Installation Manual

English

SMX series
SMX Compact 2. Generation

Read and obverse installation manual before initial commissioning/ integration of the module!

Observe safety instructions!

Keep for future use!

Installation manual for SMX series devices
SMX Compact of the 2. Generation (SMXGen2)

Status: 08/2021

Valid from FW-Release: 05.00.00.01

INFORMATION

The German version is the original version of the installation manual.

- Contact the manufacturer immediately if the instructions are missing!
- Always keep the manual at hand!
- Make sure that the manual is complete!
- Obtain this document only through the original publisher!

Subject to technical changes!

The content of this documentation has been compiled with the most carefulness, and corresponds to our current state of information.

Nevertheless, we point out that the technical update of this documentation cannot always be carried out simultaneously with the technical evolution of our products.

Information and specifications can always be changed. For the current version, please refer to www.bbh-products.de.

Manufacturer BBH Products

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NOTICE:

The documentation (installation manual, programming manual) is freely available via the online download from BBH Products.

1 Contents

1. General information

1.1. Identification

Basic modules of the SMX10/2 series - SMXGen2 Version (/2)

- SMX 10A/2 (/x(1))
- SMX 10R/2 (/x(1))
- SMX10 HI (/x(1))
- SMX 11/2 (/x(1)),
- SMX11 HI (/x(1))
- SMX11-PXV/2 (/x(1))
- SMX11-WCS/2 (/x(1))
- SMX11-2/2 (/x(1))
- SMX12/2 (/x(1))
- SMX 12A/2 (/x(1))
- SMX12-1-PXV/2 (/x(1))
- SMX 12-2/2 (/x(1))
- SMX 12-2A/2(/x(1))

and its extension modules

- SMX 31/2
- SMX 31R/2
- SMX 31R-4/2
- SMX 32-0/2/D
- SMX 32-0R/2/D
- SMX 32-1/2/D
- SMX 32-1R/2/D

(1) *Characteristic, see: „Optional integrated communication* interface"

Options:

/x - Universal communication interface
/D - Decentral extensopn module Erweiterungsmodul
A - Safe, analog inputs
R - Relay

Firmware version: *The firmware version is noted on the device type plate.*

Hardware version: *The hardware version is indicated on the device type plate.*

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1.2. Important information of use

The documentation is part of the product and contains important information on the integration of the module into devices as well as on their operation and service. The programming and parameterization of the devices are described in the programming manual. Their exact knowledge and understanding is a mandatory prerequisite for installation or modification of the device function or device parameters.

The documentation is intended for all persons involved in integration and installation planning and who perform assembly, installation, commissioning and service work on the product.

The documentation must be made available to this group of persons in a legible condition.

Make sure that the persons responsible for planning and integration, plant and operation, as well as persons who work with the modules under their own responsibility, have read and understood the documentation in full.

In case of ambiguities or further information requirements, please contact BBH Products GmbH.

1.3. Warranty claims

Compliance with the following documentation is a prerequisite for trouble-free operation and the fulfillment of any warranty claims. Therefore, read the documentation first before you start planning the integration and/or work with the connected devices from BBH Products GmbH!

Make sure that the documentation is made available in a legible condition to integration and installation planners, employees and persons who carry out assembly, installation, commissioning and service work on the product, to persons responsible for the system and its operation, and to persons who work on the devices under their own responsibility.

1.4. Liability exclusion

Observance of this documentation and the documentation on the connected devices from BBH Products GmbH is a basic prerequisite for safe operation and for achieving the specified product properties and performance characteristics.

BBH Products GmbH assumes no liability for personal injury, property damage or financial loss resulting from non-observance of the documentation.

Liability for material defects is excluded in such cases.

1.5. Copyright

1.6. Definitions

The designation SMX is used as generic term for all derivatives from the SMX product range. Wherever this description refers to a certain derivative, the complete designation is used.

The term **"safe"** used in the following text in any case refers to the classification as a safe function for application up to Pl e acc. to EN ISO 13849-1 or SIL3 acc. to IEC 61508.

The system software "**Safe PLC²"** serves the purpose of configuring and programming SMX modules.

The modules of the SMXGen2 series are internally built up of two independent processing units. In the following these are referred to as system A and system B.

1.7. Supplied documents

Description	***Reference***
Configuration of the SMX module for stand-alone applications without field-bus interfacing with the program "SafePLC2"	HB-37480-820-01-xxF-EN Programming manual SafePLC2.pdf (System CD)
Validation report for implemented parameterization and PLC-program	Safety inspection with acceptance protocol
Acceptance for general safety relevant applications	Certificate for type approval test as safety control acc. to machine guideline 2006/42/EG for the product groups **SMXGen2** SMX10/2 (/x[(1)]) SMX10A/2 (/x[(1)]) SMX10R/2 (/x[(1)]) SMX10 HI (/x[(1)]) SMX11/2 (/x[(1)]) SMX11 HI (/x[(1)]) SMX11-PXV/2 (/x[(1)]) SMX11-WCS/2 (/x[(1)]) SMX11-2/2 (/x[(1)]) SMX12/2 (/x[(1)]) SMX12-1-PXV/2 (/x[(1)]) SMX12-2/2 (/x[(1)]) SMX12-2A/2 (/x[(1)]) SMX12A/2 (/x[(1)]) SMX31/2 SMX31R/2 SMX31R-4/2
Acceptance for applications in the elevator technology (validity range EN 81)	Certificate for type approval test as PESSRAL acc. to EN 81-20/-50 resp. EN 81-1/-2 for the product groups SMX10P SMX11P

Options:

/x - Universal communication interface
/D - Decentral expansion module
A - Secure, analog inputs
R - Relays

(1) Specifications; see: „Optional integrated communication interface"

NOTICE:

- Thoroughly read the manuals before you start the installation and the commissioning of the SMX module.
- Paying attention to the documentation is a prerequisite for trouble-free operation and fulfilment of possible warranty claims.
  For PXV variants of the SMX assemblies, the following also applies “TS-37000-410-01-810-01-xxF SMX-x-PXV Installationshandbuch.pdf”

1.8. Abbreviations used

Abbreviation	*Meaning*
AC	Alternating voltage
AWL (IL)	Instruction list
ELIA	Employer's liability insurance association
CLK	Clock (cycle)
CPU	Central Processing Unit
DC	Direct voltage
I1..I14	Digital Input
DIN	Deutsches Institut für Normung (German Institut for Standardization)
DO	Digital Output
EMU	Emergency Monitoring Unit
EMC	Electromagnetic compatibility
ELC	Emergency Limit Control
EN	European Standard
HISIDE	Output with 24VDC nominal level switching to plus
IP20	Protection type for housing
ISO	International Organisation for Standardisation
LED	Light Emitting Diode
LOSIDE	Output switching to reference potential
OLC	Operational Limit Control
PAA (PIA)	Process image of outputs
PAE (PII)	Process image of inputs
T1,T2	Pulse-/ Cycle outputs
PESSRAL	Programmable electronic system in safety related applications for elevators
PLC	Programmable Logic Controller
POR	Power on Reset
PSC	Position Supervision Control
SELV	Safety Extra Low Voltage
SRP/CS	Safety-Related Parts of Control System
SSI	Synchronous Serial Interface
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik e. V.
SDDC	Safe Device-Device Communication
SMMC	Safe Master-Master Communication
SSI	Synchronous Serial Interface

Abbreviation	*Meaning*
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik e. V. (association for electrical engineering, electronics and information technology)
x.y(1)	Auxiliary Output
G.P.	General purpose (General use)

(1) Module address x = 0 ….. 2

Channel address y = 1 ….. 40

2 Safety regulations

2.1 Intended use

The devices of the SMX10/11/12 series of the 2nd generation (SMXGen2) are programmable safety controllers for the production of safety cut-offs and functions. The devices are intended for usein Emergency stop devices,

- as safety related components according to Machine Directive 2006/42/EG,,
- as PES for zur risk reduction according to IEC 61508,
- in safety circuits EN 60204-1 u. EN 60204-32,
- as PES for functional safety according to IEC 62061,
- als SRP/CS im Sinne der EN ISO 13849-1,
- as device for the manufacturing of security devices according to EN 61800-5-2,
- as logic units for signal conversion and for signal processing in two hand controls according to EN 574.

The SMX10/P and SMX11/P devices are suitable for use as PESSRAL (programmable electronic system in safety-related applications for elevators) in elevator technology, i.e. within the scope of EN 81-20/-50 or EN 81-1/-2. Devices from the basic series without the suffix "/P" cannot be used in this area of application!

WARNING

Devices of the basic series without the suffix "/P" cannot be used in the area of application of EN 81-20/-50 or EN 81-1/-2!

CE

The devices in the SMX 10/11/12 series, including the SMX 3x expansion module, are safety components in accordance with Annex IV of the EC Machinery Directive 2006/42/EC.

They have been developed, designed and manufactured in accordance with the above-mentioned directive and the EC EMC Directive 2014/30/EU.

Cf. Appendix B – EC declaration

2.2 Use in regions with UL/CSA requierments

The **SMXGen2** series has **cULus approval** in accordance with the following standards::

Base standard(s):	UL 61010-1, 3rd Edition, May 11, 2012, Revised July 15 2015, CAN/CSAC22.2 No. 61010-1-12, 3rd Edition, Revision dated July 2015
Additional Standards:	UL/CSA 61010-2-201: 2014 (First Edition)

2.3 General safety information

SAFETY NOTICE:

- In order to avoid damage to persons and property only qualified personnel is entitled to work on the device. The term qualified personnel refers to persons who have successfully completed electrotechnical training and are fully familiar with the applicable rules and standards of electrical engineering.

  The qualified person must become familiar with the operating instructions (see IEC 364, DIN VDE 0100).

- The qualified must have profound knowledge of the national accident prevention regulations.
- The use of the device must be strictly limited to the intended use as specified in the following list. The values of data listed under section "3.2 Characteristic data of devices" must also be observed.
- The contents of this installation manual is restricted to the basic function of the device or its installation. The "Programming instructions SMX10/11/ 12 contains a more detailed description of the programming and re-parameterization of the devices. Exact knowledge and understanding of these instructions is mandatory for a new installation or modification of device functions or device parameters.
- Commissioning (i.e. starting up the intended operation) is only permitted in strict compliance with the EMC-directive. The EMC-testing regulations EN 55011:2009 + A2:2010 and EN 61000-6-2:2005 are used as basis.
- Compliance with the conditions acc. to IEC 60068-2-6 related to the values specified under "Technical characteristics" is mandatory for storage and transport
- The wiring and connecting instructions in chapter "Installation" must be strictly followed.
- The applicable VDE-regulations and other special safety regulations of relevance for the application must be strictly followed.
- Evidence of the configured monitoring functions as well as their parameters and links must be issued by means of a validation report.
- The implementation of the module must be coordinated with the demands of the responsible acceptance testing authority (e.g. TÜV or ELIA).
- Do not install or operate damaged products. Report damages immediately to the responsible forwarding agent.
- Never open the housing and/or make unauthorized conversions.
- Inputs and outputs for standard functions or digital and analog data transmitted via communication modules must not be used for safety relevant applications.

WARNING **Danger due to improper handling!!**

Use of our devices contrary to the rules and conditions listed here may result in injury or death to persons and damage to connected devices and machines!

This also leads to the loss of any warranty or compensation claims against the manufacturer.

2.4 Transport/Storage

The information concerning transport, storage and appropriate handling must be observed.

The climatic conditions indicated in the chapter "Characteristic data of deviceseinzuhalten.

2.5 Electrical connection

When working on live appliances, the applicable national accident prevention regulations (e.g. BGV A3) must be observed.

The electrical installation must be carried out in accordance with the relevant regulations (e.g. cable cross-sections, fuses, protective conductor connection). Additional instructions are contained in the documentation.

Instructions for EMC-compliant installation - such as shielding, earthing, arrangement of filters and routing of cables - can be found in the documentation. Compliance with the limit values required by EMC legislation is the responsibility of the manufacturer of the system or machine.

Protective measures and protective devices must comply with the applicable regulations (e.g. EN 60204-1).

WARNING **Personal danger due to electric shock!**

Only supply the device from voltage sources with safety extra-low voltage (e.g. SELV or PELV in accordance with EN 61131-2)

If a SELV voltage source is used, it may become PELV due to the design of the module and the connections (earth leakage!).

Protective extra-low voltage circuits must always be safely isolated from circuits with dangerous voltages.

CAUTION **Fire hazard in the event of component failure**

Ensure that the 24 V DC power supply of the control system is adequately protected in the end application! (Information on this can be found in the Power supply section).

2.6 ESD information

Electronic components are generally at risk from electrostatic discharge (ESD).

Electrostatic discharge can occur during any moving activity.

Electrostatic discharge can occur during any moving activity.

ESD can occur with every touch.

Most discharges are so small that they are not perceived. However, they can still endanger or destroy unprotected electronic components. Therefore, any handling of open electronics is generally only under effective ESD protection.

Observe the following ESD measures when handling **open** electronics:

- Only touch open electronics if absolutely necessary. Only touch open components at the edge of the circuit board.
- Apply dissipative ESD wrist strap.
- Use a dissipative work surface.
- Establish a conductive connection between the device/system, carpet pad, wrist strap and earth connection.
- Prefer cotton work clothing to synthetic fiber materials.
- Keep the work area free of highly insulating materials (e.g. polystyrene, plastics, nylon, ...).
- Keep the devices in their original packaging and only remove them immediately before installation
- Also use ESD protection for defective assemblies.

CAUTION

Electrostatic discharge

Destruction of electrical components. Minor health hazard

Observe the ESD instructions.

2.7 Operation and service

The module must always be de-energized before installation and removal, or before disconnecting signal lines. For this purpose all live supply lines to the device must be checked for safe isolation from supply.

The fact that the operation LED and other display elements go out is not a sufficient indicator that the appliance has been disconnected from the mains and is de-energized.

When installing or removing the module appropriate measures must be applied to prevent electrostatic discharge to the externally arranged terminal and plug connections. Contact with such terminals should be reduced to a minimum and earthing should by means of e.g. an earthing strap should take place before and during these procedures.

3 Device types

The series SMX10/11/12 (SMXGen2) consists of

- Basic devices SMX10/2, SMX11/2 and SMX12/2
    - optional with integrated communication interface with standard or safe fieldbus SMXxx-x/2(/x)
- and expansion modules SMX3x/2

The following device types are available as SMXGen2:

Basic devices	**Expansion modules**
SMX10/2	SMX31/2
SMX10A/2	SMX31R/2
SMX10R/2	SMX31R-4/2
SMX10 HI	
SMX11/2	
SMX11 HI	
SMX11-2/2	
SMX11-PXV/2	
SMX11-WCS/2	
SMX12/2	
SMX12A/2	
SMX12-1-PXV/2	
SMX12-2/2	
SMX12-2A/2	

NOTICE **An exception exists with SMX10 HI and SMX11 HI these correspond to 1:1 of SMX10/2 and SMX11/2!!!**

NOTICE The following functions are not supported with firmware release **05.00.04.19**:

- Expansion modules SMX3x
- FastChannel
- DEM – Dynamic-Encoder-Muting
- SMF – Safe-Matrix-Function

Basic devices

The 2nd generation SMX10/11/12 series (SMXGen2) is a compact safety controller with optional integrated drive monitoring for one (SMX11/2, SMX11-2/2) or two (SMX12/2, SMX12-2/2) axes. The device is freely programmable for the safe processing of EMERGENCY-STOP button, two-hand operation, light curtains, operating mode selector switches, etc. as well as drive-related safety functions. Preconfigured modules are available for safety-related signal pre-processing for a large number of input devices. The same applies to safety functions for drive monitoring. Details can be found in the programming manual.

The basic version of the device has 14 safe inputs and up to 5 safe cut-off channels.

Single encoder solutions as well as two encoder solutions are supported for reliable speed and/or position detection. See „Encoder specifications".

NOTICE The following safety controllers are available for special system:

- SMX11-PXV/2: with 1 safePXV encoder interface; for safe position monitoring for barcode-based positioning system
- SMX11-WCS/2: with 2 WCS encoder interfaces; for position and speed monitoring for WCS position coding system

Expansion modules

Various central I/O extensions can be combined with the basic devices in the series. A maximum of 2 extension modules can be used in total.

Integrated communication interface

The communication interface has a bi-directional data transfer from and to a subordinate control via standard field bus or secure standard field bus.

Labeling of the 2nd generation devices

The distinguishing of the device types takes place through the SMXGen2 characterization (/2).
(e.g.: SMX10 = SMXGen1
SMX10/2 = SMXGen2)

The following characteristics distinguish the two versions:

- Switchable outputs on the base devices; See technical data.
- Higher nominal loads of the outputs on the base devices. See technical data.
- Higher nominal loads of the outputs on the I/O expansion modules See technical data.
- Optional expansion possibility via „universal communication module";
- See „Optional integrated communication interface"

3.1 Module overview

Base units				Expansion units
Designation	SMX10/2, SMX10A/2, SMX10R/2, (/x [1])	SMX11/2, SMX11-2/2 SMX11-PXV/2[2)] SMX11-WCS/2 [2)] (/x[1])	SMX12/2, SMX12A/2, SMX12-1-PXV/2, SMX12-2/2, SMX12-2A/2 (/x[1])	SMX31/2, SMX31R/2, SMX31R-4/2
				
Max. no. of expansion modules	2*	2*	2*	-
Safe digital inputs	14	14	14	12
Safe digital I/O	-	-	-	10/2/6
Safe digital outputs pn-switching / pp-switching	2, 4	2, 4	2, 4	-/-
Safe analog inputs	-, 2, -	-	-, 2,-, -, 2	-
Relay outputs	2, 2, 6	2	2	-, 8, 6
Auxiliary outputs	2	2	2	2
Pulse outputs	2	2	2	2
Integrated communication interface	**Optional:(/x[1])** PROFIBUS-PROFIsafe, PROFINET-PROFIsafe, FSoE Failsafe-over-EtherCAT, CANopen, EtherNet/IP, Modbus TCP/IP, DeviceNet			-
Axis monitoring	-	1	2	-
Encoder technology [3]	-	SSI SIN/COS Inkr. TTL Proxi Resolver Inkr. HTL	SSI SIN/COS Inkr. TTL Proxi Resolver Inkr. HTL	-

(1) (1) Characteristics, see: „Optional integrated communication interface“
(2) Encoder technology: especially for the respective supported positioning system
(3) See also: 3.2.4 “Encoder specifications”

3.2 Characteristic data of devices

3.2.1 Basic modules

3.2.1.1 SMX10/2, SMX10A/2, SMX10R/2 (/x(1))

Type designation	***Device design***
	Design of module with the following periphery: 14 Digital inputs 2 Pulse outputs 2 Relay outputs (6x SMX10R/2) 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 2 Analog inputs (SMX10A/2, SMX10A/2) 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/Os,
  - max. 11 safe relay otputs,
  - max. 10 Auxiliary outputs
- Logic processing up to PL e acc. to EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Freely programmable compact controller for up to 800 IL instructions
- Function plan-oriented programminging
- Pulse outputs fror cross-circuit detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Monitored relay outputs for safety-related functions
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Parameter management for expansion modules in base device
- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs
- Multifunction buttons (quit, start, reset) can be operated from the front side
- Optional: Communication interface
  - Standard and safe fieldbus protocoll for communication with a higher level controller
  - Safe cross communication (SMMC) for data exchange between multiple base devices
  - Safe remote IO communication for data exchange with distributed I/O systems

see: chapter 3.2.3.1 “Optional integrated communication interface”

- Assembly on top hat rail
- SMX 10A/2 (Analog) – with 2 safe analog inputs
- SMX 10R/2 (Relay) – with total 6 relay outputs and no pn-, pp-switching outputs
- Relay outputs and no pn-, pp-switching outputs
- The mechanical construction of the SMX10/2, SMX10A/2, SMX10R/2(/x[1]) depends on the respective specification of the base module (see mechanical data)

Technical characteristic data SMX10/2, SMX10A/2, SMX10R/2 (/x[1])

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4 Plus with SMX10R 1-channel per Rel 20 FIT (max. 4) 2-channel per Rel 1,0 FIT (max. 2)	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operation period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
	pn-switching **	SMX10x/2	2	
		SMX10R/2/x	-	
	pp-switching **	SMX10x/2	4	
		SMX10R/2/x	-	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
		SMX10R	6	
	Number of safe analogue inputs		-	
		SMX10A/x	2 *	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Max. Anzahl Erweiterungsbaugruppen		2	
	Axis monitoring (axes / Encoder interfaces)		-/-	
	Encoder interfaces (D-Sub / screw terminals)		-	
Electrical data				
	Supply voltage (Tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	min. 30 VDC; max. 3,15A	
		X11.2	min. 30 VDC; max. 10A	
	Max. Power consumption (Logic)			
		SMX10x/2	3,1W	
		SMX10x/2/x	6,5W	
	Rated data digital inputs		24 VDC; 20 mA Type 1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
		Normally closed DC13 (Read back contact)	24 VDC; 2A	
	Rated data safe analaogue inputs			
		SMX10A/2 SMX10AR	-10 … +10V 4 … 20 mA	
Electrical data (For UL only)				
	Related data digital outputs			
		pn-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)

		Max. total current (pn or pp)	8A
		Auxiliary outputs	24 VDC; 250mA (G.P.)
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)
		Normally closed (Read back contact)	24 VDC; 2A (Pilot Duty)
Environmental data			
	Temperature		0°C … +50°C operation -25°C … +70°C storage, transport
	Protection class		IP 20
	Climatic category		3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX10/2 = 100x115x45 SMX10A/2 = 100x115x67,5 SMX10R/2 = 100x115x67,5 SMX10/2, (/x(1)) = 100x115x67,5 SMX10A/2,(/x(1)) = 100x115x90 SMX10R/2, (/x(1))= 100x115x90
	Weight (g)		SMX10/2 = 300 SMX10A/2 = 380 SMX10R/2 = 420 SMX10/2, (/x(1)) = 400 SMX10/2, (/x(1)) = 480 SMX10R/2,(/x(1)) = 520
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX10/2	2
		SMX10A/2	3
		SMX10R/2	3
		SMX10/2, SMX10A/2, SMX10R/2 (/2, /x(1))	SMX10x/2 + 1
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) Analog current and voltage inputs optionally available
z.B.: SMX10A-U/2 Voltage inputs
SMX10A-I/2 Current inputs
SMX10A/2 Voltage and current inputs

(**) pn/pp via SafePLC² configurable

(***) Derating, see chapter „Derating Outputs“

(1) Specifications see: „Communication interface“

3.2.1.2 SMX11/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 1 Axis 3 Encoder interfaces 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O's,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs
  - max. 1 safe axis
- Logic processing up to PL e acc. to EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Movement monitoring of one axis up to Pl e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Speed monitoring
- RPM-monitoring
- Standstill monitoring
- Sense of rotation monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable compact controller for up to 800 IL instructions
- Function plan-oriented programming via SafePLC²
- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Monitored relay outputs for safety relevant functions
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Complete speed and position-based safety functions for drive monitoring in accordance with IEC 61800-5-2 are integrated in firmware
  - Spatial functions for safe speed and are monitoring are possible.
- Parameter management for expansion modules in base device
- Comprehensive diagnostics functions integrated

- Coded status display via front-side 7 segment display and status LEDs
- Multifunction buttons (quit, start, reset) can be operated from the front side
- Optional: universal communication interface
    - Standard and safe field bus protocols for communication with a higher level controller
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapterl 3.2.3.1 “Optional integrated communication interface”

- Assembly on top hat rail
- The mechanical structure of SMX11/2 (/x(1)) depends on the respective specification of the base module (see mechanical data)

Technical characteristic data SMX11/2 (/x[1])

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn- switching **	2	
		pp- switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (Axes / encoder interfaces		1 / 3 *	
	Encoder interfaces (D-Sub / screw terminals)		**D-SUB X31**: SSI, SinCos, Incremental-TTL **Terminal X23**: Incremental-HTL (10kHz)	
Electrical data				
	Supply voltage (Tolerance)		24 VDC; 2 A (-15%, +20%)	
	Fuse	X11.1	min. 30 VDC; 3,15 A	
		X11.2	min. 30 VDC; max. 10 A	
	Max. power consumption (Logic)			
		SMX11/2	3,1 W	
		SMX11/2/x	6,5 W	
	Rated data digital inputs		24 VDC; 20 mA Type 1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn- switching	24 VDC; 2A ***	
		pp- switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data safe analog inputs		-	
Electrical data (For UL only)				
	Rated data digital outputs			
		pn-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		pp- switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	24 VDC; 250mA (G.P.)	
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)	
Environmental data				
	Temperature		0°C … +50°C operation -25C° … +70C° storage, transport	

	Protection class		IP 20
	Climatic category		3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX11/2 = 100x115x45 SMX11/2 (/x(1)) = 100x115x67,5
	Weight (g)		SMX11/2 = 310 SMX11/2(/x(1)) = 410
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX11/2	2
		SMX11/2 (/x(1))	3
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp via SafePLC² configurable
(***) Derating, see chapter „Derating Outputs“
(1) Specifications, see: „Optional integrated communication interface“

3.2.1.3 SMX11-PXV/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 1 Axis 1 Encoder interface (safePXV) 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O's,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs
  - max. 1 safe axis
- Freely programmable for safe processing of emergency stop buttons, two-hand operation, light grids, mode switches, etc.
- Complete speed and position-based safety functions for drive monitoring in accordance with IEC 61800-5-2 are integrated in firmware
  - Spatial functions for safe speed and are monitoring are possible
- Safe position monitoring with just one sensor in combination with the optical read head PXV100AS-F200-R4-V19
- Logic processing up to PL e EN ISO 13849-1 or SIL 3 in accordance with IEC 61508
- Motion monitoring of an axis up to PL e EN ISO 13849-1 or SIL 3 in accordance with IEC 61508
- RPM-monitoring
- Standstill monitoring
- Direction of movement monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable compact controller for up to 800 IL instructions
- Function plan-oriented programming via SafePLC²

- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Monitored relay outputs for safety relevant functions
- Parameter management for expansion modules in base device
- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs
- Multifunction taster (Quit, Start, Reset) can be operated from the front side
- Configurable with SafePLC² via USB serial adapter or Ethernet-based fieldbus
- Extended functionality: safePXV encoder interface
- Optional: integrated Memory Card
- Optional: universal communication interface
    - Standard and safe fieldbus protocols for communication with a higher-level controller (PROFIBUS, PROFINET, DeviceNet, CANopen, EtherNET/IP, EtherCAT, Modbus TCP, PROFIsafe, FSoE)
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Fieldbus protocols with the same hardware can be switched using SafePLC²
    - Safe remote-IO communication for data exchange with distributed IO systems

  see: chapter 3.2.3.1 “Optional integrated communication interface”
- Assembly on top hat rail
- The mechanical structure of SMX11-PXV/2(/x[1]) depends on the respective specification of the base module (see mechanical data)
- For further information, please refer to the SMX-x-PXV Installation Manual.

