is not permitted!

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Value	Information
0	0	Input 11 high level disabled
	1	Input 11 high level enabled for comparator
1	0	Input 12 high level disabled
	1	Input 12 high level enabled for comparator
2	0	Input 13 high level disabled
	1	Input 13 high level enabled for comparator
3	0	Input 14 high level disabled
	1	Input 14 high level enabled for comparator
4	0	Input 11 low level disabled
	1	Input 11 low level enabled for comparator
5	0	Input 12 low level disabled
	1	Input 12 low level enabled for comparator
6	0	Input 13 low level disabled
	1	Input 13 low level enabled for comparator
7	0	Input 14 low level disabled
	1	Input 14 low level enabled for comparator

16.4.3.4 Clear counter value and enable/disable latch function

Name:
Counter01Reset
Counter02Reset
Latch01Enable
Latch02Enable

These registers clear the counter value or start the latch procedure based on the corresponding bit.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	Counter0xReset	0	Do not clear the counter value
		1	Clear the counter value
1	Latch0xEnable	0	Do not latch the counter value
		1	Latch the counter value
2 - 7	Reserved	0	

16.4.3.5 Counter value

Name:
Counter01Value
Counter02Value

The current counter values are saved in these registers.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Current counter value

16.4.3.6 Latched counter value

Name:
Counter01Latch
Counter02Latch

As soon as the latch conditions have been met, the contents of the respective counter value are copied to these registers.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Latched counter value

16.4.3.7 Counter value of latch events

Name:
Latch01Count
Latch02Count

The counter value of the latch events that have occurred is stored in these registers. This allows detection of whether a new latched counter value has been saved.

Data type	Values	Information
SINT	-128 to 127	Running counter: Number of detected latch events

16.4.3.8 Timestamp of last counter change

Name:
Counter01TimeChanged
Counter02TimeChanged

The controller system time at the time of the last change to the counter value is saved in these registers.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	The controller system time at the time of the last change to the counter value

16.4.3.9 Timestamp of last valid counter value

Name:
Counter01TimeValid
Counter02TimeValid

The controller system time at the time of the last valid counter value is saved in these registers.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Controller system time of current counter value

16.5 Register overview of the I/O data points on the integrated X3 I/O slot

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
X3 - Configuration						
10240	X3CfO_DI_Filter	USINT				•
10752	X3CfO_Mov01Mode	USINT				•
10756	X3CfO_Mov01SpeedLimit	UDINT				•
10768	X3CfO_Mov02Mode	USINT				•
10772	X3CfO_Mov02SpeedLimit	UDINT				•
12032	X3CfO_PhyIOConfigCh01	USINT				•
12033	X3CfO_PhyIOConfigCh02	USINT				•
12034	X3CfO_PhyIOConfigCh03	USINT				•
12035	X3CfO_PhyIOConfigCh04	USINT				•
12036	X3CfO_PhyIOConfigCh05	USINT				•
12037	X3CfO_PhyIOConfigCh06	USINT				•
12038	X3CfO_PhyIOConfigCh07	USINT				•
12039	X3CfO_PhyIOConfigCh08	USINT				•
12040	X3CfO_PhyIOConfigCh09	USINT				•
12041	X3CfO_PhyIOConfigCh10	USINT				•
12042	X3CfO_PhyIOConfigCh11	USINT				•
12043	X3CfO_PhyIOConfigCh12	USINT				•
X3 - Communication						
8192	Digital inputs	USINT	•			
	DigitalInput05	Bit 0				
	DigitalInput06	Bit 1				
	DigitalInput07	Bit 2				
	DigitalInput08	Bit 3				
8208	Digital outputs	USINT			•	
	DigitalOutput01	Bit 0				
	DigitalOutput02	Bit 1				
	DigitalOutput03	Bit 2				
	DigitalOutput04	Bit 3				
	DigitalOutput05	Bit 4				
	DigitalOutput06	Bit 5				
	DigitalOutput07	Bit 6				
	DigitalOutput08	Bit 7				
8209	Digital outputs	USINT			•	
	DigitalOutput09	Bit 0				
	DigitalOutput10	Bit 1				
	DigitalOutput11	Bit 2				
	DigitalOutput12	Bit 3				
8193	Status feedback	USINT	•			
	StatusDigitalOutput01	Bit 0				
	StatusDigitalOutput02	Bit 1				
	StatusDigitalOutput03	Bit 2				
	StatusDigitalOutput04	Bit 3				
	StatusDigitalOutput05	Bit 4				
	StatusDigitalOutput06	Bit 5				
	StatusDigitalOutput07	Bit 6				
	StatusDigitalOutput08	Bit 7				
8194	Status feedback	USINT	•			
	StatusDigitalOutput09	Bit 0				
	StatusDigitalOutput10	Bit 1				
	StatusDigitalOutput11	Bit 2				
	StatusDigitalOutput12	Bit 3				
4864	PWMPeriod09	UINT			•	
4866	PWMOutput09	INT			•	
4880	PWMPeriod10	UINT			•	
4882	PWMOutput10	INT			•	
4896	PWMPeriod11	UINT			•	
4898	PWMOutput11	INT			•	
4912	PWMPeriod12	UINT			•	
4914	PWMOutput12	INT			•	
8704	Movement 1	USINT			•	
	Mov01Enable	Bit 1				
8706	Mov01Speed	INT			•	
8708	Mov01Position	DINT	•			
8720	Movement 2	USINT			•	
	Mov02Enable	Bit 2				
8722	Mov02Speed	INT			•	
8724	Mov02Position	DINT	•			
8196	StatusInput01	BOOL	•			