Technical characteristic data SMX11-PXV/2 (/x[1])

Safety related characteristic data				
	PL acc.to EN ISO 13849-1		PL e	
	PFH / architecture When using the SafePXV, please refer to the "TS-37000-410-01-810-01-04F SMX-x-PXV Installation Manual.pdf".		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, RJ-45 (Ethernet)	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp- switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analog inputs		-	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (axes / encoder interfaces)		1 / 1 *	
	Encoder interfaces (D-Sub / screw terminals)		***RS 485, X35:*** PXV100AS-F200-R4-V19-BBH	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2 A (-15%, +20%)	
	Fuse	X11.1	max. 30 VDC; 3,15 A	
		X11.2	max. 30 VDC; max. 10 A	
	Max. power consumption (Logic)			
		SMX11-PXV/2	3,5 W	
		SMX11-PXV/2/x	6,8 W	
	Rated data digital inputs		24 VDC; 20 mA Type 1 acc. IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	-	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data safe analog inputs		-	
Electrical data (For UL only)				
	Rated data digital outputs			
		pn- switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	-	
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)	
Environmental data				
	Temperature		0°C … +50°C operation -25C° … +70C° storage, transport	
	Protection class		IP 20	
	Climatic category		3k3 acc. to DIN 60 721-3	

	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
Mechanical data			
	Dimensions (HxDxW [mm])		SMX11-PXV/2 = 100x115x67,5 SMX11-PXV/2 (/x(1)) = 100x115x90
	Weight (g)		SMX11-PXV/2 = 390 SMX11-PXV/2(/x(1)) = 490
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX11-PXV/2	3
		SMX11-PXV/2 (/x(1))	4
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp via SafePLC² configurable
(***) Derating, see chapter „Derating Outputs“
(1) Specifications, see: „Optional integrated communication interface“

3.2.1.4 SMX11-WCS/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 1 Axis 2 WCS encoder interfaces 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O's,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs
  - max. 1 safe axis
- Freely programmable for safe processing of emergency stop buttons, two-hand operation, light grids, mode switches, etc.
- Complete speed and position-based safety functions for drive monitoring integrated in firmware
- Motion monitoring of an axis up to PL e EN ISO 13849-1 or SIL 3 in accordance with IEC 61508
- Position and speed monitoring for WCS path coding system (WCS3B-LS2xx, Pepperl+Fuchs)
- RPM-monitoring
- Standstill monitoring
- Direction of movement monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable compact controller for up to 800 AWL instructions
- Function plan-oriented programming via SafePLC²
- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Monitored relay outputs for safety relevant functions
- Parameter management for expansion modules in base device

- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs
- Multifunction buttons (quit, start, reset) can be operated from the front side
- Optional: Integrated communication interface
    - Standard and safe field bus protocols for communication with a higher level controller (PROFIBUS, PROFINET, DeviceNet, CANopen, EtherNET/IP, EtherCAT, Modbus TCP/IP, FSoE)
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Fieldbus protocols with the same hardware are switchable via SafePLC²
    - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapter 3.2.3.1 “Optional integrated communication interface”
- Assembly on top hat rail
- The mechanical structure of SMX11-WCS/2 (/x(1)) depends on the respective specification of the base module (see mechanical data)

Technical characteristic data SMX11-WCS/2 (/x[1])

Safety releated characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail, RJ-45 (Ethernet)	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp-switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (Axes / encoder interface)		1 / 1 *	
	Encoder interfaces (D-Sub / screw terminal)		***RS485, X35-1 / X35-2:*** WCS3B-LS2xx	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	max. 30 VDC; max. 3,15A	
		X11.2	max. 30 VDC; max. 10A	
	Max. power consumption (Logic)			
		SMX11-WCS/2	3,5W	
		SMX11-WCS/2/x	6,8W	
	Rated data digital inputs		24 VDC; 20 mA Type1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data safe analogue inputs		-	
Electrical data (For UL only)				
	Rated data digital outputs			
		pn-switching	Temperatur Rating 30°C	24 VDC; 2A (G.P.)
			Temperatur Rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperatur Rating 30°C	24 VDC; 2A (G.P.)
			Temperatur Rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	24 VDC; 250mA (G.P.)	
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)	
Environmental data				
	Temperature		0°C … +50°C operation -25C° … +70C° storage, transport	
	Protection class		IP 20	
	Climatic category		3k3 nach DIN 60 721-3	

	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
Mechanical data			
	Dimensions (HxDxW [mm])		SMX11-WCS/2 = 100x115x67,5 SMX11-WCS/2 (/x(1)) = 100x115x90
	Weight (g)		SMX11-WCS/2 = 390 SMX11-WCS/2 (/x(1)) = 490
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX11-WCS/2	3
		SMX11-WCS/2 (/x(1))	4
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp via SafePLC² configurable
(***) Derating, see chapter „Derating Outputs“
(1) Specifications, see: „Optional integrated communication interface“

3.2.1.5 SMX11-2/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 1 Axis 5 Encoder interfaces 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O's,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs
  - max. 1 safe axis
- Logic processing up to PL e acc. to with EN ISO 13849-1 or SIL 3 acc. to with IEC 61508
- Movement monitoring of one axis up to Pl e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Speed monitoring:
- RPM-monitoring
- Standstill monitoring
- Sense of rotation monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable compact controller for up to 800 IL instructions
- Function plan-oriented programming via SafePLC²
- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Monitored relay outputs for safety relevant functions
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Complete speed and position-based safety functions for drive monitoring in accordance with IEC 61800-5-2 are integrated in firmware
  - Spatial functions for safe speed and are monitoring are possible
- Parameter management for expansion modules in base device

- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs
- Multifunction buttons (quit, start, reset) can be operated from the front side
- Optional: Integrated communication interface
    - Standard and safe field bus protocols for communication with a higher level controller (PROFIBUS, PROFINET, DeviceNet, CANopen, EtherNET/IP, EtherCAT, Modbus TCP/IP, FSoE)
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Fieldbus protocols with the same hardware are switchable via SafePLC²
    - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapter 3.2.3.1 “Optional integrated communication interface”
- Assembly on top hat rail
- Extended functionality:
    - allows the connection of 2 rotary encoders per axis (SSI, Sin/Cos, TTL)
    - 2. encoder interface also supports HTL (200 kHz), Sin/Cos High-Resolution and Resolver
- The mechanical structure of SMX11-2/2 (/x(1)) depends on the respective specification of the base module (see mechanical data)

Technical characteristic data SMX11-2/2 (/x[1])

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp-switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (Axes / encoder interfaces)		1 / 5 *	
	Encoder interfaces (D-Sub / screw terminals)		***D-SUB X31:*** SSI, SinCos, Incremental-TTL ***D-SUB X33:*** SSI, SinCos, SinCos (HighRes), Incremental-TTL, Resolver ***Terminal X23:*** Incremental-HTL (10kHz) ***Terminals X27, X28:*** Incremental-HTL (200kHz)	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	min. 30 VDC; max. 3,15A	
		X11.2	min. 30 VDC; max. 10A	
	Max. power consumption (logic)			
		SMX11-2/2	3,5W	
		SMX11-2/2/x	6,8W	
	Rated data digital inputs		24 VDC; 20 mA Type1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relays	Normally open DC13	24 VDC; 2A	
		AC15	230 VAC; 2A	
	Rated data safe analogue inputs		-	
Electrical data (For UL only)				
	Rated data digital outputs			
		pn-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperature rating 30°C	24 VDC; 2A (G.P.)
			Temperature rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	24 VDC; 250mA (G.P.)	

	Rated data relays	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)
Environmental data			
	Temperature		0°C … +50°C operation -25C° … +70C° storage, transport
	Protection class		IP 20
	Climatic category		3k3 nach DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX11-2/2 = 100x115x67,5 SMX11-2/2 (/x(1)) = 100x115x90
	Weight (g)		SMX11-2/2 = 390 SMX11-2/2 (/x(1)) = 490
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX11-2/2	3
		SMX11-2/2 (/x(1))	4
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp via SafePLC² configurable
(***) Derating, see chapter „Derating Outputs“
(1) Specifications, see: „Optional integrated communication interface“

3.2.1.6 SMX12/2, SMX12A/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 2 Axes 4 Encoder interfaces 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 2 Analog inputs (SMX12A/2) 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs,
  - max. 2 safe axes
- Logic processing up to PL e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Movement monitoring of one or two axes up to PL e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Speed monitoring
- RPM-monitoring
- Standstill monitoring
- Sense of rotation monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable compact controller for up to 800 IL instructions
- Function plan-oriented programming via SafePLC²
- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Monitored relay outputs for safety relevant functions
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Parameter management for expansion modules in base device
- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs

- Multifunction buttons (quit, start, reset) can be operated from the front side
- optional: integrated communication interface
    - Standard and safe field bus protocols for communication with a higher level controller
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapter 3.2.3.1 Optional integrated communication interface

- Assembly on top hat rail
- The mechanical structure of SMX12/12A/2 (/x(1)) depends on the respective specification of the base module (see mechanical data)
- SMX 12A/2 – Variant (analog) – with 2 analog inputs

Technical characteristic data SMX12/2, SMX12A/2 (/x(1))

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp-switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
		SMX12A/x	2 ****	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (axis / Encoder interfaces)		2 / 4 *	
	Encoder interfaces (D-Sub / screw terminals)		***D-SUB X31, X32:*** SSI-Absolut, SinCos, Incremental-TTL ***Terminal X23:*** Incremental-HTL (10kHz)	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	min. 30 VDC; max. 3,15A	
		X11.2	min. 30 VDC; max. 10A	
	Max. power consumption (Logic)			
		SMX12x/2	3,1W	
		SMX12x/2/x	6,7W	
	Rated data digital inputs		24 VDC; 20 mA Type1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data analogue inputs			
		SMX12A/2/x	-10 … +10V 4 … 20 mA	
Electrical data (Only for UL)				
	Rated data digital outputs			
		pn-switching	Temperatur Rating 30°C	24 VDC; 2A (G.P.)
			Temperatur Rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperatur Rating 30°C	24 VDC; 2A (G.P.)
			Temperatur Rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	24 VDC; 250mA (G.P.)	
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)	

Environmental data			
	Temperature		0°C … +50°C operation -25°C … +70°C storage, transport
	Protection class		IP 20
	Climatic category		3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX12/12A/2 = 100x115x67,5 SMX12/12A/2 (/x(1))= 100x115x90
	Weight (g)		SMX12/12A/2 = 390 SMX12/12A/2 (/x(1))= 490
	Mounting		To snap on top-hat rail
		SMX12/12A/2	3
		SMX12/12A/2 (/x(1))	4
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp via SafePLC² configurable
(***) Derating, see chapter „Derating Outputs"
(****) Analog current and voltage inputs optionally available
e.g.: SMX12A-U/2 Voltage inputs
SMX12A-I /2 Current inputs
SMX12A/2 Voltage and current inputs
(1) Specifications, see: „Optional integrated communication interface"

3.2.1.7 SMX12-1-PXV/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 2 Axes 6 Encoder interfaces (with 1 safePXV encoder interface) 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/Os
  - max. 9 safe relay outputs,
  - max. 10 Auxiliary outputs,
  - o max. 2 safe axes

- Freely programmable for the safe processing of emergency stop buttons, two-hand operation, light curtains, mode selector switches, etc.
- Complete speed and position-related safety functions for drive monitoring of one or two axes
- Spatial functions for safe speed and area monitoring possible
- Safe position monitoring with just one sensor in combination with the PXV100AS-F200-R4-V19 optical read head
- Logic processing up to PL e EN ISO 13849-1 or SIL 3 in accordance with IEC 61508
- Speed monitoring
- Standstill monitoring
- Direction of travel monitoring
- Safe incremental dimension
- Emergency stop monitoring
- Position monitoring
- Position/travel range monitoring
- Target position monitoring
- Function plan-oriented programming via SafePLC²
- Pulse outputs for cross-circuit detection of digital input signals
- External contact monitoring of connected switching devices (EMU)
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Monitored relay outputs for safety-relevant functions
- Extensive integrated diagnostic functions

- Coded status display via 7-segment display on the front and status LEDs
- Multifunction button (Quit, Start, Reset) can be operated from the front
- Configurable with SafePLC² via USB serial adapter or Ethernet-based fieldbus
- Extended functionality: safePXV encoder interface

- Optional: integrated Memory Card
- Extended functionality:
    - Allows the connection of 2 encoders per axis (SSI, TTL HTL proximity sensor)
    - Extended encoder interface additionally supports HTL (200 kHz), Sin/Cos High-Resolution and Resolver

- Optional: integrated communciation interface
    - Standard and safe fieldbus protocols for communication with a higher-level control system (PROFIBUS, PROFINET, DeviceNet, CANopen, EtherNET/IP, EtherCAT, Modbus TCP, PROFIsafe, FSoE)
    - Standard and safe field bus protocols for communication with a higher level controller
    - Safe cross communication (SMMC) for data exchange between multiple base devices
    - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapter 3.2.3.1 Optional integrated communication interface

- Assembly on top hat rail
- The mechanical structure of SMX12-1-PXV/2 (/x(1)) depends on the respective specification of the base module (see mechanical data)
- For further information, please refer to the SMX-x-PXV Installation Manual.

Technical characteristic data SMX12-1-PXV/2 (/x[1])

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture When using the SafePXV, please refer to the "TS-37000-410-01-810-01-04F SMX-x-PXV Installation Manual.pdf".		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operating period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail, RJ-45 (Ethernet)	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp- switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (axis / Encoder interfaces)		2 / 6 *	
	Encoder interfaces (D-Sub / screw terminals / RS485)		***D-SUB X31:*** SSI-Absolut, SinCos, Incremental-TTL ***D-SUB X33:*** SSI-Absolut,SinCos (HighRes), Incremental-TTL, Resolver ***Terminal X23:*** Incremental-HTL (10kHz) ***Terminals X27, X28:*** Incremental-HTL (200kHz) ***RS485, X35:*** PXV100AS-F200-R4-V19-BBH	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	max. 30 VDC; max. 3,15A	
		X11.2	max. 30 VDC; max. 10A	
	Max. power consumption (logic)			
		SMX12-1-PXV/2	4,8 W	
		SMX12-1-PXV/2/x	7,2 W	
	Rated data digital inputs		24 VDC; 20 mA Type1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normmaly open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data analogue inputs		-	
Electrical data (For UL only)				
	Rated data digital outputs			
		pn-switching	Temperature Rating 30°C	24 VDC; 2A (G.P.)
			Temperature Rating 50°C	24 VDC; 1,8A (G.P.)

		pp-switching	Temperature Rating 30°C	24 VDC; 2A (G.P.)
			Temperature Rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current (pn or pp)	8A	
		Auxiliary outputs	24 VDC; 250mA (G.P.)	
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)	
Environmental data				
	Temperature		0°C … +50°C operation -25°C … +70°C storage, transport	
	Class of protection		IP 20	
	Climatic category		3k3 acc. to DIN 60 721-3	
	Min-, Maximum relative humidity (no condensation)		5% - 85%	
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061	
	Operating altitude		2000m	
	Overvoltage category		III	
Mechanical data				
	Dimensions (HxDxW [mm])		SMX12-1-PXV/2 =100x115x90 SMX12-1-PXV/2 (/x[1])=100x115x112,5	
	Weight (g)		SMX12-1-PXV/2 = 520 SMX12-1-PXV/2 (/x[1])= 620	
	Mounting		To snap on top-hat rail	
	Number of T-bus			
		SMX12-1-PXV/2	4	
		SMX12-1-PXV/2 (/x[1])	5	
	Min. terminal cross-section / AWG		0,2 mm² / 24	
	Max. terminal cross-section / AWG		2,5 mm² / 12	

(*) maximum 2 encoder / axis
(**) pn/pp are configurable via SafePLC2
(***) Derating, see chapter „Derating Outputs"
(1) Specifications see: „Optional integrated communication interface"

3.2.1.8 SMX12-2/2, SMX12-2A/2 (/x(1))

Type designation	*Device design*
	Design of module with the following periphery: 2 Axes 8 Encoder interfaces 14 Digital inputs 2 Pulse outputs 2 Relay outputs 2/4 pn- or pp-switching outputs 2 Auxiliary outputs 2 Analog inputs (SMX12-2A/2) 1 Diagnostic- and configuration interface 1 Function button 1 7-Segment display 1 Status LED 14 Status LEDs for inputs 2 Status LEDs for pulse outputs 2 Status LEDs for relay outputs 6 Status LEDs for outputs 1 Optional: communication interface (/x(1))

Characteristic of the module:

- Extendable to:
  - max. 42 safe digital inputs,
  - max. 12 safe digital outputs,
  - max. 20 safe digital I/O,
  - max. 9 safe relay outputs,
  - max. 10 auxiliary outputs,
  - max. 2 safe axes

- Logic processing up to PL e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Movement monitoring of one or two axes up to Pl e EN ISO 13849-1 or SIL 3 acc. to IEC 61508
- Speed monitoring
- RPM-monitoring
- Standstill monitoring
- Sense of rotation monitoring
- Safe incremental dimension
- Emergency Stop monitoring
- Position monitoring
- Position range monitoring
- Trend range monitoring
- Target position monitoring
- Freely programmable Modular controller for up to 800 IL instructions
- Function plan-oriented programming
- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Monitored relay outputs for safety relevant functions
- Switchable safe semi-conductor outputs pn-, pp- switching for safety-relevant functions
- Parameter management for expansion modules in base device
- Comprehensive diagnostics functions integrated
- Coded status display via front-side 7 segment display and status LEDs
- Multifunction buttons (quit, start, reset) can be operated from the front side
- Optional: Communication interface

  - Standard and safe field bus protocols for communication with a higher level controller
  - Safe cross communication (SMMC) for data exchange between multiple base devices
  - Safe remote I/O communication for data exchange with distributed I/O systems

  see: chapter 3.2.3.1 "Optional integrated communication interface"

- Assembly on top hat rail
- Extended functionality:
  - allows the connection of 2 rotary encoders per axis(SSI, Sin/Cos, TTL)
  - 2. encoder interface also supports HTL (200 kHz), Sin/Cos High-Resolution and Resolver

- The mechanical structure of SMX12-2/12-2A/2, (/x[1]) differs from the figure.
  (see mechanical data)
- SMX 12-2A/2 – Variant (Analog) – with 2 analog inputs

Technical characteristic data SMX12-2/2, SMX12-2A/2 (/x(1))

Safety related characteristic data				
	PL acc. to EN ISO 13849-1		PL e	
	PFH / architecture		12,6 FIT /Cat 4	
	SIL acc. to IEC 61508		SIL 3	
	Proof test interval		20 years = max. operation period	
General data				
	Max. no. of expansion modules		2	
	Interface for expansion modules		T-bus connector, pluggable in top-hat rail	
	Number of safe digital inputs		14 (OSSD capable)	
	Number of safe digital outputs			
		pn-switching **	2	
		pp-switching **	4	
	Number of safe digital I/O		-	
	Number of relay outputs		2	
	Number of safe analogue inputs		-	
		SMX12-2A/2/x	2 ****	
	Number of auxiliary outputs		2	
	Number of pulse outputs (clock outputs)		2	
	Type of connection		Plug-in terminals with spring or screw connection	
	Axis monitoring (axis / Encoder interfaces)		2 / 8 *	
	Encoder interfaces (D-Sub / screw terminals)		***D-SUB X31, 32:*** SSI, SinCos, Incremental-TTL ***D-SUB X33, 34:*** SSI, SinCos, SinCos (HighRes), Incremental-TTL, Resolver ***Terminal X23:*** Incremental-HTL (10kHz) ***Terminals X27, X28, X29, X30:*** Incremental-HTL (200kHz)	
Electrical data				
	Supply voltage (tolerance)		24 VDC; 2A (-15%, +20%)	
	Fuse	X11.1	min. 30 VDC; max. 3,15A	
		X11.2	min. 30 VDC; max. 10A	
	Max. power consumption (logic)			
		SMX12-2x/2	4,8W	
		SMX12-2x/2/x	7,2W	
	Rated data digital inputs		24 VDC; 20 mA, Typ1 acc. to IEC 61131-2	
	Rated data digital outputs			
		pn-switching	24 VDC; 2A ***	
		pp-switching	24 VDC; 2A ***	
		Auxiliary outputs	24 VDC; 250mA	
		Pulse outputs (clock outputs)	24 VDC; 250mA	
	Rated data relay outputs	Normally open DC13 AC15	24 VDC; 2A 230 VAC; 2A	
	Rated data analogue inputs			
		SMX12-2A/2/x	-10 … +10V 4 … 20 mA	
Electrical data (Only for UL)				
	Rated data digital outputs			
		pn- switching	Temperature Rating 30°C	24 VDC; 2A (G.P.)
			Temperature Rating 50°C	24 VDC; 1,8A (G.P.)
		pp-switching	Temperature Rating 30°C	24 VDC; 2A (G.P.)
			Temperatuer Rating 50°C	24 VDC; 1,8A (G.P.)

		Max. total current (pn or pp)	8A
		Auxiliary outputs	24 VDC; 250mA (G.P.)
	Rated data relay outputs	Normally open	24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)
Environmental data			
	Temperature		0°C … +50°C operation -25°C … +70°C storage, transport
	Protection class		IP 20
	Climatic category		3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX12-2/12-2A/2 = 100x115x112,5 SMX12-2/12-2A/2 (/x(1))= 100x115x135
	Weight (g)		SMX12-2/12-2A/2 = 520 SMX12-2/12-2A/2 (/x(1)) = 620
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX12-2/SMX12-2A/2	5
		SMX12-2/12-2A/2 (/x(1))	6
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(*) maximum 2 encoder / axis
(**) pn/pp über SafePLC^2 configurable
(***) Derating, see chapter „Derating Outputs"
(****) Analogue current, voltage inputs are available as options

z.B.: SMX12-2A-U/2 voltage inputs
SMX12-2A-I/2 current inputs
SMX12-2A/2 voltage and current inputs

(1) Specification see: „Optional integrated communication interface"

3.2.2 Central expansion modules

3.2.2.1 SMX31/2, SMX31R/2, SMX31R-4/2

Type designation	***Device design***
	Design of module with the following periphery: 12 Digital inputs 10 Digital I/Os 2 Pulse outputs 2 Auxiliary outputs 8 Relay outputs (SMX31x) 12 Status LEDs for inputs 10 Status LEDs for I/O

Characteristic of the module:

- Pulse outputs for cross-shorting detection of digital input signals
- External contact monitoring of connected switchgear (EMU)
- Comprehensive diagnostics functions integrated
- Assembly on top hat rail
- SMX 31/2 – with a total of 10 I/O‘s
- SMX 31R/31R-4/2 – with a total of 8/4 relay outputs and only 2/6 I/Os.
- The mechanical structure of the SMX31R/2, SMX31R-4/2 deviates from the figure. (see mechanical data)

Technical characteristic data SMX31/31R/31R-4/2

Safety related characteristic data				
	PL acc. to EN ISO 13849-1			PL e
	PFH / architecture			9,2 FIT /Cat 4 [1)] Plus with SMX31R/31R-4 1-channel per Rel 20 FIT (max. 8) 2-channel pro Rel 1,0 FIT (max. 4)
	SIL acc. to IEC 61508			SIL 3
	Proof test interval			20 years = max. operation period
General data				
	Max. no. of expansion modules			-
	Interface for expansion modules			T-bus connector, plug-in in top-hat rail
	Number of safe digital inputs			12 (OSSD capable)
	Number of safe digital outputs			-
	Number of safe digital I/O			
		SMX31/2		10
		SMX31R/2		2
		SMX31R-4/2		6
	Number of relay outputs			
		SMX31R/2		8
		SMX31R-4/2		4
	Number of safe analog inputs			-
	Number of auxiliary outputs			2
	Number of pulse outputs (clock outputs)			2
	Type of connection			Plug-in terminals with spring or screw connection
	Axis monitoring (axis / encoder interfaces)			-/-
	Encoder interfaces (D-Sub / screw terminals)			-/-
Electrical data				
	Fuse	X11.1		min. 30 VDC; max. 10A
	Max. power consumption (logic)			7,1W
	Rated data digital inputs			24 VDC; 20 mA Type1 acc. to IEC 61131-2
	Rated data digital outputs			
		Auxiliary outputs		24 VDC; 250mA
		Pulse outputs (clock outputs)		24 VDC; 250mA
		Digital I/O 01 – 05 06 – 10		 24 VDC; 0,5A 24 VDC; 2A ***
	Rated data relay outputs	Normally open DC13 AC15		24 VDC; 2A 230 VAC; 2A
		Normally closed DC13 (Read back contact)		24 VDC; 2A
	Rated data analogue inputs			-
Electrical data (Only for UL)				
	Rated data digital outputs			
		Auxiliary outputs		24 VDC; 250mA (G.P.)
		Digital I/O 01 – 05		24 VDC; 0,5A (G.P.)
		06 – 10	Temperature Rating 30°C	24 VDC; 2A (G.P.)
			Temperature Rating 50°C	24 VDC; 1,8A (G.P.)
		Max. total current		10A
	Rated data relay outputs	Normally open		24 VDC; 2A (Pilot Duty) 120 VAC; 2A (Pilot Duty)
		Normally closed (Read back contact)		24 VDC; 2A (Pilot Duty)

Environmental data			
	Temperature		0°C … +50°C operation -25°C … +70°C storage, transport
	Protection class		IP 20
	Climatic category		3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)		5% - 85%
	EMC		EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude		2000m
	Overvoltage category		III
	Degree of pollution		2
Mechanical data			
	Dimensions (HxDxW [mm])		SMX31/2 = 100x115x45 SMX31R/2 = 100x115x90 SMX31R-4/2 = 100x115x67,5
	Weight (g)		SMX31/2 = 300 SMX31R/2 = 680 SMX31R-4/2 = 545
	Mounting		To snap on top-hat rail
	Number of T-bus		
		SMX31/2	2
		SMX31R/2	4
		SMX31R-4/2	3
	Min. terminal cross-section / AWG		0,2 mm² / 24
	Max. terminal cross-section / AWG		2,5 mm² / 12

(***) Derating, see chapter „Derating Outputs“

[1)] Value only applies to expansion module. For an overall evaluation in accordance with EN ISO 13849-1, a series connection with the respective basic device must be used.

=> $PFH_{Logic} = PFH_{Base} + PFH_{expansion}$

3.2.3 Communication interface

3.2.3.1 Optional integrated communication interface

Specification	***Device design***
/D	Decentralized SDDC and SMMC interface (2x RJ 45) Communication interface for decentralized slave and master modules
/xN	Fieldbus interface (2x RJ 45) Standard and safe fieldbus
/xB	Fieldbus interface (Sub-D) Standard and safe fieldbus
/xxM	MemoryCard (Mini SD) Storage medium for safety program

Properties of the integrated communication interface:

- Optional specification of the communication interface of the SMX series
- Subsequent expansion capability from standard to safe fieldbus possible via additional mini SD card on the rear of the module. (/xNx and /xBx)
- Different specifications can be combined. See „Combination options“.
- For more detailed information, please refer to the "COM installation manual".

3.2.3.1.1 Combination options

		Specifications						
		/D	/DxM	/DNM	/xNM	/xxM	/DBM	/xBM
Module type	SMX10/2	x	x	x	x	x	x	x
	SMX10A/2	x	x	x	x	x	x	x
	SMX10R/2	x	x	x	x	x	x	x
	SMX11/2	x	x	x	x	x	x	X
	SMX11-2/2	x	x	x	x	x	x	x
	SMX11-PXV/2	x	x	x	x	x	x	x
	SMX11-WCS/2	x	x	x	x	x	x	x
	SMX12/2	x	x	x	x	x	x	x
	SMX12A/2	x	x	x	x	x	x	x
	SMX12-1-PXV/2	x	x	x	x	x	x	x
	SMX12-2/2	x	x	x	x	x	x	x
	SMX12-2A/2	x	x	x	x	x	x	x
	SMX31/2							
	SMX31R/2							
	SMX31R-4/2							

Technical characteristic data: Optional universal communication interface

Safety related characteristic data		
	Pl acc. to EN ISO 13849-1	n.a.
	PFH / architecture	n.a.
	SIL acc. to IEC 61508	n.a.
	Proof test interval	n.a.
General data		
	Decentralized communication interfaces	
	/D	2x RJ 45*
	Fieldbus interfaces	
	/xN	2x RJ 45**
	/xB	1x Sub-D***
	Memory Card (safety program)	
	/xxM	1x Mini SD (front side)
	MemoryCard (License for safety fieldbus)	
	/xNx /xBx	1x Mini SD (back side)
	SD bus	Phoenix Stecker
	Status LEDs	4
	Fieldbus address rotary switch	
	/xBx	2
Electrical data		
	Power consumption (Logic)	3,5W
	Power consumption (SD- Bus)	?
Environmental data		
	Temperature	0°C … +50°C operation -25C° … +70C° storage, transport
	Protection class	IP 20
	Climatic category	3k3 acc. to DIN 60 721-3
	Min-, Maximum relative humidity (no condensation)	5% - 85%
	EMC	EN 61000-6-2, EN 61000-6-4, EN 61000-6-7, EN 61800-3, EN 61326-3, EN 62061
	Operating altitude	2000m
	Overvoltage category	III
	Degree of pollution	2
Mechanical data		
	Dimension (HxDxW [mm])	100x115x22,5

	Weight (g)	110
	Mounting	To snap on top-hat rail
	Number of T-Bus	1
	Min. terminal cross-section / AWG	0,2 mm² / 24
	Max. terminal cross-section / AWG	2,5 mm² / 12

(*) Optional for SDDC or SMMC
(**) Available fieldbuses PROFINET (PROFIsafe), EtherCAT (FSoE), Modbus TCP/IP and EtherNet/IP
(***) Available fieldbuses PROFIBUS (PROFIsafe), DeviceNet and CANopen

For available fieldbuses „HB-37450-810-01-xxF-DE COM Installation Manual"

3.2.4 Encoder specifications

Incremental-TTL		
	Physical Layer	RS-422 compatible
	Measuring signal A/B	Track with 90 degree phase difference
	Max. frequency of input cycles (X31, X32 / X33, X34)	250 kHz / 500 kHz
	Type of connection	D-SUB 9pole
Sin / Cos		
	Physical Layer	RS-422 compatible
	Measuring signal A/B	Track with 90 degree phase difference
	Standard Mode	
	Max. frequency of input cycles (X31, X32 / X33, X34)	200 kHz / 250 kHz
	High Resolution Mode	
	Max. frequency of input cycles (X33, X34)	15 kHz
	Type of connection	D-SUB 9pole
SSI-Absolut		
	Data interface	**S**erial **S**ynchronous **I**nterface (SSI) (SSI) with variable data length of 12 – 28 Bit
	Data format	Binary, grey code
	Physical Layer	RS-422 compatible
	SSI-Master operation	
	Clock rate	150 kHz
	SSI-Listener operation (Slave mode)	
	Clock rate (X31, X32 / X33, X34)	250 kHz / 350 kHz
	Min. clock pause time	150 µsec
	Max. clock pause time	1 msec
	Type of connection	D-SUB 9 pole
Resolver		
	Measuring signal	Sin/Cos – Track with 90 degree phase difference
	Signal frequency	max. 600 Hz (900Hz Deep pass)
	Input voltage	max. 8 Vss (on 16 kΩ)
	Resolution	9 bit / pole
	Supported pole number	2 - 16
	Reference frequency (Listener)	4 kHz – 16 kHz
	Reference frequency (Master)	8 kHz
	Reference amplitude	8 Vss – 28 Vss
	Reference signal form	Sine, triangle
	Transformation ratio	2:1; 3:1; 4:1
	Phase fault	max. 8°
	Type of connection (X33, X34)	D-SUB 9pole
Incremental-HTL		
	Signal level	24V / 0V
	Physical Layer	PUSH / PULL
	Max. counting pulse frequency	200 kHz
	Type of connection (X27, X28, X29, X30)	Plug-in terminals with spring or screw connection
Proxi		
	Signal level	24V / 0V
	Max. counting pulse frequency (switching logic debounced)	10 kHz
	Pulse width	50 µsec
	Type of connection (X23)	Plug-in terminals with spring or screw connection

Proxi – Extended mnitoring		
	Signal level	24V / 0V
	Max. counting pulse frequency (switching logic debounced)	4 kHz
	Physical Layer	PUSH / PULL
	Measuring signal A/B	Track with 90 degree phase difference
	Type of connection (X23)	Plug-in terminals with spring or screw connection

3.3 Derating Outputs

Maximum current load based on temperature.

The maximum total current is **10A**.

Device	*Temperature 30°C / 50°C*	
SMX1x/2/x	Q1 – Q4	2A / 1,8A
SMX31/2	IQ 6 – IQ 10	2A / 1,8A
SMX31R-4/2	IQ 6	2A / 1,8A

3.4 Identification

The type plate is located on the left side wall of the module and contains the following information:

3.4.1 Type plate

- Type designation
- Part number
- Serial number
- Identification of Hardware (HW)-Release
- Identification of Software (FW)-Release
- Safety category
- Input characteristics
- Output characteristics
- Date of manufacture (week/year)

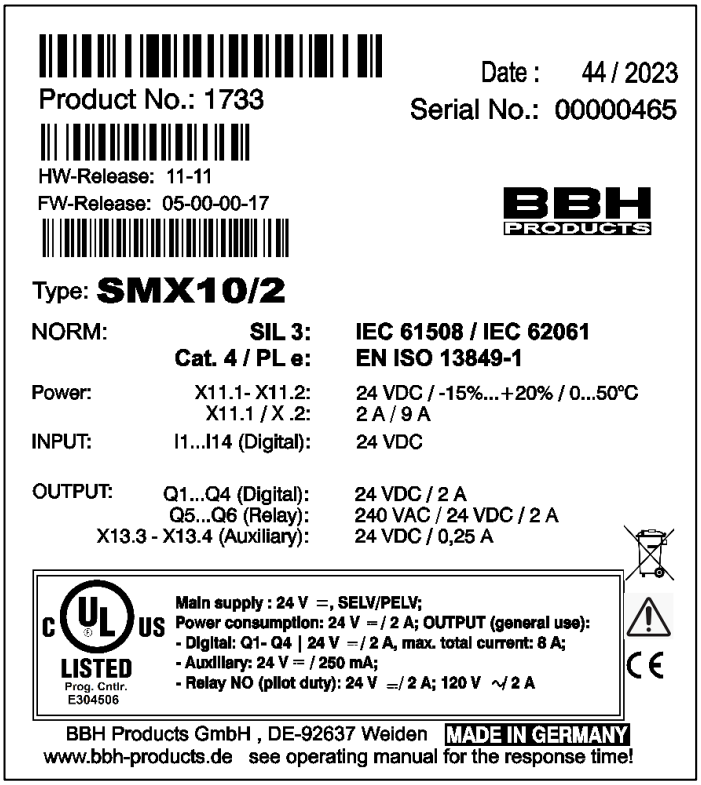


Fig. 1: Type plate of SMXGen2 (image enlarged)

3.4.2 Scope of delivery

The scope of delivery contains:

SMX module:

- Plug (screw terminals) for all signal terminals without encoder connection

Not included in the scope of delivery:

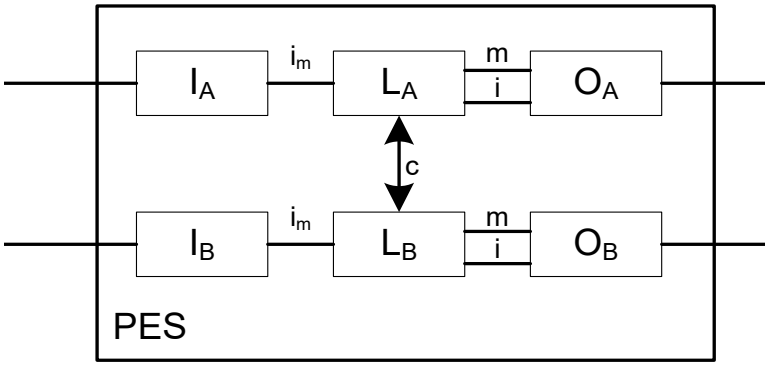
- SafePLC2 configuration software with
  - Installation manual
  - Programing manual
  - Driver for Programing adapter
- Programing adapter SMX91
- License key (USB-Dongle) for SafePLC^2
- System CD with user manuals
- Backplane bus plug SX0000-9 (SMX3x)

4 Safety related characteristics

4.1 General design, safety related architecture & characteristic data

The inner structure of **SMX** series consist of two separate channels with reciprocal comparison of results. High quality diagnoses for fault detection are made in each of the two channels.

With respect to architecture and function the internal structure corresponds with category 4 of EN 13849-1.



PES = programmable electronical system

I_A = Input channel A

I_B = Input channel B

L_A = Logic channel A

L_B = Logic channel B

O_A = Output channel A

O_B = Output channel B

c = Cross comparison

m = Monitoring

The overall architecture therefore corresponds with the following structure:

Fig. 2: Dual reading of each input and diagnose by cross-comparison

The specific safety related characteristic data of the corresponding module can be taken from the technical characteristic data in chapter 3.2.

The characteristic data specified in chapter 3 (e.g. PI e and PFH-value acc. to table as evidence acc. to EN 13849) for the partial system PES can be used for the safety related assessment of the overall system.

For the safety-related assessment of overall systems, the technical characteristics specified in chapter 3.2. can be used for the PES partial system (e.g. PL e and PFH value according to the table for verification in accordance with EN ISO 13849-1)

NOTICE

Safety-related information specifically on the SMX-x-PXV modules can be found in the:

- SMX-x-PXV Installation Manual
  TS-37000-410-01-810-01-xxF SMX-x-PXV Installationshandbuch

Safety technical characteristic data:

Max. obtainable safety class	• SIL 3 acc. to IEC 61508 • Category 4 acc. to EN ISO 13849-1 • Performance-Level e acc. to EN ISO 13849-1	
System structure	2- channel with diagnostics (1002) acc. to IEC 61508 Architecture category 4 acc. to EN ISO 13849-1	
Rating of operating mode	„high demand" acc. to IEC 61508 (high demand rate)	
Probability of an endangering failure per hour (PFH-value) Specific values acc. to table "safety-technical characteristic data"	SMX1x/2	PFH = 12,6 FIT
	SMX3x/2	PFH = 9,2 FIT
	SMXxR/2 (1-channel)	PFH = 20 FIT
	SMXxR/2 (2-channel)	PFH = 1,0 FIT
Proof test interval (IEC 61508)	20 years, after this period the assembly must be replaced	

SAFETY NOTICE

- The specific safety related characteristic data of the corresponding module can be taken from the technical characteristic data in chapter 3.2.
- When using several sensors with different functions (e.g. position indicator access door + speed detection) for a safety function (e.g. safe reduced speed when access door is open), these must be assumed as being connected in series for the safety related assessment of the overall system. See also exemplary calculation in appendix.
- The safety regulations and EMC-directives must be strictly followed.
- Concerning the applicable fault exclusions please refer to the tables under D in the appendix of EN 13849-2.
- The characteristic data specified in chapter 3. for the partial system PES (e.g. PI e and PFH-value acc. to table as evidence acc. to EN ISO 13849-1) can be used for the safety related assessment of the overall system.

The following examples and their characteristic architecture are mainly responsible for the assignment to a category acc. to EN ISO 13849-1.

The maximum possible Performance Levels acc. to EN ISO 13849-1 resulting from this still depend on the following factors of the external components:

- Structure (simple or redundant)
- Detection of common cause faults (CCF)
- Degree of diagnostic coverage on request (DC_{avg})
- Mean time to dangerous failure of a channel ($MTTF_d$)

4.2 Safety related characteristic data and wiring for the connected sensors

The SMX modules have completely separated signal processing paths for each safety input. This applies for both the digital and the analogue inputs. Furthermore, measures for achieving the highest possible DC-values have been implemented.

4.2.1 Digital sensors

Digital inputs and outputs are generally of a completely redundant design, except the electro-magnetic input terminal. The following list contains details for classification, the DC and the achievable PI or SIL.

4.2.1.1 Characteristics of sensors /input elements

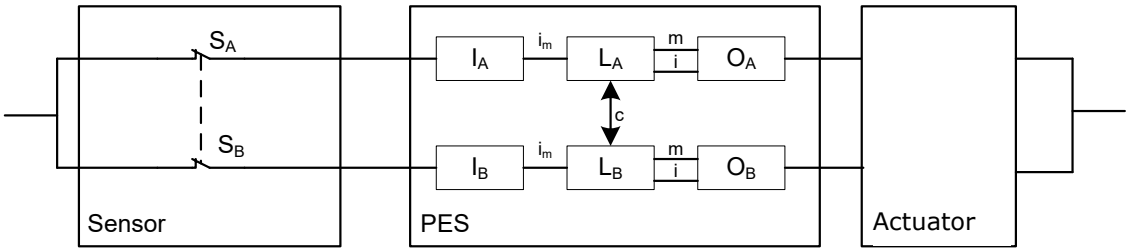


Fig. 3: Two-channel input element in parallel connection (Cat. fault tolerance 1) with high DC caused by signal in two channels and diagnose by means of cross-comparison in the PES

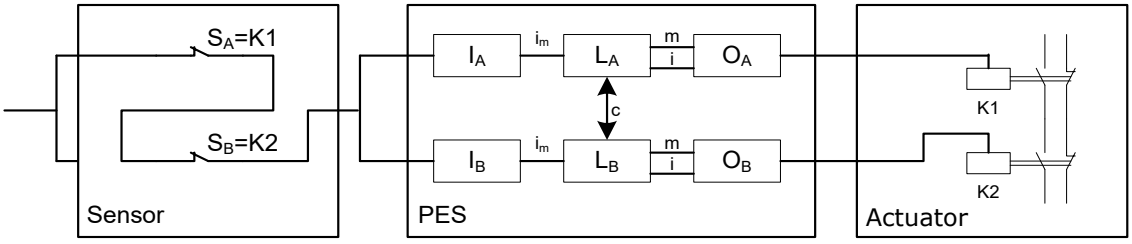


Fig. 4: Two-channel input element in series connection (Cat. 4, fault tolerance 1) with low to medium DC caused by signal processing in two channels and diagnose by means of cyclic testing

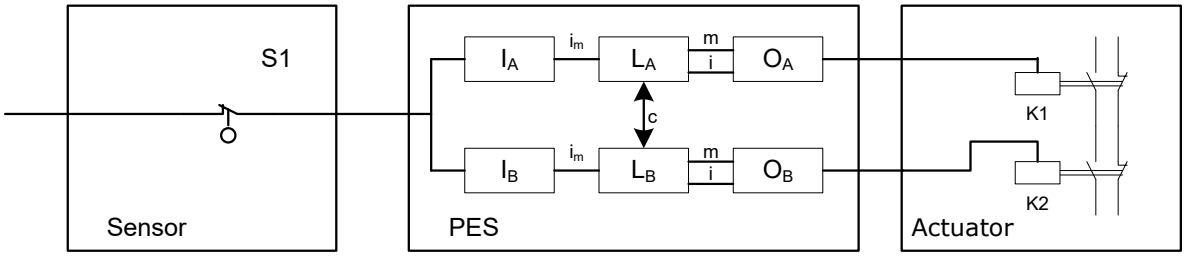


Fig. 5: Single channel input element and dual channel processing with low to medium DC by signal processing in two channels and diagnose by means of cyclic testing, PI / SIL depending on permissible fault exclusions and test rate for input element.

4.2.1.2 DC digital sensors/inputs

The SMX modules ensure far reaching diagnostics functions for the input element. These are carried out permanently, or optionally (cross-shorting monitoring by means of pulse detection, cross-comparison, 2- or multi-channel sensor with/without time monitoring, start-up test).

Permanently active diagnostic functions:

Cross-comparison:

SMX module inputs are in general internally designed with two channels. The status of input signals is permanently compared crosswise. Only with High signals in both partial input systems the input is considered a High input, should the signal level deviate between both channels, the input is set to Low state.

Dynamic test of the switching thresholds of the partial input system:

The switching thresholds for detecting the High level are tested cyclically with a high cycle rate. Falling below the defined threshold value a module triggers a module alarm.

Dynamic test of the input system's switchability:

The switchability of the input system to Low level is tested for all inputs with a high rate, except I05—I08. Falling below the defined threshold value a module triggers a module alarm.

Diagnostic functions to be activated by parameterization:

Cross-shorting test:

The SMX modules have pulse signal outputs, identified by an unambiguous signature. When performing the cross-shorting test the switching elements of the digital sensors / input elements are supplied with auxiliary voltage by the SMX-module via the pulse signal outputs. The signature is thus stamped on the High signal level of the sensors / input elements and checked by the SMX module. With the signature test short-circuits and cross-shorting to High signals can be recognized. With alternating use of the pulse signals of multi-contacts, parallel signal lines or adjacent terminal assignment, cross-shorting between the respective input elements is detected.

Sensors / input elements with 2- or multi-pole contacts without time monitoring:

Several contacts can be assigned to the sensors / input elements. These are therefore compatible with at least 2-channel elements. A High level of the sensor/input element requires a logic series connection of both contacts.

Example 1:

Input element with 2 normally closed contacts: High level when both contacts are closed.

Example 2:

Input element with 1 normally closed and 1 normally open contact: High level when normally open contact is actuated and normally closed contact is not actuated.

Sensors / input elements with 2- or multi-pole contacts with time monitoring:

Same test as before, but additional monitoring of the input signals for compliance with the defined level connections within a time window of 0.5 seconds. Defining the levels over a time period of > 0.5 seconds triggers a module alarm.

Start test:

Each time the safety module (=SMX module) is switched on, the input element must be tested in direction of the Low signal status (defined Safe State), e.g. by actuating the Emergency Stop button or a door lock after the system has been started.

Operational / organizational tests:

Apart from the previously mentioned diagnostic measures for the SMX modules, cyclic testing can be performed within the application. These tests can also be used when assessing the DC.

NOTICE

Operational/organizational tests can also be used for a combination of hardware inputs and functional inputs (input information transferred via standard field bus). However, an exclusive use of functional inputs is ruled out in this context (combination of two or more functional inputs).

The SMX modules therefore ensure far reaching diagnostics functions for the partial input system. These are performed permanently or optionally (cross-shorting monitoring by means of pulse detection).