16.5.1 Physical configuration of I/O channels

These registers are used to define the functionality of the channels. Depending on the desired configuration, the following assignments can be made with respect to the existing software and hardware:

- A physical configuration as input or output for mixed channels
- An explicit assignment as direct I/O channel: i.e. digital input or digital output
- An explicit assignment as PWM output
- An explicit assignment as D or F movement output

16.5.1.1 Physical configuration

Name:
X3CfO_PhyIOConfigCh01 to X3CfO_PhyIOConfigCh12

These registers are used to configure the functionality of the channels.

Data type	Values
USINT	See the bit structure.

Bit structure:

Name:
X3CfO_PhyIOConfigCh01 to X3CfO_PhyIOConfigCh04

Channels 1 to 4 are digital outputs and can only be used as direct I/O channel.

Bit	Description	Value	Information
0 - 7		0	Direct I/O operation of output

Name:
X3CfO_PhyIOConfigCh05 to X3CfO_PhyIOConfigCh08

Channels 5 to 8 are digital mixed channels and can be configured as either input or output.

Bit	Description	Value	Information
0 - 1		00	Configured as digital output
		01	Reserved
		10	Reserved
		11	Configured as digital input
2 - 7		0	Direct I/O operation of output

Name:
X3CfO_PhyIOConfigCh09 to X3CfO_PhyIOConfigCh12

Channels 9 to 12 are high-speed digital outputs and can be configured as direct I/O, PWM or movement channels.

Bit	Description	Value	Information
0 - 3	Reserved	0	
4 - 5		00	Direct I/O operation of output
		01	Output operated as PWM
		10	Reserved
		11	Output operated as D/F movement
6 - 7	Reserved	0	

16.5.2 Monitoring of the I/O power supply voltage

Name:
StatusInput01

The state of the I/O supply voltage is indicated in this register.

Data type	Values	Information
USINT	0	I/O power supply voltage within permissible range
	1	I/O power supply voltage not connected or outside of the permissible range

16.5.3 Digital inputs

Unfiltered

The input state is recorded in a 100 µs cycle.

Filtered

The filtered state is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

16.5.3.1 Digital input filter

Name:
X3CfO_DI_Filter

The filter value for all digital inputs can be configured in this register.

The filter value can be configured in steps of 100 µs.

Data type	Values	Filter
USINT	0	No software filter
	1	0.1 ms
	...	...
	250	25 ms - Higher values are limited to this value.

16.5.3.2 Input state of digital inputs 5 to 8

Name:
DigitalInput05 to DigitalInput08

This register contains the input state of digital inputs 5 to 8.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Name	Value	Information
0	DigitalInput05	0 or 1	Input status of digital input 5
...		...	
3	DigitalInput08	0 or 1	Input status of digital input 8

16.5.4 Digital outputs

The output state is processed internally in a 100 µs cycle.

16.5.4.1 Switching state of digital outputs 1 to 12

Name:
DigitalOutput01 to DigitalOutput12

These registers are used to store the switching state of digital outputs 1 to 12.

Data type	Values
USINT	See the bit structure.

Bit structure:

Register 8208:

Bit	Description	Value	Information
0	DigitalOutput01	0	Digital output 1 reset
		1	Digital output 1 set
...		...	
7	DigitalOutput08	0	Digital output 8 reset
		1	Digital output 8 set

Register 8209:

Bit	Description	Value	Information
0	DigitalOutput09	0	Digital output 9 reset
		1	Digital output 9 set
...		...	
3	DigitalOutput12	0	Digital output 12 reset
		1	Digital output 12 set

16.5.5 Monitoring status of the digital outputs

The error states of the outputs must be programmed in the application. The status information that is read is the actual voltage state on the channel (set or reset). The error state is therefore determined by a difference between the data points "DigitalOutputxx" and the corresponding "StatusDigitalOutputxx".