The following diagnoses for input sensors can generally be used for the safety related assessment of the entire system:

Input element characteristic	***Parameterized / operational tests***				***DC***	***Definition of measure***	***Note***
	Cross-shorting test	With time monitoring	Start test	Cyclic test during operation			
Single-channel			O	O	>60	Cyclic test pulse by dynamic change of input signals	A sufficiently high test rate must be ensured.
	X				90	Cyclic test pulse by dynamic change of input signals	Only effective if pulse assignment is active
	X		O	O	90-99	Cyclic test pulse by dynamic change of input signals	DC depending on frequency of start / cyclic test DC = 90 test only in > 4 week intervals DC = 99 test at least 1 x day / or 100-time request rate
Dual channel					90	Cross-comparison of input signals with dynamic test, if short-circuits cannot be detected (for multiple inputs/outputs)	For fault exclusion short-circuit up to DC=99 possible
			O	O	90-99	Cyclic test pulse by dynamic change of input signals	DC depending on frequency of start / cyclic test
	X				99	Cross-comparison of input signals with immediate and intermediate results in the logic (L) and temporal as well as logic program sequence monitoring and detection of static failures and short circuits (for multiple inputs/outputs).	Only effective if pulse assignment is active
		X			99	Plausibility test, e.g. use of normally open and normally closed contacts = non-equivalent signal comparison of input elements.	Only effective in connection with activated time-out function for input element

X: Diagnostic measure activated
O: at least 1 diagnostic measure activated

SAFETY NOTE

- The manufacturer's data (MTTFD, FIT-numbers, etc.) must be used for a safety related assessment of the partial system "Sensors".
- The DC-values listed in the table must be used conservatively and compliance with the boundary conditions (see table under „Remarks“) must be ensured
- According to the applicable standards, fault exclusions are permitted. The boundary conditions mentioned in this context must permanently be met.
- If several sensor systems are required for the correct function of a single safety function, their partial values must be correctly merged by following the chosen method.

4.2.1.3 Classification of safe digital inputs

4.2.1.3.1 Digital inputs I01 … I14

Digital inputs	*Achievable performance level*	*Comment*
I01 … I04 I09 … I14	PL e	Suitable for any kind of input elements, with / without pulse, achievable PL depending on the $MTTF_d$ of the input element, as well as fault exclusions in the external wiring.
I05 … I08	PL e	Single-channel with pulse: - Mainly High level required (T_{High} > 100 * T_{Low}) - At least one request/day required by application - Fault detection upon request
	PL d	Single-channel without pulse : - F Fault exclusion short-circuit between signals and to VCC - Fault detection upon request
	PL e	Dual-channel: - At least one request/day required by application - Fault detection upon request

4.2.1.3.2 Digital inputs I/Os (IQIx)

Digital inputs	*Achievable performance level*	*Comment*
IQIx		Without pulse, single channel static signal -> auxiliary input
	PL e	Without pulse, dual-channel static signal - At least one request/day required by application - Fault detection only upon request
	PL d	Without pulse, dual-channel static signal - Less than one request/day required by application
	PL e	Single-channel with pulse - Mainly High level required (T_{High} > 100 * T_{Low}) - At least one request/day required by application - Fault detection only upon request
	PL d	Single-channel with pulse - Less than one request/day
	PL e	Dual-channel with pulse1 and pulse2

NOTE:

The achievable PI for a combination of HW-inputs and functional inputs depends on the chosen operational/organizational tests as well as on the independence of both channels in the system structure. The determination of the PI requires an application related analysis.

4.2.1.4 Exemplary connections of digital sensors

4.2.1.4.1 Single-channel sensor, without cross-shorting test

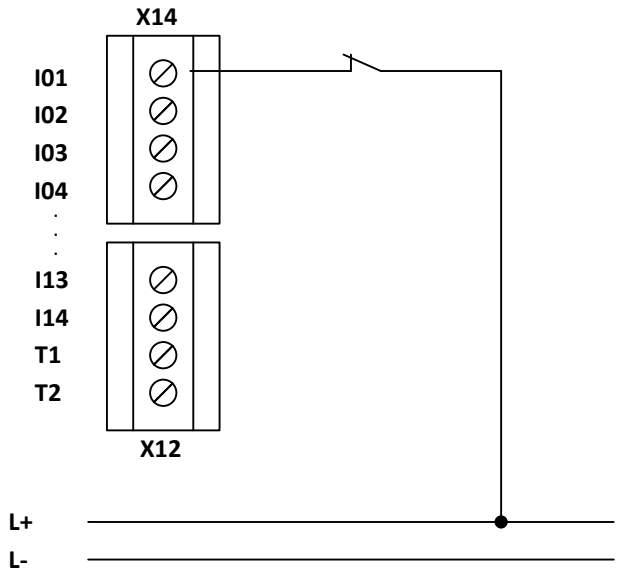


Fig. 6: Single-channel, without cross-shorting test

The single-channel sensor is connected to the SMX without clocking or without cross-shorting test. This design is not recommended for safety applications. Pl b acc. to EN ISO 13849-1 can maximally be reached.

4.2.1.4.2 Single-channel sensor with cross-shorting test

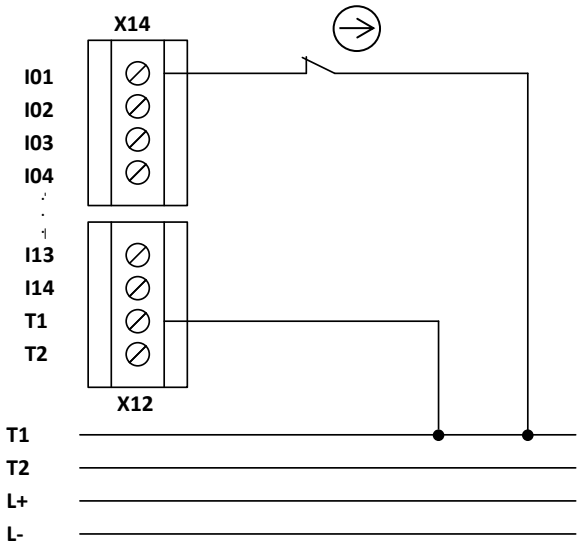


Fig. 7: Single-channel sensor with cycling

When using a single-channel sensor with clocking, the power supply of the switching element is attached to the clock exit T1 or T2. The clock must subsequently be assigned to the SMX.

The use of a single-channel sensor with clock detects:

- short-circuit to supply voltage DC 24 V
- short-circuit to DC 0 V
- cable interruption (current interruption is safe state!)

However, be cautious in case of a cable short between the two sensor connections, because this is not detected! A short-circuit between T1 and I01.

Due to the single-channel character of the switching element / sensor its failure requires an fault exclusion. This is permissible when using positively disconnecting switches with correct constrained actuation.

A series connection of 2 switching elements with corresponding fault exclusion of a double fault is on equal footing with the application (Occurrence of two errors at the same time.

These may be e.g. the safety outputs of an electronic monitoring device (light curtain, switching mat) with internal dual-channel switch-off.

PI d acc. to EN ISO 13849-1 can be achieved by using a suitable switching element and with cautious wiring of the sensor. In special cases, i.e. in connection with suitable switching elements and permissible fault exclusions one may also achieve PL e as per EN ISO 13849-1.

SAFETY NOTICE

- Pl e or higher acc. to EN ISO 13849-1 is achieved if the short-circuit between input and associated pulse output as well as the short-circuit between the sensor connections can be excluded. Here one must take care that in a fault scenario the switch must be positively opening in accordance with EN 60947-5-1. The sensor must additionally be triggered in regular intervals and the safety function requested. Fault exclusions can be achieved in accordance with EN ISO 13849-2 table D8. In case of single-channel use of the inputs, the achievable safety level must be limited to SIL 2 or PL d, if the safety function is demanded at regular intervals.
- A series connection of 2 switching elements with fault exclusion for double fault requires testing of the suitability in accordance with the intended safety level of this element. We would like to draw your attention to the applicable regulations in the EC machine directive 2006/42/EC.
- For single-channel sensors a safety related use of the inputs is only intended in connection with the clock outputs.

4.2.1.4.3 Dual-channel sensor without timeout with cross-shorting test

Faults are at least detected when requested. The DC is medium and by using cyclic tests (start test, operational/organizational tests) can be changed up to high level. depending on the test frequency.

Only normally closed contacts should be used for safety related applications.

PI d acc. to EN 13849-1 can be achieved when using sensors / switching elements with fault exclusion for not opening the switch contacts. This is permissible when using positively disconnecting switches with correct constrained actuation. The use of sensors with self-monitoring output contacts is also permitted.

Pl e in accordance with EN ISO 13849-1 can be achieved when using sensors / input elements with sufficiently high MTTFd in connection with temporal plausibility monitoring and a sufficiently high change of the switching state = dynamic testing.

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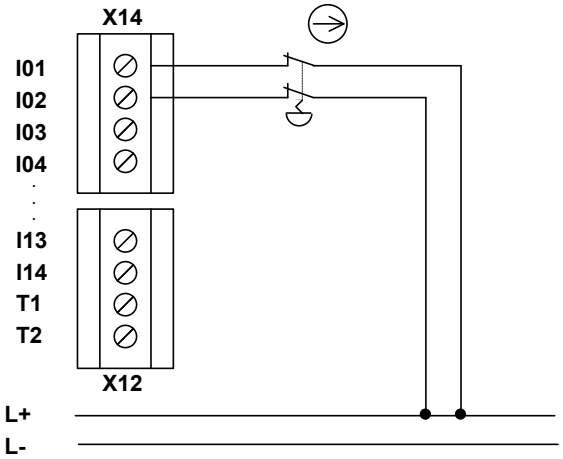


Fig. 8: Dual-channel sensor homogeneous without testing, with positive disconnection

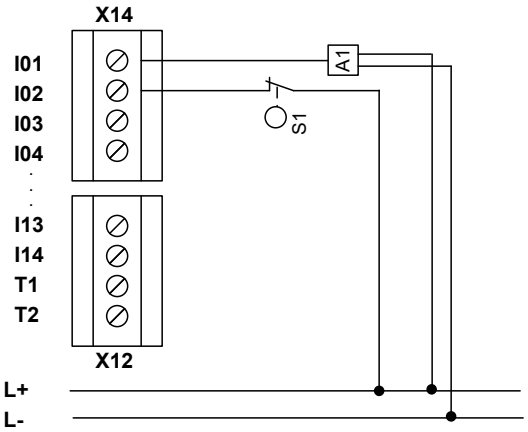


Fig. 9: ***dual-channel input element heterogeneous, without cycling***

SAFETY NOTICE

- Pl d or higher in accordance with EN ISO 13849-1 is achieved by using switching elements / sensors with positively opening contacts or positive actuation acc. to EN 60947-5-1
- Using devices for which the fault exclusion double fault for the intended safety level can be specified for the switching elements, is permitted. We would like to draw your attention to the applicable regulations in the EC machine directive 2006/42/EC.

4.2.1.4.4 Dual-channel sensor with time-out and cross-shorting test

Cross-shorting as well as connections to DC 24 V and DC 0 V can be detected by using two independent clock signals on the homogeneous sensor.

Pl d or higher acc. to EN ISO 13849-1 can be achieved when:

- Use of sensors/switching elements with forced actuation.
- Use of 2 sensors/switching elements with independent manipulation
- dto. However with actuation via a common actuation device in connection with an error exclusion for this device.

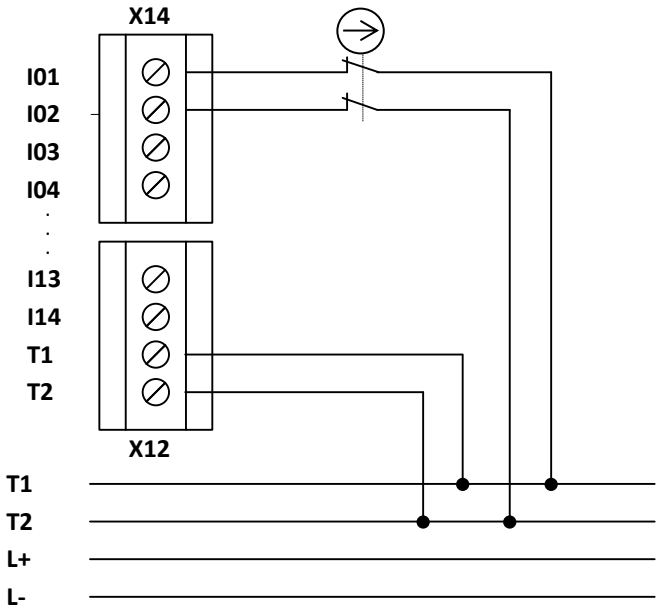


Fig. 10: Dual-channel sensor homogenous with clock

SAFETY NOTICE

- PI d or higher in accordance with EN ISO 13849-1 is achieved by using switching elements / sensors with positively actuation
- When using two independent sensors with independent actuation, PI d or higher acc. to EN ISO 13849-1 can be achieved.
- When using common elements in the actuation chain, an fault exclusion is required for this purpose. The corresponding limitations and criteria acc. to EN 13849-1 must be observed.

4.2.1.5 Overview of achievable PL for digital safety inputs

Type of Sensor / Input element	***Input***	***Parameterized / operational tests***				***Achievable PI acc. to EN ISO 13849-1***	***Fault exclusion for input element***	***Condition for input element***
		Cross-shorting test	With time-out	Start test	Cyclic test during operation			
Single-channel	I01..I14					b		Operation proven input element
				O	O	d	All faults at the input element Short-circuit at input/signal line	$MTTF_D$ = high Connection in control cabinet or protected routing
	I01..I04 I09..I14					e	All faults at the input element Short-circuit at input/signal line	Input element does not comply with min. PIr Connection in control cabinet or protected routing
	all	X				d	Getting caught Short-circuit at input/signal line	Mainly High level required (THigh > 100 * TLow). Positively disconnecting MTTFD = high Connection in control cabinet or protected routing
		X		O	O	e	All faults at the input element Short-circuit at input/signal line	Input element does not comply with min. PIr Connection in control cabinet or protected routing $MTTF_D$ = high
Dual-channel parallel	all					d	Short-circuit between input/signal line	Connection in control cabinet or protected routing $MTTF_D$ = medium
		X				e		$MTTF_D$ = high
Dual-channel parallel	all		X			e	Short-circuit between input/signal line (only with common switching elements = 2xNO or 2xNC	Connection in control cabinet or protected routing $MTTF_D$ = high

Type of Sensor / Input element	***Input***	***Parameterized / operational tests***				***Achievable PI acc. to EN ISO 13849-1***	***Fault exclusion for input element***	***Condition for input element***
		Cross-shorting test	With time-out	Start test	Cyclic test during operation			
Dual-channel Serial	I01..I04 I09..I14					d	Short-circuit at input/signal line Getting caught / positively disconnecting	Connection in control cabinet or protected routing $MTTF_D$ = medium
				O	O	e	Short-circuit at input/signal line	Connection in control cabinet or protected routing $MTTF_D$ = high
	all			O	O	d	Short-circuit at input/signal line	Connection in control cabinet or protected routing $MTTF_D$ = medium
		X		O	O	e		$MTTF_D$ = high

X: Diagnostic measure activated

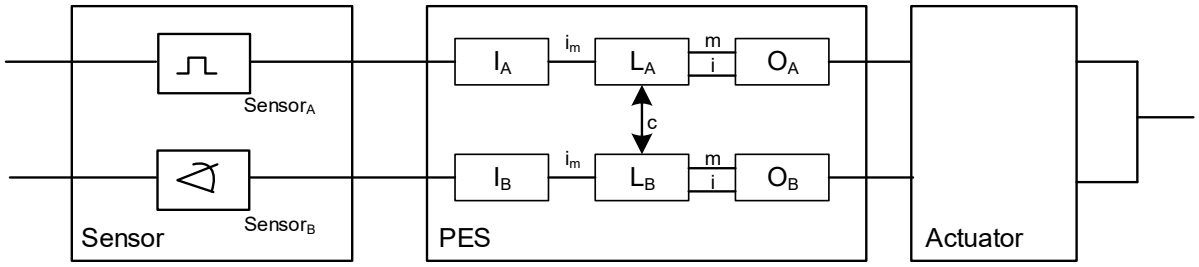
O: min. 1 diagnostic measure activate

4.2.2 Sensors for speed and/or position detection

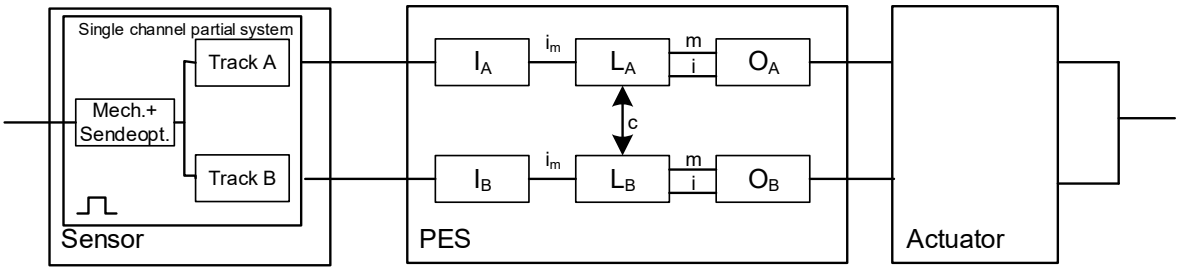
4.2.2.1 General safety related structure of the sensor interface for position and/or speed

The base modules of the SMXGen2 series can be optionally equipped with one ((SMX11/2, SMX12/2), or two encoder interfaces (SMX11-2/2, SMX12-2/2) per axis.

Depending on encoder type and combination, different safety levels can be reached. The following system reflection results for the corresponding partial system:



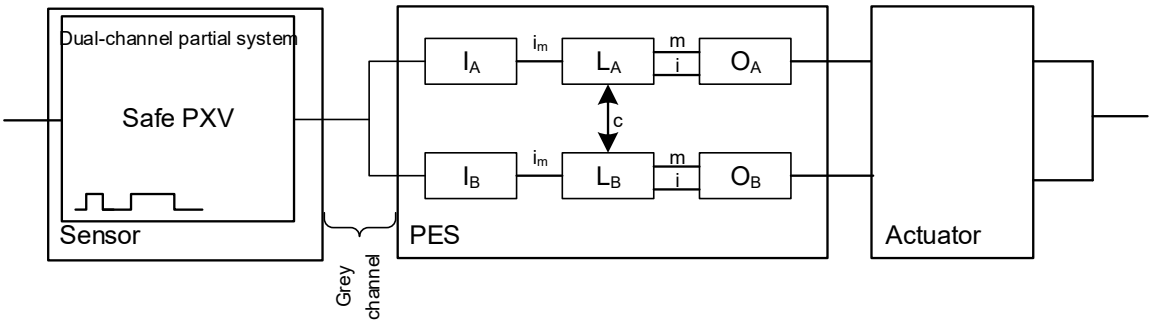
Dual sensor system with separate signal processing in two channels, diagnose by cross-comparison in the PES



Sensor system with single and dual-channel partial system (example incremental encoder). Diagnose by separate signal processing in two channels and cross-comparison in the PES as well as further specific diagnoses.

The SMX-PXV module has an encoder interface for connecting a Safe connection of a Safe PXV sensor PXV100AS-F200-R4-x-BBH.

The use of the Safe PXV sensor ensures the maximum safety level to be achieved, as listed in the technical characteristics.



Sensor system with two-channel subsystem. Diagnosis through separate signal processing in two channels and cross-comparison in the PES as well as other specific diagnoses.

NOTICE

➲ Diagnostic measures and precise information on the safe position and speed with a safePXV sensor can be found in the TS-37000-410-01-810-01-xxF SMX-x-PXV installation manual.

SAFETY NOTICE

➲ EMC measures such as shielding etc. must be observed.

4.2.2.1 General diagnostic measures for encoder interface

For fault detection in the sensor system the SMX series has a number of diagnostic measures implemented, depending on the chosen encoder type or its combination. These are automatically activated when choosing the encoder type.

With respect to their type and effectiveness diagnostic measures can generally be classified using the following table:

Diagnoses for sensors for position and/or speed detection:

Measure	***DC***	***Note***	***Use***
Cross-comparison of input signals with immediate and intermediate results in the logic (L) and temporal and logical program run monitoring and detection of static failures and short circuits (with multiple inputs/outputs)	99%	Only applicable to: - two-channel sensor systems (2 separate sensors), - the two-channel partial system of single-channel sensors (incremental encoder) - Diagnostics for the single and dual-channel partial system of specially suitable sensor systems (SIN/COS encoder, resolver) - Dynamic operation / no standstill monitoring	Monitoring of 2-channel sensor systems or the corresponding partial system of sensors for dynamic operation **Not to be used for standstill monitoring!**
Cross-comparison of input signals without dynamic test	80-95%	DC depends on the frequency of the dynamic state, i.e. standstill or movement, and on the quality of the monitoring measure (80 - 90% for incremental encoders, 95 % for SIN/COS encoders)	Monitoring of 2-channel sensor systems or the corresponding partial system of sensors for non-dynamic operation. To be used in particular for standstill monitoring!
Monitoring of some characteristics of the sensor (response time, the range of analog signals, e.g. electrical resistance, capacitance)	60%	Diagnosis of specific characteristics of sensors, only applicable for speed and position sensors according to chapter 4.2.2.3	Monitoring of the single-channel partial system of single-channel sensor systems

4.2.2.2 Encoder type and their combination, diagnostic data

Encoder A	***Encoder B***	***Safe speed***	***Safe direction***	***Safe absolute Position***	***Fault exclusion***	***DC***		
						1-channel partial system	**2-channel partial system dynamic**	***2-channel partial system non-dynamic (standstill monitoring)***
1 x Proxi	1 x Proxi	X			Actuation actuator ***)	n.a.	99%	80-90%
Incremental	NC	X			Mech. Encoder connection*) Code disk mounting **)	60%	99%	80-90%
Incremental	Incremental	X	X			n.a.	99%	95%
Incremental	1 x Proxi	X				n.a.	99%	90-95%
Incremental	2 x Counter Proxi 90°	X	X			n.a.	99%	90-95%
Incremental	SIN/COS	X	X			n.a.	99%	99%
Incremental	HTL	X	X			n.a.	99%	90-95%
Incremental	Resolver	X	X			n.a.	99%	99%
Incremental	SSI	X	X	X		n.a.	99%	90-95%
SIN/COS	NC	X	X		Mech. Encoder connection*) Code disk mounting **)	60% / 90%*) **)	99%	90-95%
SIN/COS	Incremental	X	X			n.a.	99%	95-99%
SIN/COS	1 x Proxi	X	X			n.a.	99%	90-95%
SIN/COS	2 x Counter Proxi 90°	X	X			n.a.	99%	95-99%
SIN/COS	HTL	X	X			n.a.	99%	95-99%
SIN/COS	Resolver	X	X			n.a.	99%	99%
SIN/COS	SSI	X	X	X		n.a.	99%	95-99%
SSI	2 x Counter Proxi 90°	X	X	X		n.a.	99%	90-95%
SSI	SIN/COS	X	X	X		n.a.	99%	95-99%
SSI	Resolver	X	X	X		n.a.	99%	95-99%
SSI	SSI	X	X	X		n.a.	99%	90-95%
NC	SIN/COS	X	X		Mech. Encoder connection*) Code disk mounting **)	60% / 90% *) **)	99%	90-95%
NC	Resolver	X	X		Mech. Encoder connection*) Code disk mounting **)	60 / 90% *) **)	99%	90-95%
NC	HTL	X			Mech. Encoder connection*) Code disk mounting **)	60%	99%	80-90%
2 x Counter Proxi 90°	SSI	X	X	X		n.a.	99%	90-95%

Safe PXV	NC	X	X	X	****)	n.a.	99%	97%
WCS	WCS	X	X	X		n.a.	99%	90-95%

*) A fault exclusion can be made for the mechanical connection with the note "... only form-fit connections are permitted for the shaft-hub connection of the encoder axis; alternatively, other forms of connection can also be used if they meet the safety requirements. In any case, comprehensible proof of their reliability with regard to the desired safety level must be provided (e.g. overdimensioning in the case of a positive shaft-hub connection). The corresponding notes on fault exclusion in the standard EN/IEC 61800-5-2, Annex D.3.16 (Table D.8) must be observed."
For SINCOS encoders suitable for safety applications (see notes under...), a DC of 90% can be used for the single-channel transmission LED.