At least 3 system ticks are needed internally to read the output status. This is the reason for the delay after which the earliest possible comparison is permitted to be made after a change in the status of the output.

The digital input filter is not applied to this status information.

16.5.5.1 Status of digital outputs 1 to 12

Name:
StatusDigitalOutput01 to StatusDigitalOutput12

These registers contain the state of digital outputs 1 to 12.

Data type	Values
USINT	See the bit structure.

Bit structure:

Register 8193:

Bit	Description	Value	Information
0	StatusDigitalOutput01	0	Channel 1: Digital output reset or short circuit
		1	Channel 1: Digital output set or voltage feedback
...		...	
7	StatusDigitalOutput08	0	Channel 8: Digital output reset or short circuit
		1	Channel 8: Digital output set or voltage feedback

Register 8194:

Bit	Description	Value	Information
0	StatusDigitalOutput09	0	Channel 9: Digital output reset or short circuit
		1	Channel 9: Digital output set or voltage feedback
...		...	
3	StatusDigitalOutput12	0	Channel 12: Digital output reset or short circuit
		1	Channel 12: Digital output set or voltage feedback

16.5.6 Pulse width modulation (PWM) function

Digital inputs 9 to 12 can be configured as PWM outputs. 2 data points are available per channel for controlling the PWM signal.

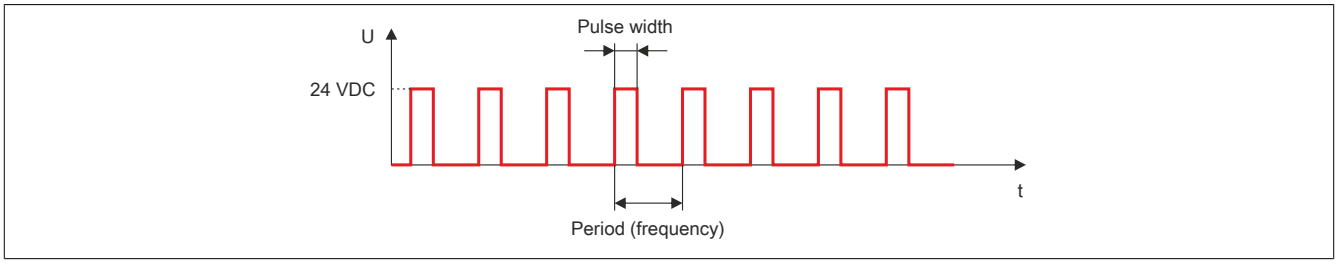


Figure 28: The PWM signal is controlled by setting the pulse width and period duration.

16.5.6.1 Period duration of the PWM outputs

Name:
PWMPeriod09 to PWMPeriod12

These registers define the period duration, i.e. the time base for the respective PWM output. This time represents the 100% value, which can be incremented in 0.1% steps through the duty cycle.

Data type	Values	Information
UINT	5 to 65535	Period duration from 5 to 65535 µs: Corresponds to a frequency from 200 kHz to ≈15 Hz

16.5.6.2 Duty cycle of the PWM outputs

Name:
PWMOutput09 to PWMOutput12

The ratio of the duty cycle of the respective PWM output in relation to the period duration is set in these registers with a resolution of 0.1%.

Data type	Values	Information
INT	0 to 1000	Duty cycle of the output in 0 to 100.0%

Example: Period duration T [µs] with a duty cycle of 25% corresponds to switch-on time t_1 [µs].