**) The code disk / shaft connection and the sensor embodiment must be analyzed in detail. For a possible fault exclusion, the relevant notes in the standard EN/IEC 61800-5-2, Annex D.3.16 (Table D.8) must be observed.

***) For speed detection using a Proxi, the reliability of the actuating actuator and the mounting of the Proxi must be analyzed. The relevant information in the standard EN/IEC 61800-5-2, Annex D.3.16 (Table D.8) must be applied analogously for a possible fault exclusion.
Other single-channel parts to which the 60% apply:
Power supply, code disk mounting, mechanics of the opto-receiver (not SINCOS), code disk

****) For a possible fault exclusion, the relevant information in the standard EN ISO 13849-2, tables in Appendix D must be observed accordingly.
In order to make a safety-related assessment of the overall arrangement, the parameters from the "Technical characteristics" table can be used, as these already represent the combination of an SMX-PXV with a Safe PXV sensor PXV100AS-F200-R4-x-BBH.

4.2.2.3 Specific diagnostic measures with regard to the encoder type used

	Encoder type	***Supply voltage monitoring***	***Differential level monitoring***	***SIN/COS plausibility monitoring***	***Input signal level monitoring***	***Monitoring of the permissible quadrants***	***Monitoring of the count signal separately for track A/B***	***Monitoring of the transmission ratio Reference signal / measurement signal***	***Frequency monitoring of the reference signal***	***Voltage monitoring of the reference signal***	***Shape factor analysis Measurement signal***	***Plausibility test position signal versus speed***	***CLK frequency monitoring***	***Encoder interface specific diagnostics***
Interface X 31/32, X23	Incremental	X	X				X							
	SIN/COS	X		X										
	SSI	X	X											
	Proxi 2 x counting input	X												
	Proxi 1 x counting input	X												
Interface X 33/34	Incremental	X	X		X		X							
	HTL		X		X									
	Resolver			X		X		X	X	X	X			
	SIN/COS	X		X		X[1)]								
	SSI	X	X									X	X	
Interface X35-x	PXV	X[2)]										X		X[2)]
	WCS	X[3)]										X		X[3)]

1) Only in High-Resolution Mode

2) Diagnostic measures for encoder interface Safe PXV:

- Checking the transmission of the safe position using CRC32
- Analysis and evaluation of the encoder's error bits
- Plausibility check of the code band using dynamic color switching

▪ Further information can be found in the TS-37000-410-01-810-xxF-SMX-x-PXV Installation Manual.

3) The following diagnostic options are available with WCS:

- Redundancy with cross comparison (1oo2)
- Diversity of the sensor systems (due to different counting directions) + fixed offset between the sensor units
- Monitoring of the encoder supplies
- Monitoring for maximum limits (position, speed)
- Hardware separation of the transmission paths and point-to-point connection
- Time maintenance, time stamp
- Checking the checksum
- Sensor address check

4.2.2.4 Safety relevant cut-off thresholds encoder systems for position and speed detection

Plausibility tests with the current position and speed values are performed between both measuring channels A and B of the SMX module as a basic measure, which are then checked against parameterizable thresholds.

The ***incremental shut-down threshold*** describes the tolerable deviation of position between both sensing channels A and B in the unit of the measuring distance.

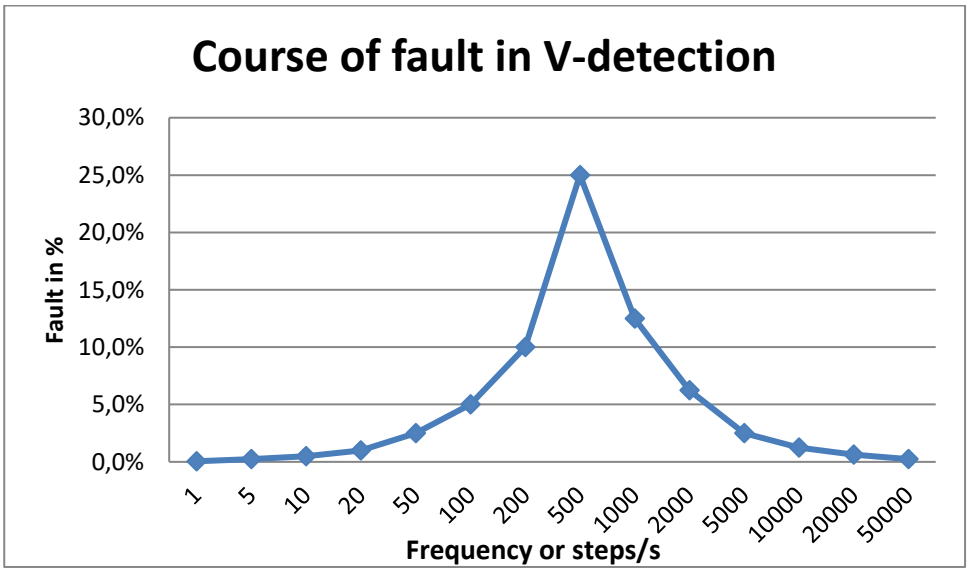
The ***speed shut-down threshold*** describes the tolerable deviation in speed between both sensing channels A and B.

Diagnostic functions for the determination of optimal parameter values for the applications are available within the SCOPE-dialog of the parameterization tool.

NOTICE	Speed and acceleration are detected values with a minimal digital resolution. This fact limits the smallest possible detection of speed or acceleration and determines the digital step width for the input values.

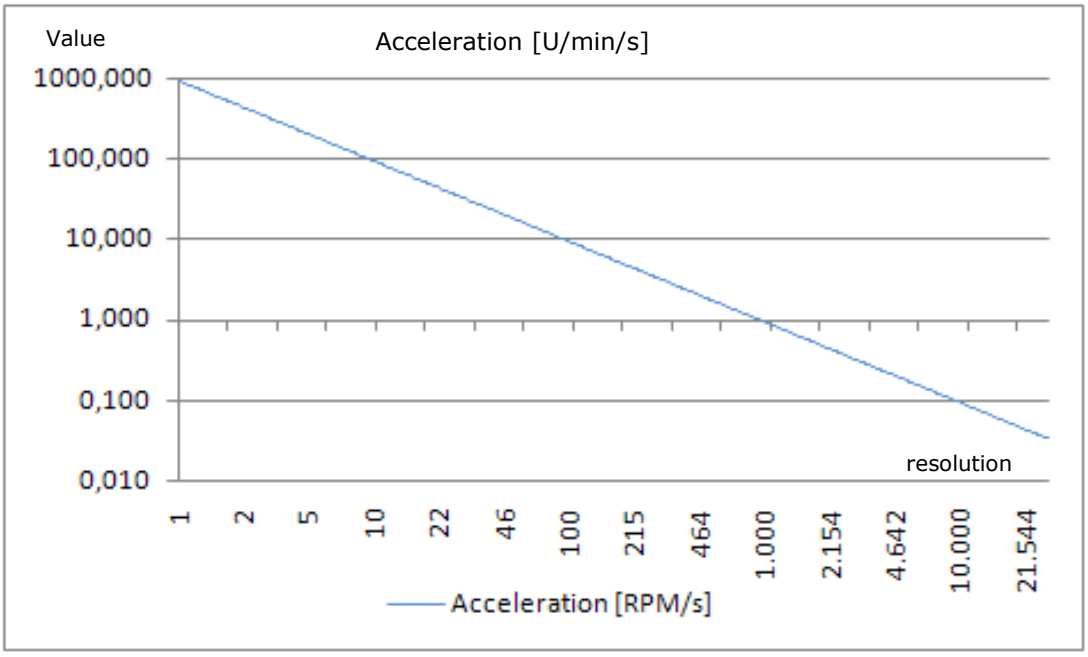
Speed resolution:

Up to a frequency of 500 Hz or 500 steps/s speed is detected with the frequency measuring method, below this it is measured with a time measuring method. This results in the following course of the sensing fault:

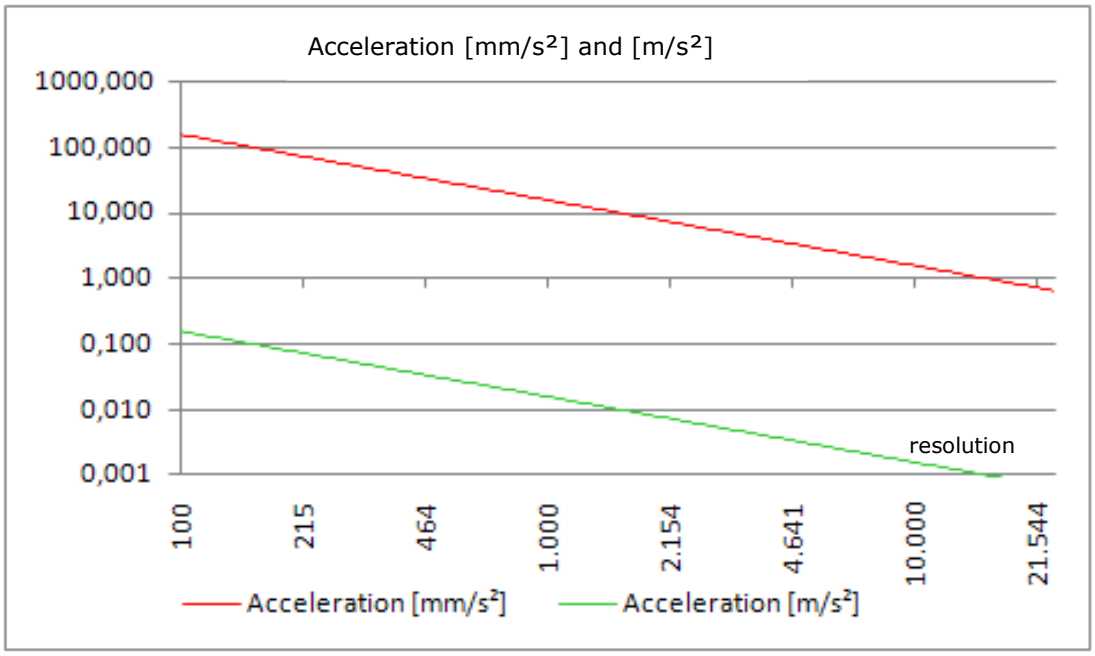


Acceleration resolution:

The digital acceleration resolution is limited by a maximum peak time of 256 ms and the encoder resolution. The graphs below show the lowest measurable acceleration in dependence on the resolution in revolutions/min, mm/s² and m/s².



Graph acceleration, rotary (Values in rev/min/s))



Graphic Acceleration resolution, linear (values in mm/s and m/s²)

SAFETY NOTICE

- The error can be optimized by selecting a suitable sensor resolution for the respective application.
- For applications with limited resolution and/or time variance of the sampling signal, the functionality of the monitoring functions used can be improved by using a mean value filter. The mean value filter "smoothes" digital interference

components of the sensors. However, this is achieved at the expense of an increased response time of the overall system.

- The filter time can be variably set between 0 and 64 in steps of 8. The dimension is "msec". To determine the response time of the overall system, the filter times must be added to the specified response times of the SMX system (see chapter 11).

SAFETY NOTICE

- The manufacturer's data ($MTTF_D$, FIT-numbers, etc.) must be used for a safety related assessment of the partial system "Sensors".
- If the manufacturer demands specific diagnoses to be able to guarantee the specified safety related characteristic values, these must be checked with respect to the specific encoder as specified in the table "Specific diagnostic measures for position and speed sensors". If in doubt, the matter must be clarified by the manufacturer.
- The DC-values listed in the table must be used conservatively and compliance with the boundary conditions (see table under „Remarks“) must be ensured.
- In order to determine the DC-value for safety functions with standstill monitoring a frequency assessment of the dynamic status may be required. A DC of 90 % may here be used a s a guide value.
- According to the applicable standards, fault exclusions are permitted. The boundary conditions mentioned in this context must permanently be met.
- If several sensor systems are required for the correct function of a single safety function, their partial values must be correctly merged by following the chosen method. This applies also for a combination of digital and analog sensors (e.g. safely reduced speed with open safety door = door contact + encoder for speed detection)
- By choosing a suitable resolution of the sensor system a sufficiently low tolerance with regard to the corresponding cut-off thresholds for the individual safety functions must be ensured.
- When using the encoder input filter one must consider the extension of the response time when assessing the safety related function.

4.2.2.5 Safety related assessment of encoder types, resolver or there combination

Due to the monitoring functions implemented in the SMX-series, no special demands are initially made on the internal design of the encoder electronics in applications with encoder systems, i.e. standard encoders can normally be used.

In general, a safety-related assessment of the overall arrangement must be made. The information provided by the encoder manufacturer (FIT, MTTF) and the DC from the tables under DC digital sensors/inputs must be used.

When using individual encoders at least a fault exclusion for the mechanical actuating chain, as well as for the single-channel part of must be made under due consideration of the applicable specification in EN ISO 13849-1. Furthermore, the information in 4.2.2 must also be observed.

PI d and higher acc. to EN ISO13849-1 is normally reached by a combination of two encoders with prioritized different technology and separated mechanical linking.

The use of compact encoders with internal 2-channel structure of different technology is also suitable for applications up to PI e acc. to EN 13849-1, however, under due consideration of the specifically required fault exclusions and their permissibility. Normally one should use encoders with proven safety related characteristics, the safety level of which meets the demanded level.

SAFETY NOTICE

- The use of standard encoders or a combination of standard encoders is permitted. A safety-related assessment is required for the overall arrangement consisting of the encoder, other sensors/switching elements for triggering the safety function, the SMX module and the switch-off channel. The manufacturer's specifications (FIT, MTTF) and the DC must be used to determine the safety level achieved.
- If only one encoder is used, the fault exclusion "shaft breakage / fault in the mechanical encoder connection" is required. Suitable measures must be applied for this purpose, e.g. a positive connection of the encoder by means of slot shim or locking pin. The applicable information issued by the manufacturer as well as EN ISO 138549-1 with respect to requirements and permissibility of the fault exclusion must strictly be followed
- Encoders with proven safety characteristics must preferably be used as individual encoders. The safety level of these encoders must at least correspond to the desired safety level of the overall arrangement. The manufacturer's instructions with regard to diagnostic measures, mechanical connection and power supply measures must be observed.
- SIN/COS encoder: The internal structure of the sensor system must be designed in such a way, that output signals for both tracks can be generated independently from each other and Common-Cause faults can be ruled out. Evidence of the mechanical design, e.g. fastening of the code disc on the shaft, must also be provided. Encoders with proven safety related characteristics should preferably be used.

- When using compact encoders with internal dual-channel structure, such as e.g. SSI + incremental/SinCos, you must strictly follow the instructions of the manufacturer concerning safety related characteristics, diagnostic measures, mechanical connection and measures concerning the electric power supply. The safety level of the encoder must at least meet the intended safety level of the overall arrangement. Encoders with proven safety related characteristics should preferably be use.

The SMX module generally detects the following errors in the external encoder system:

- Short-circuits between safety relevant signal lines
- Interruptions in safety relevant signal lines
- Stuck at 0 or 1 on one or all safety relevant signal lines

Each encoder type has further specific diagnoses for fault detection in the external encoder system assigned. The following list sows the respective diagnostic measures for the individual encoders, together with the limiting parameters.

SAFETY NOTICE

- The diagnostic measures obviously have tolerances because of measuring inaccuracies. These tolerances must be accounted for in the safety related assessment.
- The limiting values for the corresponding diagnostic measures are partly parametrizable or fixed. The diagnostic coverages resulting from this must be assessed in relation to the application and included in the safety related overall assessment.

4.2.3 Analog sensors

The base modules SMX10A/2, SMX12A/2, SMX12-2A/2 have two analog inputs with two input channels each. Only 2-channel sensors can be connected to this interface.

The internal signal processing takes place separately in the two channels with cross-comparison of the results.

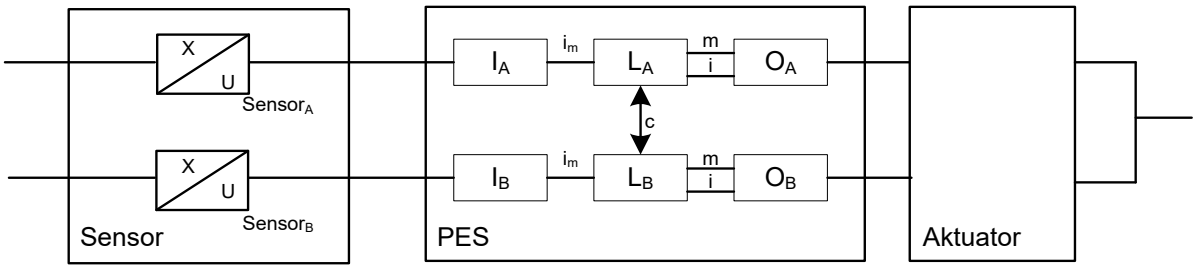


Fig. 11: Dual-channel sensor system with separate signal processing in two channels, diagnostic by cross-comparison in the PES

As with other sensor systems, a vast number of diagnostic measures has been implemented.

With respect to their type and effectiveness diagnostic measures can generally be classified using the following table:

Diagnostics for sensors for voltage and/or current detection:

Measure	***DC***	***Note***	***Use***
Cross-comparison of input signals with dynamic test, if short-circuits cannot be detected (for multiple inputs/outputs)	90%	Comparison of the analog input values with identical characteristics for both channels	Monitoring of dual-channel systems with identical characteristic of the input signals
Cross-comparison of input signals with immediate and intermediate results in the logic (L) and temporal as well as logic program sequence monitoring and detection of static failures and short circuits (for multiple inputs/outputs).	99%	Comparison of the analog input values with diverse characteristic for both channels. E.g. inverse signal course, etc.	Monitoring of dual-channel systems with diverse characteristic of the input signals

SAFETY NOTICE

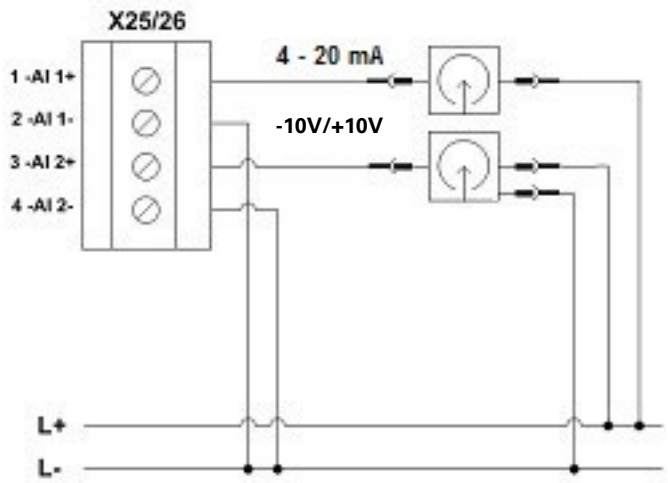
- The manufacturer's data ($MTTF_D$, FIT-numbers, etc.) must be used for a safety related assessment of the partial system "Sensors.
- The DC-values listed in the table must be used conservatively and compliance with the boundary conditions (see table under „Remarks“) must be ensured.
- According to the applicable standards, fault exclusions are permitted. The boundary conditions mentioned in this context must permanently be met.
- If several sensor systems are required for the correct function of a single safety function, their partial values must be correctly merged by following the chosen method. This applies also for a combination of digital and analog sensors (e.g. safely reduced speed with open safety door = door contact + encoder for speed detection)

4.2.3.1 Exemplary connection of analog sensors

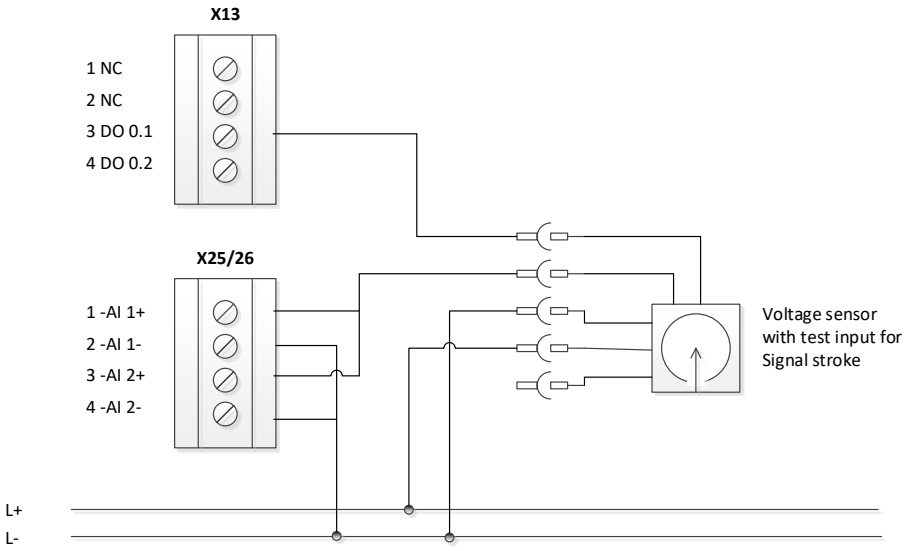
By using suitable sensors and careful wiring of the sensor Pl e acc. to EN ISO 13849-1 can be achieved.

The analog current inputs are all equipped with the fixed loading resistor of 500Ohm. For analog voltage inputs this resistor is omitted..

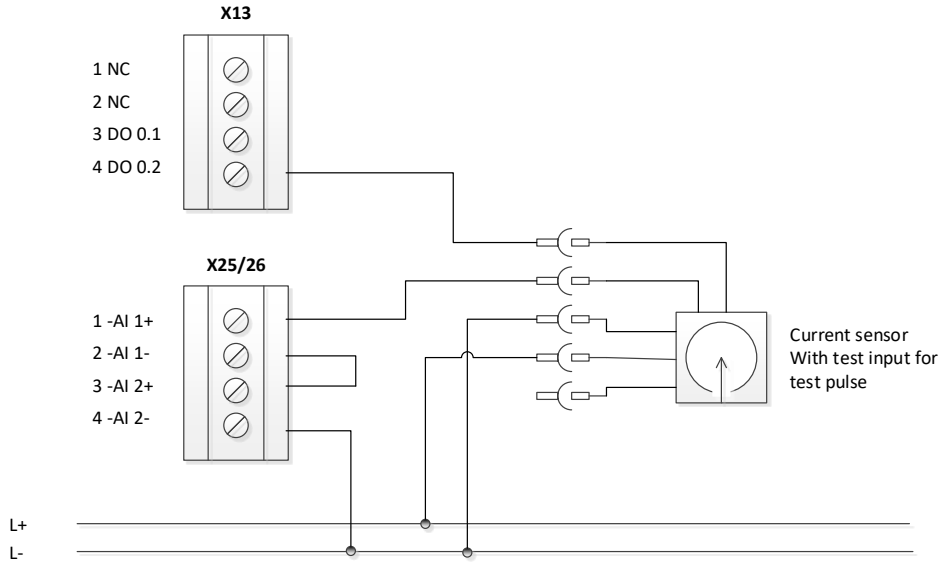
4.2.3.1.1 Voltage and current sensor



4.2.3.1.2 Voltage sensor with test pulse



4.2.3.1.3 Current sensor with test pulse



SAFETY NOTICE

➲ PI e acc. to EN ISO 134849-1 is achieved when using two non-reactive sensors, for which Common Cause faults can be ruled out.

4.3 Safety related characteristic data and wiring of the outputs

SMX modules all have safe outputs of various types. For wiring, the corresponding characteristic as specified in the following description, must be accounted for.

4.3.1 Characteristics of the output elements

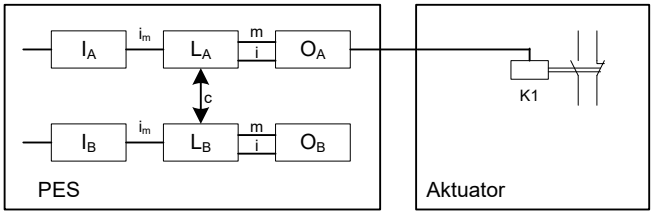


Fig. 12: Single-channel output SMX and single-channel actuator without diagnostics

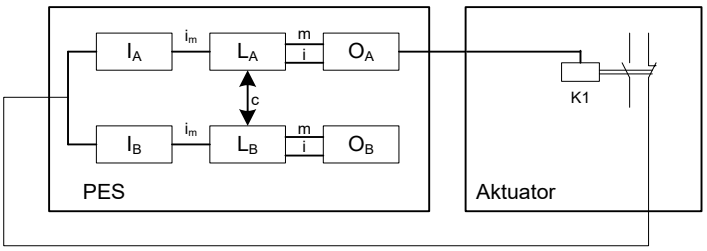


Fig. 13: Single-channel output SMX and single-channel actuator with diagnostics

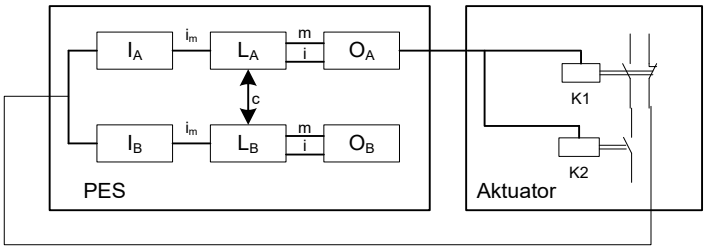


Fig. 14: Single-channel output SMX (Rel 1 / 2, DO 0/1P, DO 0/1M) and dual-channel actuator with at least single-channel diagnostics

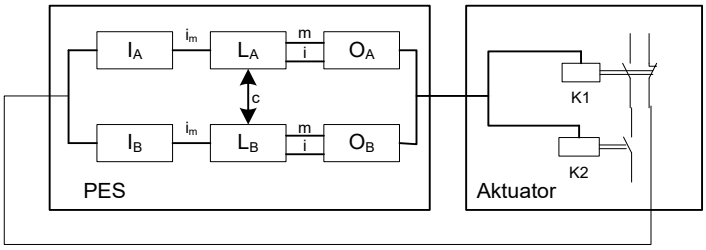


Fig. 15: Single-channel output SMX with internal dual-channel processing (IQQx) and dual-channel actuator with at least single-channel diagnose

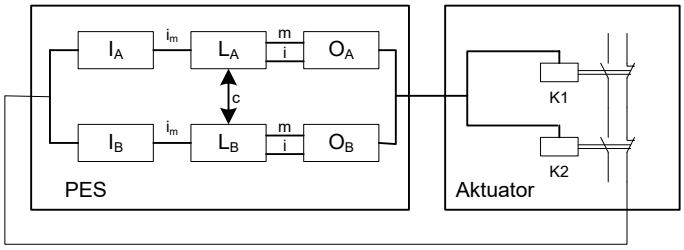


Fig. 16: Single-channel output SMX with internal dual-channel processing (IQQx) and dual-channel actuator with dual-channel diagnose

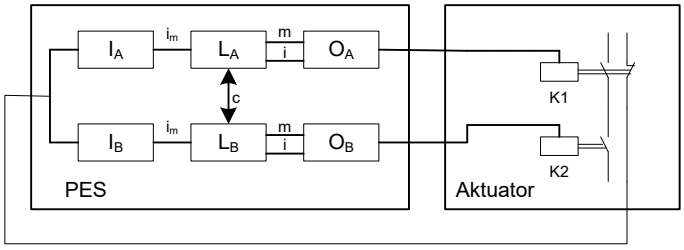


Fig. 17: Dual-channel output SMX and dual-channel actuator with single-channel diagnose

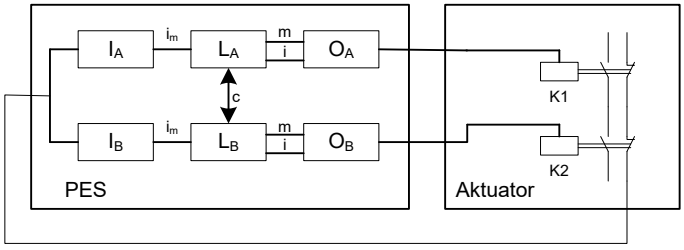


Fig. 18: Dual-channel output SMX and dual-channel actuator with dual-channel diagnose

4.3.2 Diagnoses in the cut-off circuit

The cut-off circuit is equipped with durably implemented and parametrizable diagnostics functions. Certain diagnostics functions also include the external part of the cut-off channel. Depending on he use of these diagnostics functions, different DC-values will arise.

4.3.2.1 Diagnostic functions

Permanently implemented diagnostic functions:

Cross-wise readback of outputs:

All safety outputs are read back in the complementary channel. Faults in the internal cutout circuit of the SMX module are thus detected with DC = High.

Test of cutout ability for Q4 und Q5 (only control of relay),

Q 1, Q 2, Q 3, Q 4:

The cutout ability of these outputs is cyclically tested. Failure of the cutout possibility is clearly detected.

Parametrizable diagnostics functions:

Readback of the actuator status via auxiliary contacts, position indicators, etc.:

The current status of the actuator is detected by correspondingly suitable auxiliary contacts or position indicators and compared with the nominal status. Any deviation is thereby clearly recognized.

NOTICE	The DC depends on a single-channel or dual-channel diagnose as well as on the switching frequency.

Testing the cutout ability for IQx, Q1 – Q4:

Once this function has been activated, the cutout ability of these outputs is cyclically tested. Failure of the cutout possibility is clearly detected.

4.3.2.2 Overview DC with respect to the chosen diagnostic functions

Measure	***DC***	***Note***	***Use***
Monitoring of outputs b a channel without dynamic test.	0-90%	DC depending on switching frequency When using elements for switching amplification external relays or contactors) only effective in connection with the readback function of the switching contacts	Monitoring of electro-mechanical, pneumatic or hydraulic actuators / outputs
Redundant cutout path with monitoring one of the drive elements	90%	When using elements for switching amplification external relays or contactors) only effective in connection with the readback function of the switching contacts	Monitoring of the outputs with direct functions as safety circuit or monitoring of safety circuits with elements for switching amplification of pneumatic / hydraulic control valves in connection with readback functions from their switching status
Cross-comparison of input signals with immediate and intermediate results in the logic (L) and temporal as well as logic program sequence monitoring and detection of static failures and short circuits (for multiple inputs/outputs).	99%	When using elements for switching amplification external relays or contactors) only effective in connection with the readback function of the switching contacts For applications with frequent safety shut-down requests these tests should be performed more frequently, e.g. at the beginning of the shift, 1 x per week. However, a test should at least be carried out cyclically 1 x year.	Monitoring of the outputs with direct functions as safety circuit or monitoring of safety circuits with elements for switching amplification of pneumatic / hydraulic control valves in connection with readback functions from their switching status

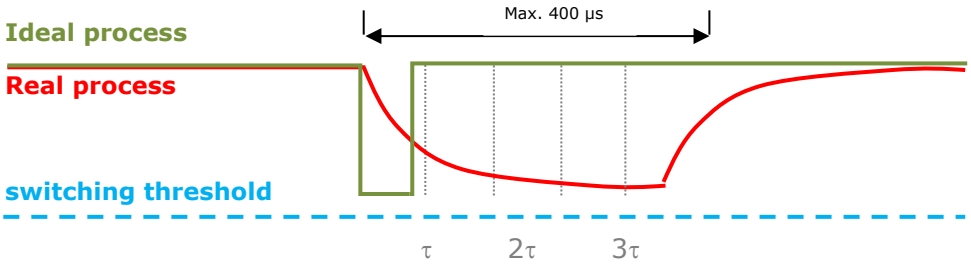
4.3.3 Permissable capacitive and inductive load at safe outputs

The safe outputs of the SMX exhibit an OSSD character. That is, the outputs are cyclically switched off for the test of the switching off ability and the status is read back.

The examination of the switching off ability takes place according to the following criteria/functions:

- After switching the output off, the output voltage may max. be 5.6 V
- The permissible voltage level must be achieved at the latest after 400 µs
- If the permissible voltage level is reached, the test is seen as successful, the output is activated again without further delay
- If the permissible voltage level is still not reached after 400 µs, an alarm is triggered and all safe outputs (second channel with safe outputs!) are deactivated

The following representation shows the ideal (green curve) and typical (red curve).



For the determination of the maximally permissible capacity or inductance, the time constant τ of the real RC or RL member at the output must be viewed.

This RC or RL member determines the real discharge curve:

The voltage level of max. 5,6 V is securely reached after 3 τ.

This applies:

$$3\tau \leq 350\mu s$$

$$\tau \leq 100\mu s$$

With the correlation

$$\tau = RC = \frac{L}{R}$$

the max. usable capacitive or inductive load can be determined in connection its Ohm's load:

$$C_{max} = \frac{\tau}{R} = \frac{10^{-4}}{R} \quad \text{resp.} \quad L_{max} = \tau R = 10^{-4} \cdot R$$

Typical values for capacity C are C=20 nF and for Longitudinal inductance L = 100 mH

4.3.4 Digital outputs

The modules

- SMX10/2, SMX10A/2, SMX10R, SMX11/2, SMX11-PXV/2, SMX11-WCS/2, SMX11-2/2, SMX12/2, SMX12A/2, SMX12-1-PXV/2, SMX12-2/, SMX12-2A/2
- SMX31/2, SMX31R/2, SMX31R-4/2

each have the identical outputs.

4.3.4.1 Characteristic data of the basic outputs

The **SMXGen2** series provides different types of outputs that can be connected either individually or in groups.

Output	***Architecture acc. to EN ISO 13849-1***	***Comment***
Combination of 2 relays Q5 – Q6	4	Complete tripping channel in compliance with architecture category 4 acc. to EN ISO 13849-1
Q5, Q6	Not safe	Only functional
Q1 _PP and Q2_PN	4	Complete tripping channel in compliance with architecture category 4 acc. to EN ISO 13849-1
Q1_PP	Not safe	Only functional
Q2_PN	Not safe	Only functional
Q3_PP and Q4_PN	4	Complete tripping channel in compliance with architecture category 4 acc. to EN ISO 13849-1
Q3_PP	Not safe	Only functional
Q4_PN	Not safe	Only functional
Q1 – Q4	4	Complete tripping channel in compliance with architecture category 4 acc. to EN ISO 13849-1
Y1	Not safe	Auxiliary output
Y2	Not safe	Auxiliary output

The Qx_PP, Qx_PN and Q1- Q4 outputs are subjected to a plausibility test in all operating states. In switched on state the correct function of all outputs is tested with a cyclic test pulse. For this purpose the output is switched to the corresponding inverse value for a test period TT <500µs (typically 200 µs) i.e. one pp-output is switched instantaneously to 0 VDC potential, while one pn-output is switched to 24 VDC potential.

The relay outputs Q5, Q6 are monitored for plausibility during each switching cycle. The relay outputs must be switched cyclically and thus tested to maintain the safety function. The switching/test cycle is determined in dependence on the application.

SAFETY NOTICE

- For applications with frequent safety shut-down requests these tests should be performed more frequently, e.g. at the beginning of the shift, 1 x per week. However, a test should at least be carried out cyclically 1 x year.
- The test function for the outputs is performed for groups and individual controls. The auxiliary outputs are not tested
- The High-Side (Qx_PP) and Low-Side (Qx_PN) outputs must individually not be used for safety duties. Any use for safety tasks is only permitted in combination high-side / low-side (Attention: not relevant from FW-Release 05-00-00-01)

A mixed operation with relay contacts is **not** permitted!

Mixed operation: A dangerous contact voltage potential may not be mixed with a protective low voltage.

Example:

FALSE: 230 VAC (120 VAC cULus) is switched via Q5.1 + Q5.2 and 24V DC is switched via Q6.1+ Q6.2.

TRUE: *230 VAC (120 VAC cULus) is switched via Q5.1 + Q5.2 and Q6.1 + Q6.2.*

Or

24V DC is switched via Q5.1 + Q5.2 and Q6.1 + Q6.2.

The outputs can be loaded as follows:

Output	***Voltage***	***Current***
Relay Qx	24 VDC	2,0 A (DC13, Pilot Duty)
Relay Qx	230 VAC	2,0 A (AC15)
	120 VDC	2,0 A (Pilot Duty)
Yx	24 VDC	250 mA
Qx_PP	24 VDC	2 A
Qx_PN	GNDEXT	2 A
Qx	24 VDC	0,5 A, 2 A

SAFETY NOTICE

- For safety-related applications, use only external switching elements with a minimum holding current of > 1.2mA.
- For safety-technical applications, only external switching elements may be used in connection with the combination p-/n-switching outputs
  - at a load resistance ≥ 100 Ω with a minimum holding current of > 2mA or
  - with a load resistance < 100 Ω with a holding power > 0.4 mW

Only relevant for SMXGen2 (/2) up to HW-Release 11-xx-xx…

- A number of diagnostic measures are implemented for the output system. Particular attention should be paid here to the inclusion of elements for switching amplification such as relays, contactors etc. in the cut-off circuit.
- When used in elevator technology in accordance with EN 81-20/-50 or EN 81-1/-2, the outputs of the internal relays must not be used to switch voltages above 24V, as the specifications of EN 81-20/-50 or EN 81-1/-2 do not permit this.
  With an infringement, the guarantee expires and BBH does not pay compensation.

NOTICE

If the auxiliary outputs are used for control purposes, it must be noted that the auxiliary outputs are in an undefined state in the start-up phase after a POR of the control system.

4.3.4.2 Wiring examples basic outputs

4.3.4.2.1 Single-channel switching relay or semi-conductor output without testing

For the connection of multi-phase applications or for higher current demands external contactors may be used. For a single-pole connection without external test please bear in mind that the SMX1x/2 module will not recognize bonding of one or several external contacts.

The following circuit example is only limited suitable for safety applications, **Pl b** acc. to EN ISO 13849-1 can maximally be achieved!

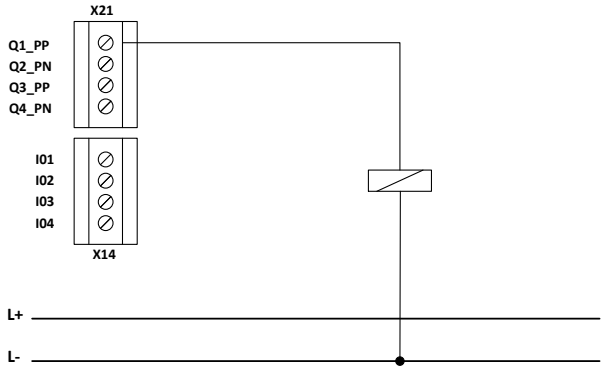


Fig. 19: Single-channel swichtingp-output

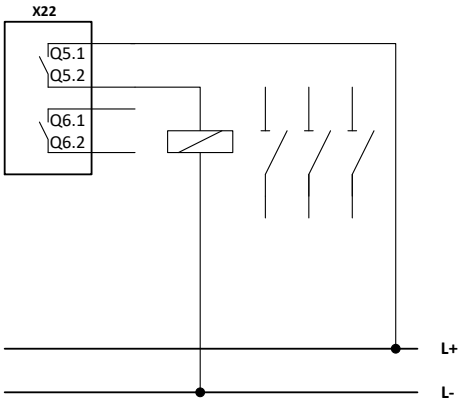


Fig. 20: Single-channel switching relay output.

SAFETY NOTICE	**Not recommended for safety applications!**
	In this context see also the notes in EN ISO 13849-1 concerning the application and the required fault exclusions.

4.3.4.2.2 Single-channel switching relay or semi-conductor output with external switching amplifier and testing

When using external switching amplifiers or downstream electro-mechanical, pneumatic or hydraulic components, the setup for testing the complete chain and a message/warning feature for detected faults is required in order to achieve PI c or higher.

Positively guided auxiliary contacts are especially needed for electro-mechanical devices and message contacts for the valve position are required for hydraulic or pneumatic components.

The message/warning device must ensure that the operator recognizes the dangerous situation immediately.

The achievable PI is mainly depending on the test rate, **PI d** acc. to EN ISO 13849-1 can maximally be achieved!

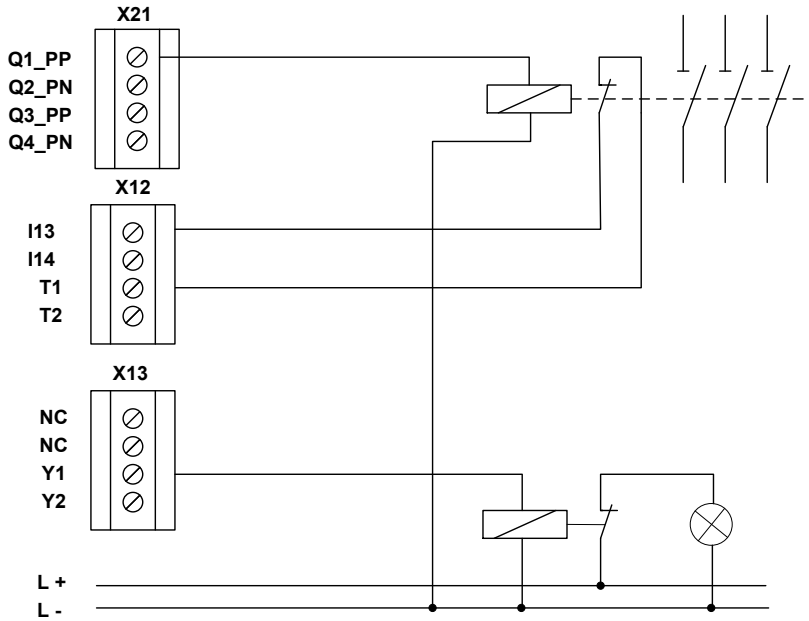


Fig. 21: Single-channel switching relay output with testing

SAFETY NOTICE

Only conditionally recommended for safety applications!

- See also the notes in EN ISO 13849-1 on application and required fault exclusions.
- A test rate >= 100 * demand rate is required for category 2.
- If a hazardous situation is detected during a test of the safety function, suitable control measures must be initiated.
- For PL d, a safe state must be initiated which must not be canceled until the fault has been eliminated.
- For PL up to and including PL c, it is also possible to indicate a fault by means of a warning or signaling device if a safe state cannot be initiated.

4.3.4.2.3 Single-channel switching relay or semi-conductor output with dual-channel external circuit with testing

For safety applications from PL c in accordance with EN ISO 13849-1, it is recommended or required to control two external switch-off elements. Furthermore, to achieve PL c or higher, a device for testing the complete chain and a signaling/warning device when a fault is detected is required - see notes under 4.3.4.2.2.

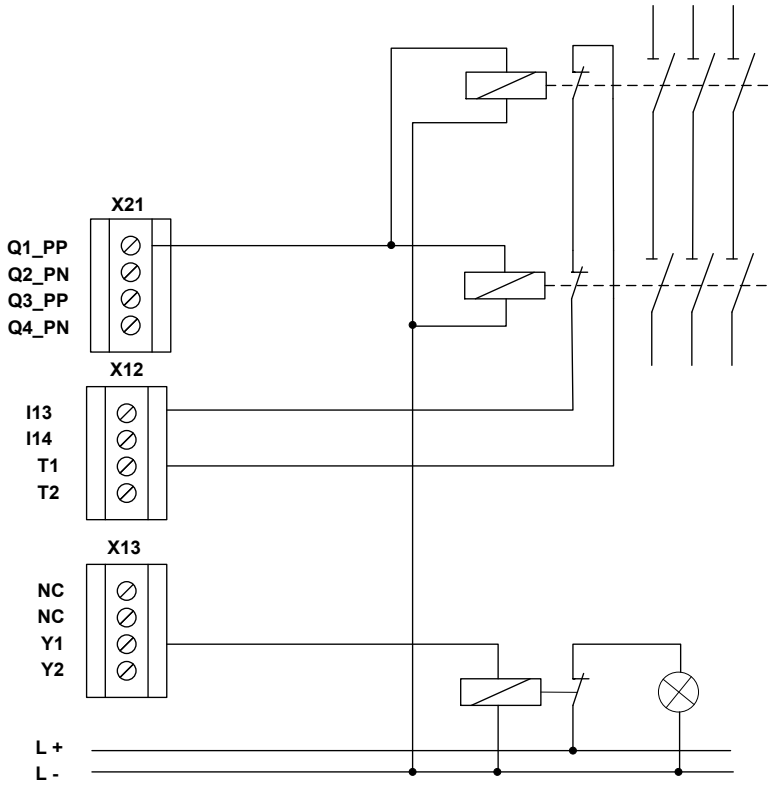


Fig. 22: ***Single-channel switching output Q1_PP with dual-channel external circuit and monitoring at output 13 1 as group feedback***

The two external monitoring contacts are switched in series, supplied by the clock signal T1 and read via input 13. Input 13 was chosen as readback input, but any other input can be assigned for this purpose.

.

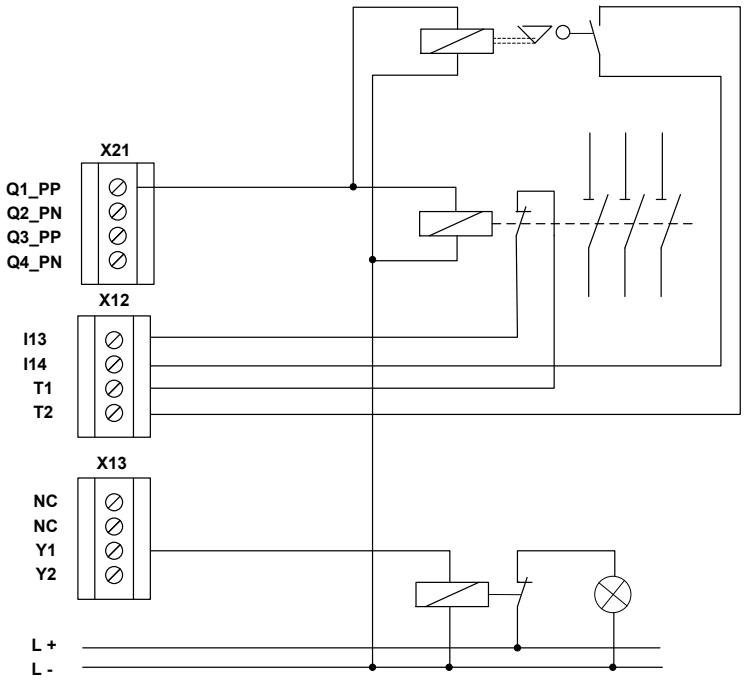


Fig. 23: ***Single-channel switching output Q1_PP with dual-channel external circuit as combination of electro-mechanical element and hydraulic/pneumatic valve and monitoring at two inputs***

SAFETY NOTICE

Only conditionally recommended for safety applications!

- Only conditionally recommended for safety applications! In this context see also the notes in EN ISO 13849-1 concerning the application and the required fault exclusions.
- For PL c and higher a message/warning feature is required, which informs the operator immediately about a dangerous situation
- For higher requirements you must make sure that at least 1 switching operation must take place every 24 hours, in order to test the switching ability of the external power contactor.

4.3.4.2.4 Two-channel switching relay output with external monitoring - group feedback

For safety related applications from **Pl d** acc. to EN ISO 13849-1 two relays on the SMX1xx module and two external power contactors are used.