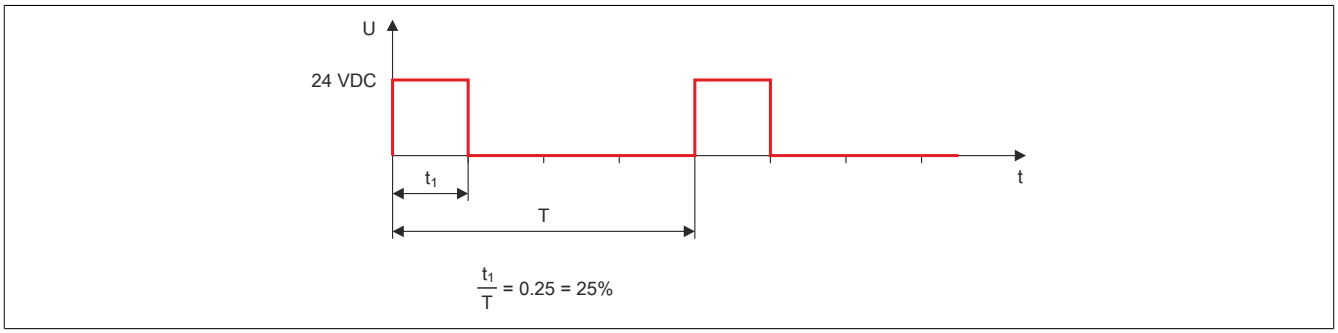


Figure 29: Switch-on time depending on the period duration and duty cycle

16.5.7 DF movement generator function

Digital output channels 9 to 12 can be configured as 2 independently functioning movement generators (Direction/Frequency) for stepper motor control. The movement generators are assigned to the following channels:

Movement generator	Channel	Function
1	DO 9	D: Direction
	DO 10	F: Frequency
2	DO 11	D: Direction
	DO 12	F: Frequency

The frequency is output via the respective F channel, and the direction is output via the respective D channel. The switchover between directions (movement/counter) takes place via the sign of the speed setpoint.

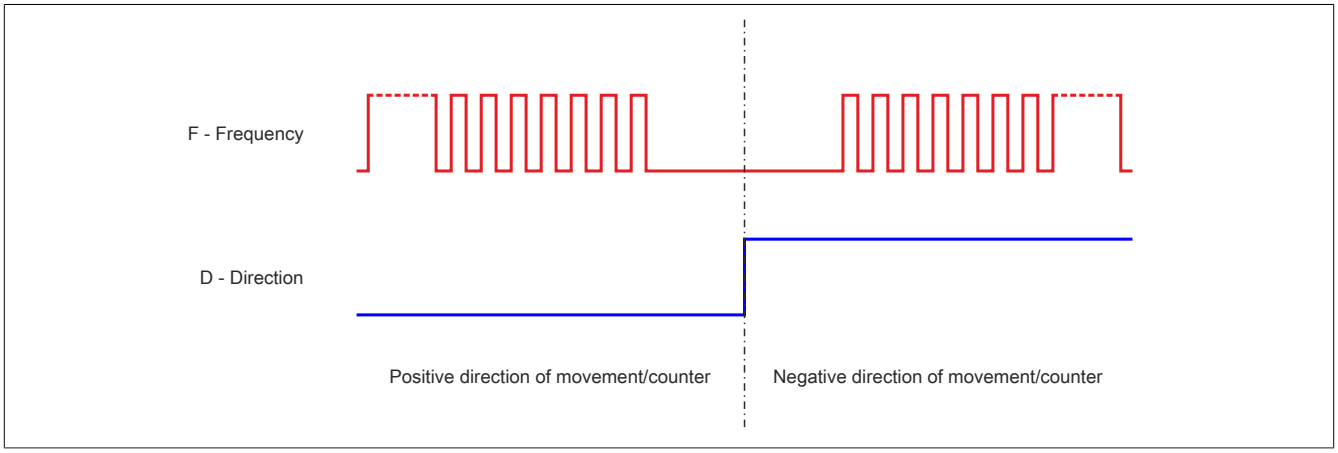


Figure 30: Frequency output via F channel, direction output via D channel

The respective output must be configured correctly in order to completely process the motion function (see "Physical configuration" on page 50).

The data points described below are available for configuring and controlling the respective movements.

16.5.7.1 Configuring the movement mode

Name:
X3Cfo_Mov01Mode
X3Cfo_Mov02Mode

These registers are used to configure how the speed setpoint is interpreted. The difference between the two modes is whether edges or periods are output for each increment of the setpoint.

Data type	Values	Information
USINT	0	Edge mode: Each increment generates an edge on the output.
	1	Pulse mode: Each increment generates a period on the output.

Edge mode

4 increments of the speed setpoint correspond to 2 periods on the output:

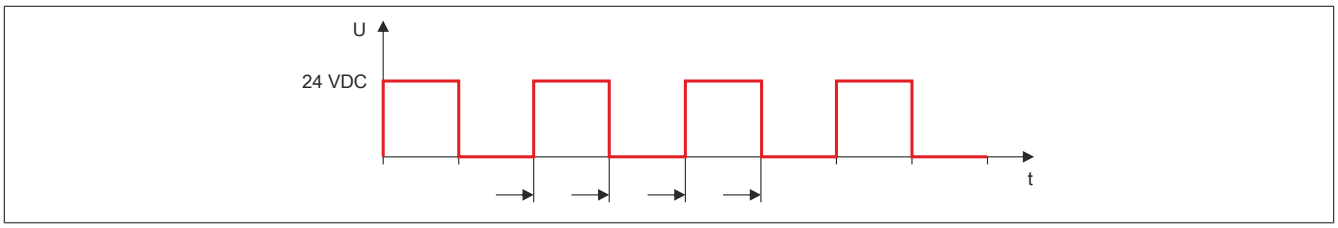


Figure 31: Interpretation of the speed setpoint with edge output for each increment