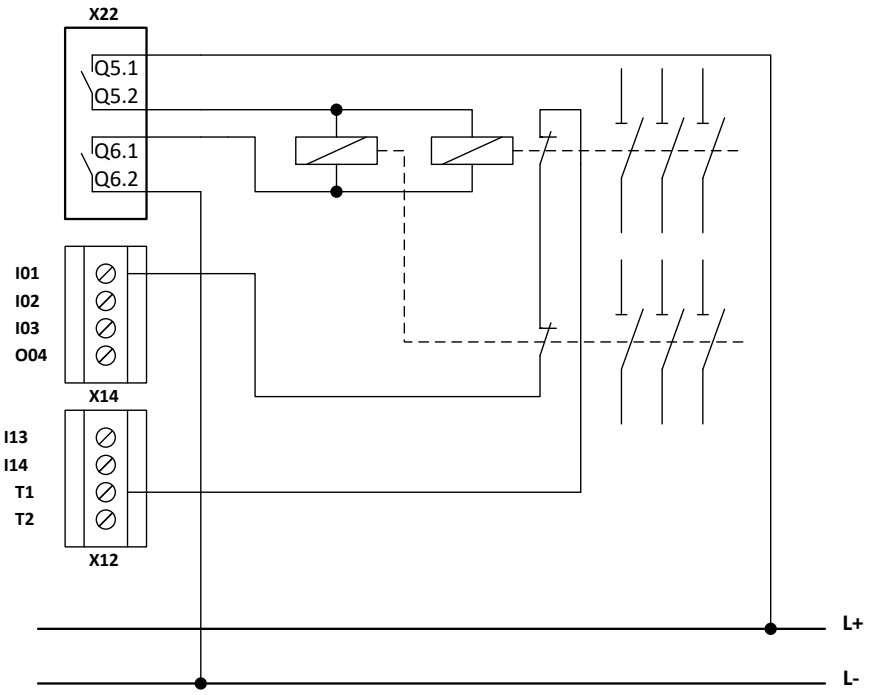


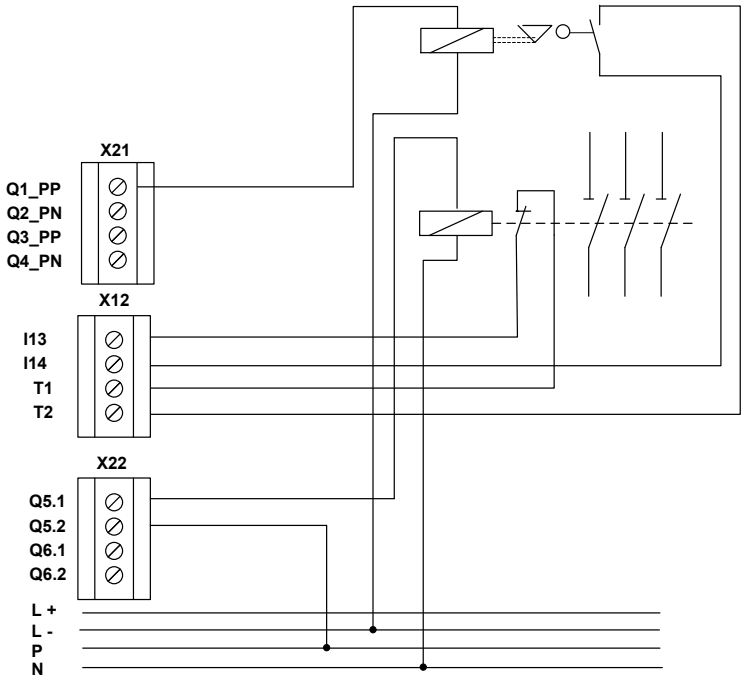
Fig. 24: ***Two-channel switching relay output with external monitoring – group feedback***

The two external monitoring contacts are switched in series, supplied by the clock signal T1 and read in from I01 (configured as EMU-input). In case of higher demands one must consider that at least 1 switching process must take place every 24 hours.

SAFETY NOTICE	For achieving PI e acc. to EN ISO 13849-1 a sufficiently high testing rate is required.
	➲ For applications with frequent requests for safety shutdown, testing should be carried out at shorter intervals, e.g. at the start of a shift, once a week. However, a test should be carried out at least cyclically once a year.

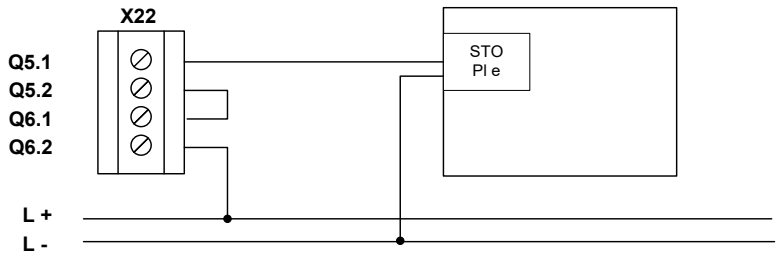
4.3.4.2.5 Dual-channel output with relay output and semi-conductor output – external control circuit with monitoring

For safety applications from PI d and higher acc. to EN ISO 13849-1. The external circuit is controlled in dual-channel mode via a relay and a semi-conductor output. Each of the two external cutout paths is monitored. For PL e acc. to EN ISO 13849-1 a sufficiently high testing rate and $MTTF_D$ = high is demanded for the external circuit.



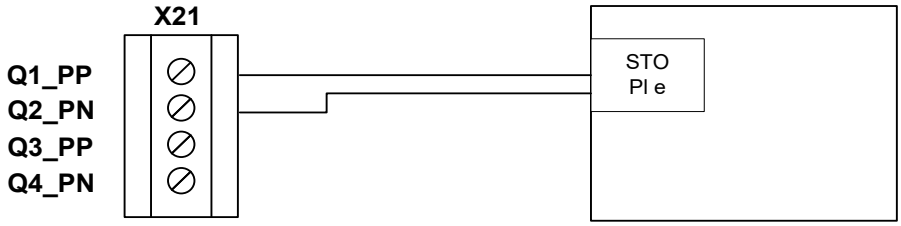
4.3.4.2.6 Dual-channel output with relay output and external control circuit in PI e

For safety applications from PI d and higher acc. to EN ISO 13849-1. The external circuit is controlled in dual-channel mode via the relay outputs. For PL e acc. to EN ISO 13849-1 a sufficiently high testing rate and PI e is demanded for the external circuit.



4.3.4.2.7 Dual-channel output with semi-conductor output and external control circuit in PI e

For safety applications from PL d and higher in accordance with EN ISO 13849-1. The external circuit is controlled in two channels via semiconductor outputs. For PL e in accordance with EN ISO 13849-1, PL e is required for the external circuit.



4.3.4.2.8 Wiring of a auxiliary output

Both semi-conductor outputs implemented on the SMX1x module can be wired for functional applications. These outputs are not pulse-commutated.

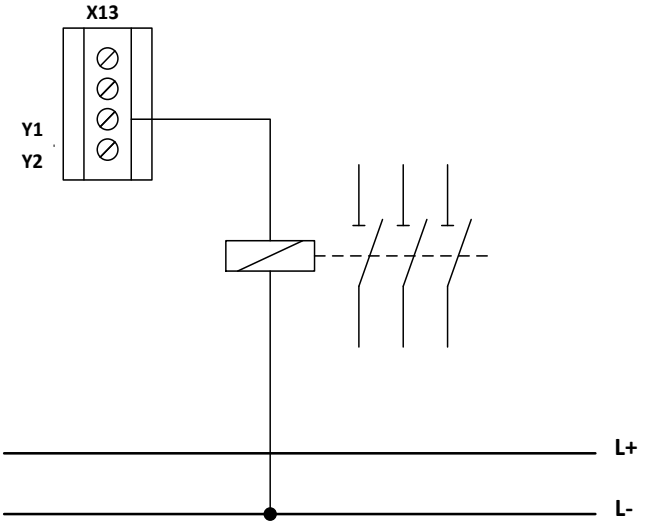


Fig. 25: ***Wiring of a notification output***

Applications with auxiliary outputs are not permitted for safety applications!

4.3.5 Digital outputs I/Os (IQQx)

The expansion of modules of the SMX31/31R/31R-4/2 have configurable safe digital I/Os (see chapter 3 module overview). This connection acts as safe digital pp-switching output parameterized as output.

4.3.5.1 Classification of the I/O's (IQQx) when used as output

Classification	***Achievable Pl acc. to EN ISO 13849-1***	***Comment***
Static single-channel[2]	PL c	- Fault detection or fault reaction acc. to cat. 2
Static two-channel[2]	PL d	Same group [1]: - Time-shifted triggering on PLC level - Fault approach short-circuit on both outputs Different group [1]: - Nom further requirements necessary
	PL e	Different group[1] required
Dynamically single-channel [2]	PL e	No further requirements necessary
Dynamically dual-channel [2]		

NOTICE

1) Group 1: IQQ1 … IQQ6
   Group 2: IQQ7 … IQQ10

2) Static: no pulse test on output
   Dynamic: Pulse test on output $t_{Test} \leq 500$ µs

4.3.5.2 Wiring examples for safe digital outputs I/O's (IQQx)

4.3.5.2.1 Wiring single-channel without testing

When using a two-channel output (IQQx) in connection with a single-channel external wiring without external examination it must be taken into account that and adherence of one or several external contacts of the SMX1x module is not recognized. The following circuitry example is only suitable in a restrictive manner, **maximally PL b** according to EN ISO 13849-1 can be reached

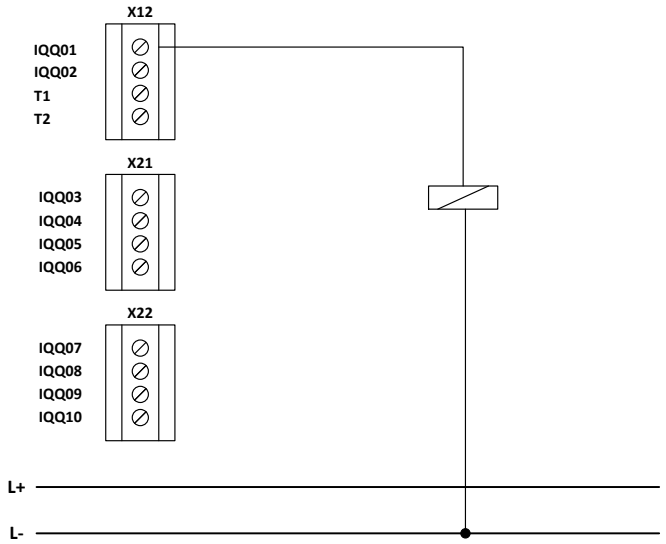


Fig. 26: Two-channel output with single-channel wiring without testing

SAFETY NOTICE

Not conditionally recommended for safety applications!

See also the notes in EN ISO 13849-1 on application and required fault exclusions.

4.3.5.2.2Wiring single-channel with testing

When using a two-channel output (IQQx) in connection with a single-channel external wiring with testing. Positively guided auxiliary contacts are especially needed for electro-mechanical devices and message contacts for the valve position are required for hydraulic or pneumatic components. Furthermore, a message/warning device for indicating a failure is required. The message/warning device must ensure that the operator recognizes the dangerous situation immediately.

The achievable PI is mainly depending on the test rate**, PI d** acc. to EN ISO 13849-1 can maximally be achieved!

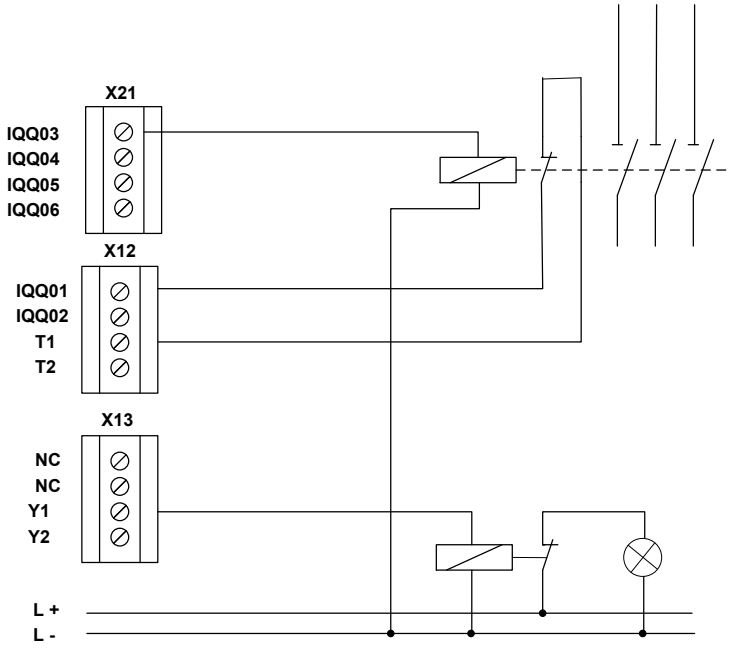


Fig. 27: Two-channel output with single-channel wiring with testing

SAFETY NOTE

Not conditionally recommended for safety applications!

- Only conditionally recommended for safety applications! In this context see also the notes in EN ISO 13849-1 concerning the application and the required fault exclusions.
- For PI c or higher a test rate of > 100 * the request rate is required.
- If a hazardous situation is detected during a test of the safety function, suitable control measures must be initiated. For PL d, a safe state must be initiated, which must not be canceled until the fault has been eliminated. For PL up to and including PL c, it is also possible to indicate a fault by means of a warning or signaling device if a safe state cannot be initiated.

4.3.5.2.3 Wiring with safe cut-off circuit

For safety applications from PL c and higher in accordance with EN ISO 13849-1. The external circuit is controlled directly via a two-channel output. The achievable PL in accordance with EN ISO 13849-1 depends on the use of dynamic testing (see 4.3.2.1 DC) and the PL of the downstream **.**

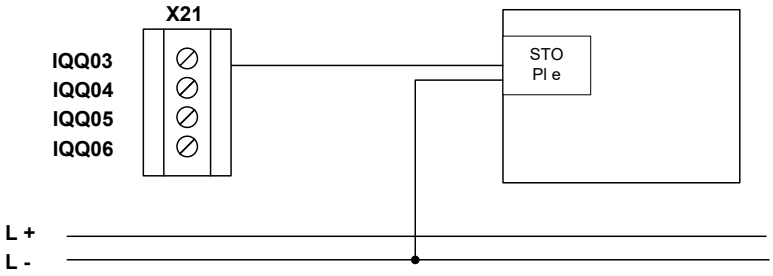


Fig. 28: Dual-channel output in conjunction with device with tested switch-off

4.3.5.2.4 Wiring in conjunction with a two-channel switch-off circuit

Suitable for **PL d or higher** in accordance with EN ISO 13849-1. Use of an IQQx output in conjunction with a two-channel external circuit with testing. In particular, positively driven auxiliary contacts are required for electromechanical devices or signaling contacts for the valve position for hydraulic or pneumatic components.

The achievable PL depends on the use of dynamic testing and the MTTFD value of the external circuit. A **maximum PL e** in accordance with EN ISO 13849-1 can be achieved!

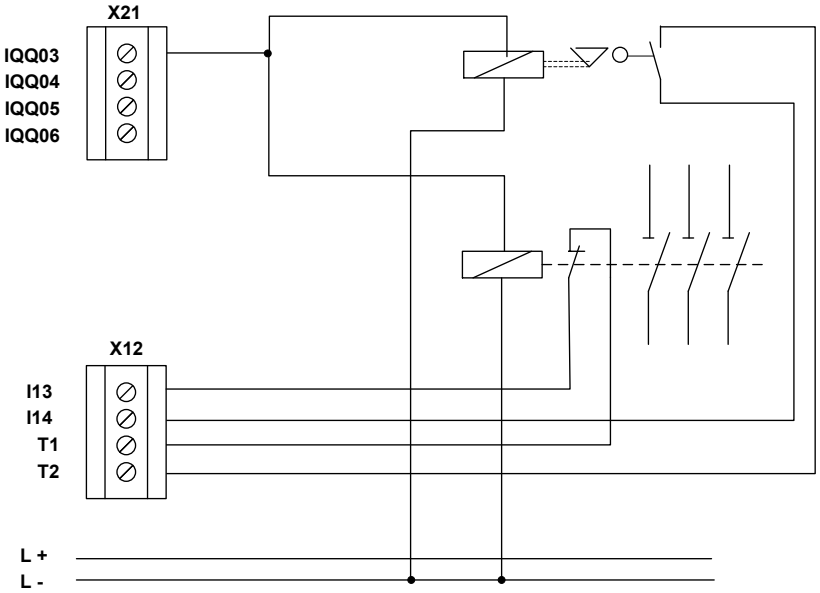


Fig. 29: Dual-channel output in conjunction with dual-channel switch-off circuit with testing

4.3.5.2.5 Redundant dual-channel output

Suitable for **PL d or higher** in accordance with EN ISO 13849-1. Use of two IQQx outputs in conjunction with a dual-channel external circuit.

4.3.5.2.5.1 Two-channel wiring in the same group

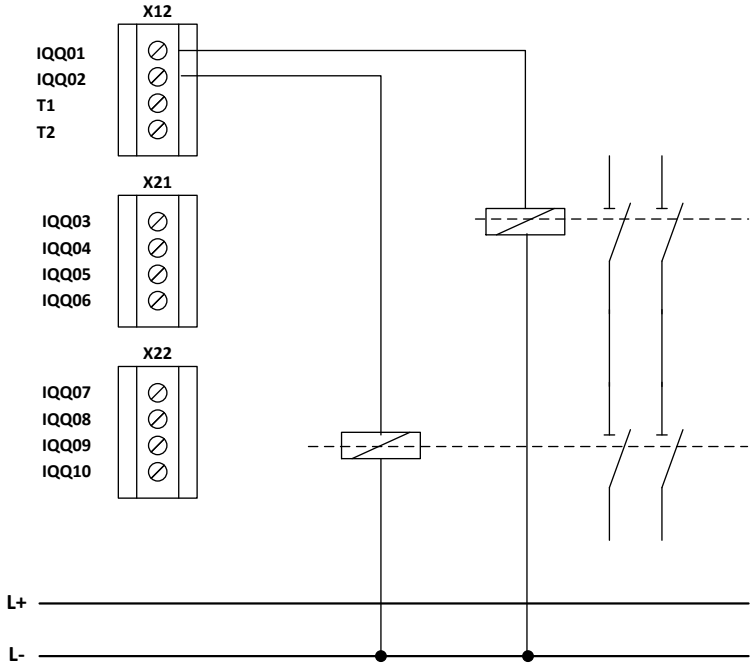


Fig. 30: Redundant dual-channel outputs in the same group in conjunction with dual-channel switch-off circuit

4.3.5.2.5.2 Two-channel wiring in different groups

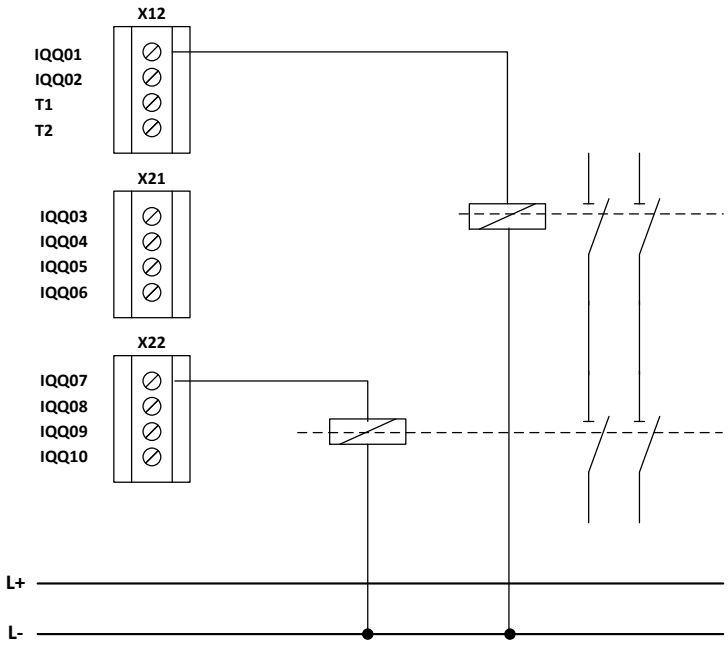


Fig. 31: Redundant dual-channel outputs in different groups in conjunction with dual-channel switch-off circuit

SAFETY NOTICE

Not conditionally recommended for safety applications!

- For a safety related assessment of the partial system output the data issued by the respective manufacturer ($MTTF_D$, FIT-numbers, B10d-value, etc.) must be used when using external elements, e.g. for switching amplification, in the shut-down circuit.
- The DC-values listed in the table must be used conservatively and compliance with the boundary conditions (see table under „Remarks“) must be ensured.
- According to the applicable standards, fault exclusions are permitted. The boundary conditions mentioned in this context must permanently be met.
- When using elements for switching amplification in safety circuits, their function must be monitored by means of suitable readback contacts, etc. (see circuitry examples). Suitable readback contacts are contacts which are linked with the contacts in the shut-down circuit in a positively switching way.
- The switching ability of the external switching amplifier must be cyclically tested. The time between 2 tests must be determined in accordance with the requirements of the application and ensured by suitable measures. Suitable measures may be of organizational (On and Off switching at the beginning of a shift, etc.) or technical (automatic, cyclic switching) nature.
-

4.3.5.3 Overview of achievable PI for digital safety outputs

Output SMX	***Actuator / external shut-down circuit***	***Category** acc. to EN13849-1*	***DC***		***MTTFD Actuator***	***Achie-vable PI** acc. to EN ISO 13849-1*	***Boundary conditions***	***Fault exclusion***
Single-channel without dynamic output test Q5 or Q6 Q1_PP, Q2_PN, Q3_PP, Q4_PN IQQx	Single-channel Contactor, valve, brake etc. without direct feedback to diagnostics	Cat. B	0 %		Medium	b	Contactor and downstream actuators suitably designed for safety applications	
	Single-channel Contactor, valve, brake etc. with monitored positively driven auxiliary contact	Cat. 2	60-90 %	Depending on switching frequency	Medium	b	Auxiliary output required for warning when malfunction is detected Contactor and downstream actuators suitably designed for safety applications	
					High	c	as before	
						d	as before DC = 90% sufficiently high test rate in relation to the application	
Single-channel without dynamic output test Q5 or Q6 or single-channel Q1_PP, Q2_PN, Q3_PP, Q4_PN	Dual-channel Contactor, valve, brake etc. with direct feedback for diagnostics in at least one channel or Actuator single-channel controlled with safety function cat. 3 (e.g. STO)	Cat. 2	90 %	Monitoring only in an external switch-off circuit	Medium	c	Auxiliary output required for warning when malfunction is detected Contactor and downstream actuators suitably designed for safety application	Short-circuit to external control
					High	d		
Single-channel without dynamic output test IQQ01..IQQ10	Dual-channel Contactor, valve, brake etc. with direct feedback for	Cat. 3	90 %	Monitoring only in an external switch-off circuit	Medium or High	d	Contactor and downstream actuators suitably designed for safety applications	Short-circuit to external control

	diagnostics in at least one channel or Actuator single-channel controlled with safety function Cat. 3 (e.g. STO)							
Single-channel with dynamic output test IQQ01..IQQ10	Dual-channel Contactor, valve, brake etc. with direct feedback for diagnostics in both channels or Actuator with Cat. 4 safety function (e.g. STO)	Cat. 4	99 %	Monitoring in both external shutdown circuits	High	e	Contactor and downstream actuators suitably designed for safety applications Monitoring of electro-mechanical components using positively driven switches, position monitoring of switching valves, etc.	
Dual-channel without dynamic output test Q1 and Q2 2 x IQQ01..IQQ10	Dual-channel Contactor, valve, brake etc. with direct feedback for diagnostics in at least one channel or Actuator with Cat. 4 safety function (e.g. STO)	Cat. 3	90 %	Monitoring in both external shutdown circuits	Medium or. High	d	Contactor and downstream actuators suitably designed for safety applications Monitoring of electro-mechanical components using positively driven switches, position monitoring of switching valves, etc. Outputs IQQ1..40 1 each from different groups (groups of 6/4 interconnected IQQ ports, e.g. IQQ1..6, IQQ7..10) or Time-delayed control at PLC level	Short-circuit to external control

Dual-channel Q1 and Q2 or Dual-channel with dynamic output test Q1_PP and, Q2_PN, Q3_PP and Q4_PN 2 x IQQ01..IQQ10	Dual-channel Contactor, valve, brake etc. with direct feedback for diagnostics in both channels or Actuator with Cat. 4 safety function (e.g. STO)	Cat. 4	99 %	Monitoring in both external shut-down circuits	High	e	Contactor and downstream actuators suitably designed for safety applications Monitoring of electro-mechanical components using positively driven switches, position monitoring of switching valves, etc. For applications with frequent requests for safety shutdown, the following should be tested at short intervals, e.g. at the start of a shift 1 x per week. However, a test should be carried out at least cyclically once a year.	Short-circuit to external control in both channels

5 Connection and installation

5.1 General notes of installation

Strictly follow the safety regulations when installing!

Protection class IP20

Route all signal lines for the interfacing of digital inputs and contact monitoring separately.

You should in any case disconnect 230VAC (120VAC cULus) voltages from low voltage power lines, if these voltages are used in connection with the application.

The cable lengths for digital inputs and outputs and all sensors must normally not exceed **30 m**.

If the cable lengths exceeds **30 m** you must apply appropriate measures for fault exclusion concerning impermissible overvoltage. Appropriate measures include e.g. lightning protection for outdoor lines, overvoltage protection of the indoor system, protected routing of cables.

Only cULus:

The maximum cable length of **30 m** shall not be exceeded.

Measures concerning the electromagnetic compatibility (EMC)

The SMX module is intended for use in the drive environment and meets the EMC-requirements mentioned above.

It is also assumed that the electromagnetic compatibility of the overall system is ensured by application of appropriate measures.