Pulse mode

2 increments of the speed setpoint correspond to 2 periods on the output:

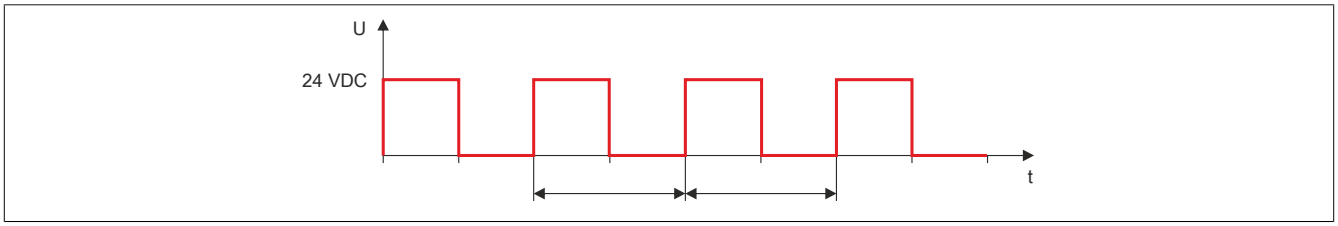


Figure 32: Interpretation of the speed setpoint with period output for each increment

16.5.7.2 Configuring the maximum speed of the movement

The maximum speed or output frequency of the movement is configured in order to protect the digital output, the actuator/drive being controlled and/or the mechanical system.

Name:
X3Cfo_Mov01SpeedLimit
X3Cfo_Mov02SpeedLimit

These registers are used to configure the maximum speed / output frequency permitted in the system. It is important that the limit values for edge and pulse mode are different.

Edge mode

Data type	Values	Information
UDINT	10 to 400000	Speed [increments per second]

Pulse mode

Data type	Values	Information
UDINT	5 to 200000	Speed [increments per second]

16.5.7.3 Activates the movement

When a movement is active, the two channels are operated according to the preset values.

Name:
Mov01Enable
Mov02Enable

These registers are used to enable or disable the motion function.

Mov01Enable

Data type	Values	Information
USINT	0	Movement 1 disabled
	2	Movement 1 enabled: The speed setpoint is being evaluated.

Mov02Enable

Data type	Values	Information
USINT	0	Movement 2 disabled
	4	Movement 2 enabled: The speed setpoint is being evaluated.

16.5.7.4 Speed and direction control of the movement

The following parameters are important for speed and direction control of the movement:

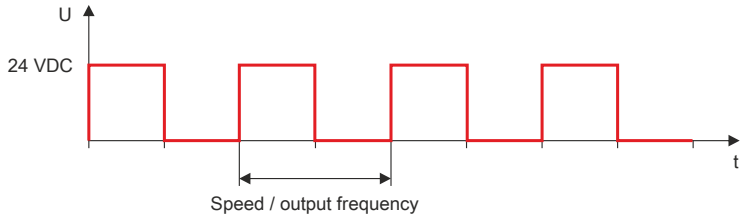
Characteristic value	Description
Speed control	The speed setpoint is specified as a percentage of the configured maximum speed: 0 to ±32767 correspond to 0 to ±100% of the configured maximum speed
Direction control	The direction of movement is defined by the sign of the speed setpoint: 0 to +32767 correspond to 0 to the maximum speed in the positive direction of movement 0 to -32767 correspond to 0 to the maximum speed in the negative direction of movement
Resolution of the speed setpoint	The resolution of the speed setpoint is: Maximum speed / 32767
Ratio: Speed / Frequency	The relationship between speed and output frequency is: (Speed setpoint / Maximum speed) * 32767 

Table 11: Parameters for speed and direction control of the movement

Name:
Mov01Speed
Mov02Speed

These registers are used to set the speed of the movement.

Data type	Values	Information
INT	0 to 32767	Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed
		Positive direction of movement: Movement output D = 0
	0 to -32767	Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed
		Negative direction of movement: Movement output D = 1

16.5.7.5 Position feedback for movement

The position feedback is represented by a fixed point value [16.16]:

- HighWord = Whole number increments
- LowWord = Positions after the decimal of the increments

Name:
Mov01Position
Mov02Position

These registers show the current position of the movement.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Position value in fixed point format [16.16]