Use of the module as PESSRAL acc. to EN 81-20/-50 resp. EN 81-1/-2:

When using the module as PESSRAL acc. to EN 81-20/-50 resp. EN 81-1/-2 (elevator standard), the device must be installed at a minimum distance of 200mm to the transmitting facility with the following frequency ranges (mobile radio, etc.) 166-1000 MHz, 1710-1784 MHz, 1880-1960 MHz. The field strength of the transmitting facility must not exceed the following field strength values:

30V/m at 166-1000 and 1710-1784 MHz, 10V/m at 1880-1960 MHz .

Installation in a closed housing with protection class IP5X or better is additionally required.

SAFETY NOTICE

- Electric power supply lines of the SMX and "discontinuous-action lines" of the power converter must be isolated from each other.
- Signal lines and power lines of the power converter must be routed through separate cable ducts. The distance between the cable ducts should be minimum 10 mm.
- Only shielded cables must be used to connect the position and speed sensors. The signal transmission cable must be RS-485-standard compliant (lines twisted in pairs).
- Care must be taken to ensure that the shielding is correctly connected in the 9-pin SUB-D plugs of the position and speed sensors. Only metal or metal coated plugs are permitted.
- The shielding on the sensor side must comply with appropriate methods.
- EMC-compliant installation of the power converter technology in the environment of the SMX module must be assured. Special attention must be paid to the routing of cables, the shielding of motor cables and the connection of the braking resistor. Strict compliance with the installation instructions of the power converter manufacturer is mandatory.
- All contactors in the environment of the power converter must be equipped with appropriate suppressor circuits.
- Suitable measures to protect against over voltages must be applied.

Used symbols acc. to UL 61010-1

 Symbol 14

- The temperature at the connecting terminals can amount to over 60°C. From this temperature, suitable cable types must be used.

Additional safety regulations when using PESSRAL acc. to EN 81-20/-50 resp. EN 81-1/-2:

- Install the device at a distance of at least 200 mm from the HF-transmitting facility (WLAN, GSM, etc.). The transmitting facilities must thereby not exceed the max. field strengths as specified above.
- The device must be installed in a closed housing, IP5X or better.

5.2 Installation and assembly

NOTICE

Installation location

The module is solely to be installed in control cabinets with a degree of protection of at least IP54.

The modules must be vertically fastened on a top hat rail

When using in non-closed spaces, it must be guaranteed that the environmental conditions of the individual modules (see technical data) are adhered to.

NOTICE

Air circulation

For air vents, there must be free space of 30 mm above and below the vents. Stringing of expansion modules is permitted. As the adjacent devices can generate waste heat, a distance of 20 mm should be maintained.

Only cULus:

This device is intended to be used indoor only.

5.3 Mounting backplane bus system

Mounting several SMX modules (SMX10/10A/10R/10AR/2, SMX11/2, SMX11-2/2, SMX12/12A/2, SMX12-2/12-2A/2) on one top hat rail in connection with the backplane bus system is also possible. These modules can be combined with an I/O extension. In this case the backplane bus system needs to be configured by BBH when placing the order and delivered in accordance with the application in question.

The backplane bus system consists of a 5-pin plug connector with snap-in contacts. In these plug connectors all 5 contacts are equipped by standard.

Note:

Central expansion modules have no power supply unit of their own and are dependent on a DC supply via the backplane bus. Base modules (SMX10/11/12) are equipped with an reinforced power supply unit and always feed into the backplane bus.

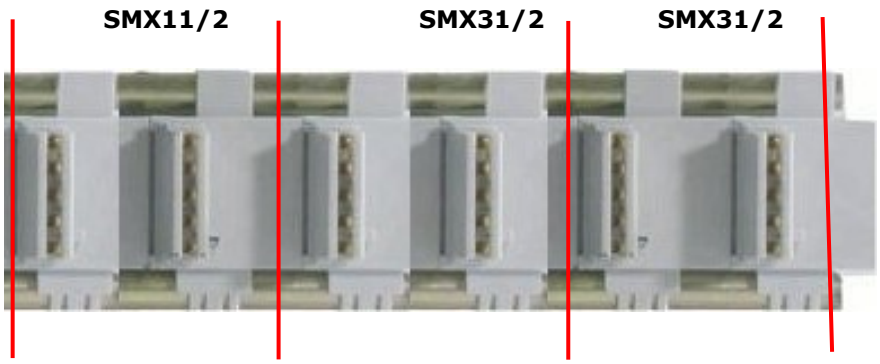
Backplane bus connectors:

- **TB1:** Standard design (all contacts are present)

Using the backplane bus connector TB1:
The backplane bus connector TB1 can only be installed in connection with expansion modules without their own power supply. Connection of several standalone modules is not possible.

5.3.1 Arrangement examples

5.3.1.1 SMX11/2 + SMX31/2 + SMX31/2



Basic device with two central I/O expansion modules, the power supply runs via the backplane bus.

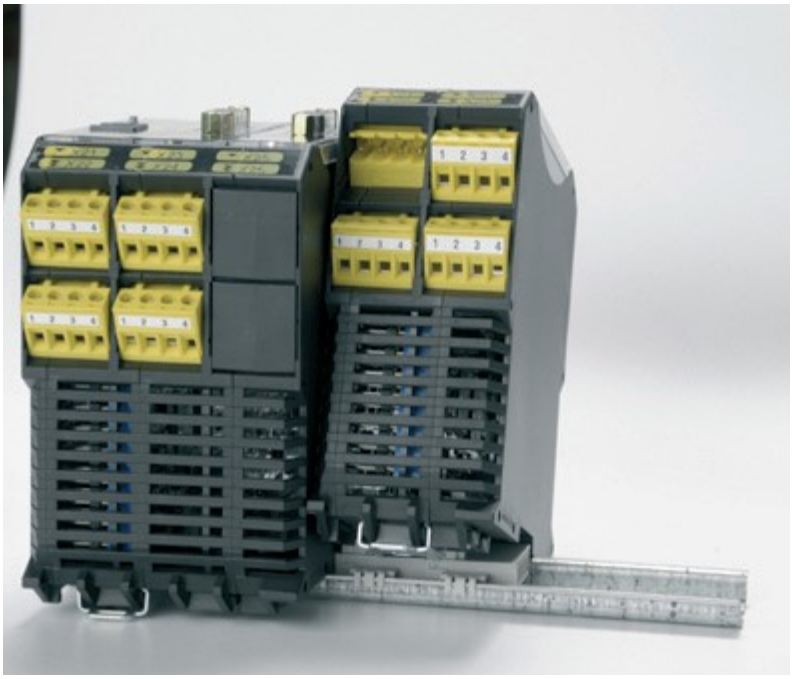
5.4 Assembly of the modules

The modules are mounted on C-standard rails by means of Snap-On latches.

5.4.1 Assembly on C-rail

The devices are inserted into the rail at an angle from above and snapped in at the bottom.

For disassembling use a screwdriver, insert it into the slot of the downwards pointing latch and then move it up.



5.4.2 Assembly on backplane bus

After assembling the backplane bus the device can be installed. For this purpose, insert the module into the plug connection from above at an angle and snap it onto the C-rail.

Insert the module from the top at an angle

Snap-on downwards on to the C-rail

The backplane connector can be subsequently extended. The system configuration can therefore be expanded by additional modules.

Snap the backplane bus element into the C-rail and insert it into the counter-piece by sliding it sideways.

5.5 Installation and configuration from Master <–> Master (SMMC) and Master <-> Slave (SDDC)

SMMC communication enables safe data exchange of 2 bytes between several SDDC masters.

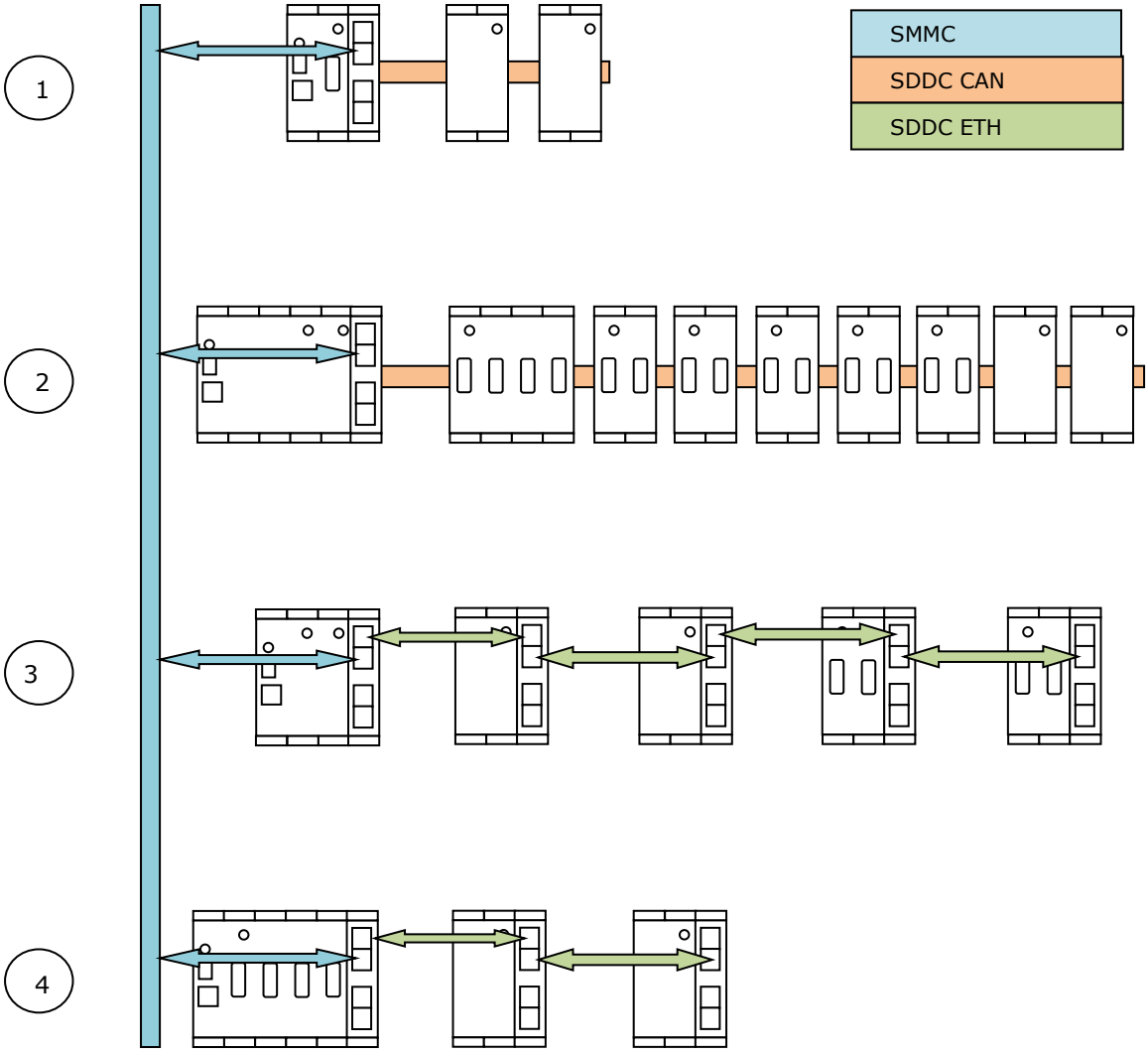
Communication takes place without a master to coordinate the data. This ensures that data is always exchanged between available participants.

This principle allows an incomplete or separate network to operate in its partial areas without changing the configuration.

In order to be able to coordinate several SDDC masters with different cycle times, an SMMC cycle time is parameterized, which must be adhered to by all participants.

This cycle time is the smallest common multiple of the cycle time of the individual participants.

5.5.1 Network topology



1 Communication of a SMX modular with

- Central expansion modules via SDDC CAN backplane bus
- SMMC via Ethernet

2 Communication of a SMX modular with

- Central expansion modules via SDDC CAN backplane
- SMMC via Ethernet

3 Communication of a SMX modular with

- Decentral expansion modules via SDDC Ethernet
- SMMC via Ethernet

4 Communication of a SMX compact with

- Decentral expansion modules via SDDC Ethernet
- SMMC via Ethernet

5.5.2 Installation I/O-expansions

NOTICE

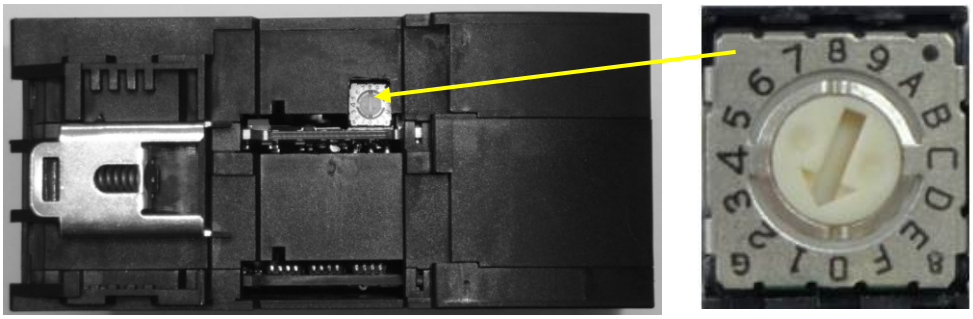
Installation of expansions

A maximum of two SMX3x/2 modules can be operated with one base module.

5.5.2.1 Physical address configuration of the slave modules (central / decentral)

On the SMX3x/2 modules, the bus address must be set using the address switch.

The setting is made on the back of the module.



NOTICE

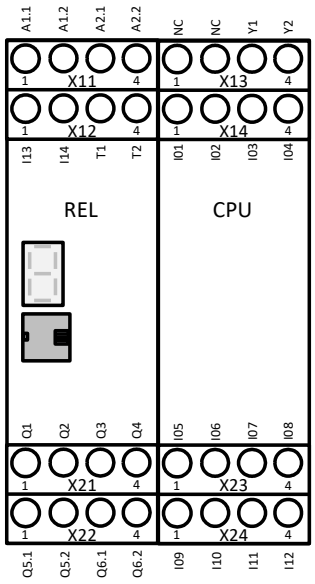
Address range of the SMX3x/2 module from 1…15.

Address „0" is reserved for the base device.

5.6 Terminal assignment

5.6.1 Terminal assignment SMX10/2

SMX10/2

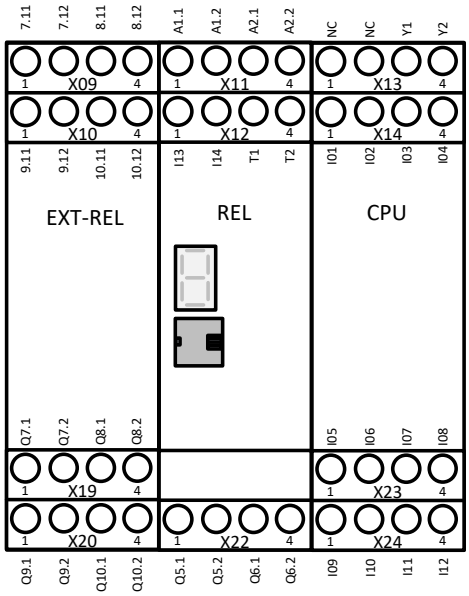


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switching Q1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switching Q2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switching Q3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switching Q4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU	**X13**	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.2 Terminal assignment SMX10R/2

SMX10R/2



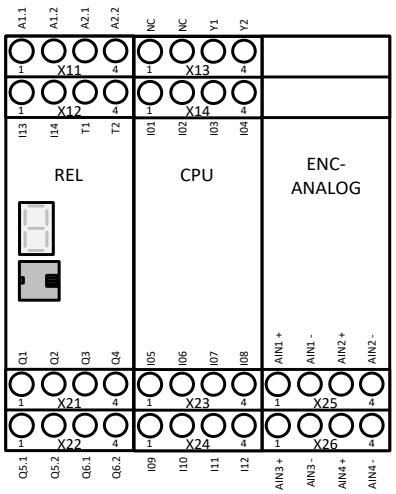
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT REL	**X09**	1 – 7.11	Read back contact Relais 3	
		2 – 7.12		
		3 – 8.11	Read back contact Relais 4	
		4 – 8.12		
	X10	1 – 9.11	Read back contact Relais 5	
		2 – 9.12		
		3 – 10.11	Read back contact Relais 6	
		4 – 10.12		
	X19	1 – Q7.1	Safe relay output	
		2 – Q7.2		
		3 – Q8.1	Safe relay output	
		4 – Q8.2		
	X20	1 – Q9.1	Safe relay output	
		2 – Q9.2		
		3 – Q10.1	Safe relay output	
		4 – Q10.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU	**X13**	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.3 Terminal assignment SMX10A/2

SMX10A/2



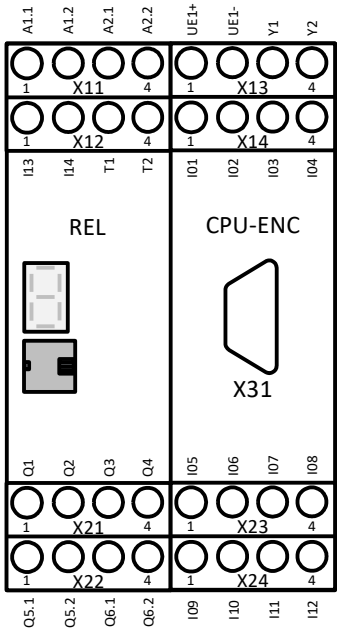
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU	X13	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
ANALOG	X25	1 – AIN 1+	Safe analog input	
		2 – AIN 1-		
		3 – AIN 2+		
		4 – AIN 2-		
	X26	1 – AIN 3+	Safe analog input	
		2 – AIN 3-		
		3 – AIN 4+		
		4 – AIN 4-		

5.6.4 Terminal assignment SMX11/2

SMX11/2

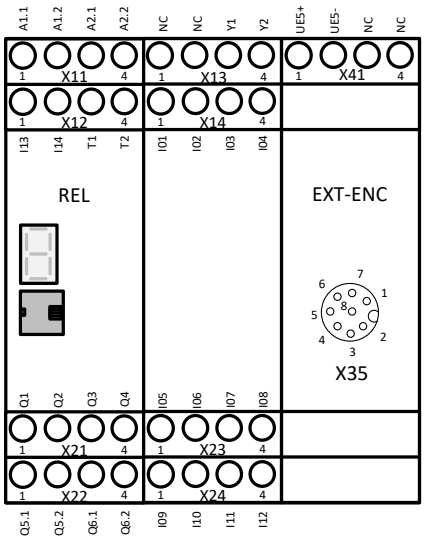


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.1 Terminal assignment SMX11-PXV/2

SMX11-PXV/2



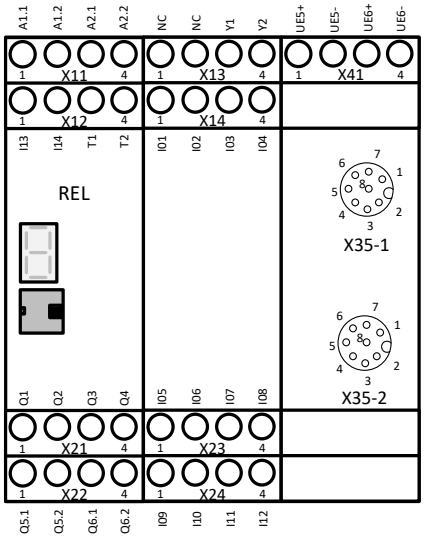
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switching Q1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switching Q2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switching Q3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switching Q4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU-ENC	**X13**	1 – NC	No function	
		2 – NC		
		3 - Y1	Auxiliary outputs	
		4 – Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-ENC	**X41**	1 – UE5+	Voltage supply Sensor +24 VDC	
		2 – UE5-	Voltage supply Sensor 0 VDC	
		3 – NC	No function	
		4 – NC		

5.6.2 Terminal assignment SMX11-WCS/2

SMX11-WCS/2



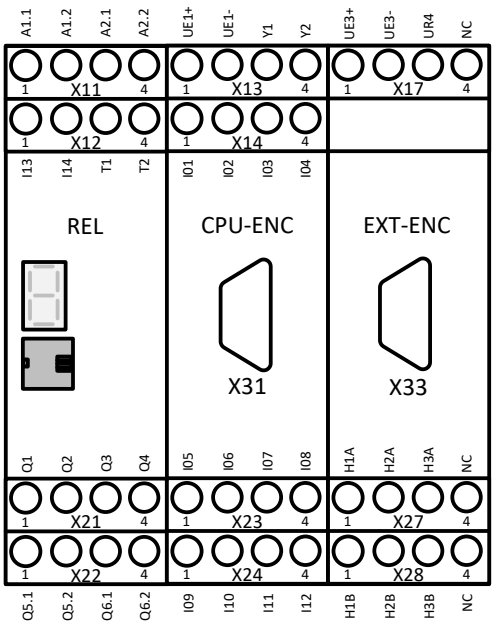
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU-ENC	**X13**	1 – NC	No function	
		2 – NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-ENC	**X41**	1 – UE5+	Voltage supply Sensor +24V DC, X35-1	
		2 – UE5-	Voltage supply Sensor 0V DC, X35-1	
		3 – UE6+	Voltage supply Sensor +24V DC, X35-2	
		4 – UE6-	Voltage supply Sensor 0V DC, X35-2	

5.6.3 Terminal assignment SMX11-2/2

SMX11-2/2

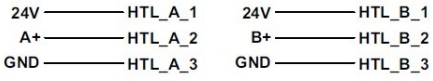


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	**X11**	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

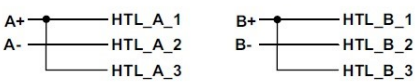
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-ENC	**X17**	1 – UE3+	Voltage supply encoder +24V DC X33	
		2 – UE3-	Voltage supply encoder 0V DC X33	
		3 – UR3	Reference voltage encoder X33	
		4 - NC	No function	
	X27	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X28	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

HTL encoder connection: A+/B+

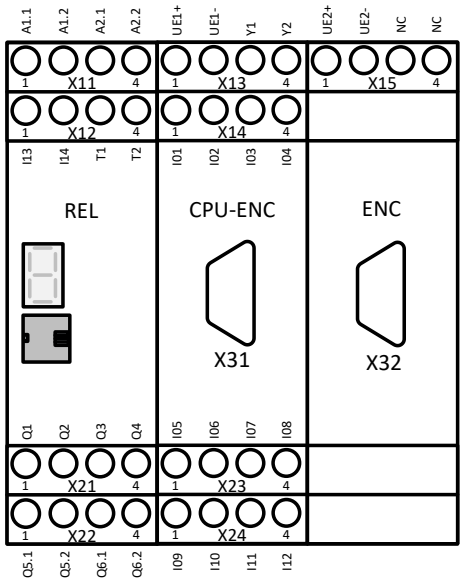


HTL encoder connection: A+, A-/B+, B-



5.6.4 Terminal assignment SMX12/2

SMX12/2

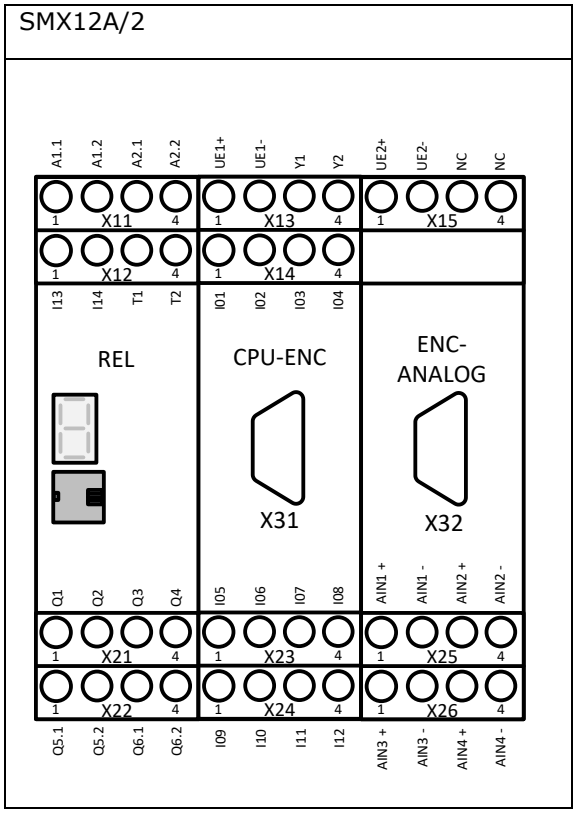


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	***X11***	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU-ENC	***X13***	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
ENC	***X15***	1 – UE2+	Voltage supply encoder +24V DC X32	
		2 – UE2-	Voltage supply encoder 0V DC X32	
		3 – NC	No function	
		4 - NC		

5.6.5 Terminal assignment SMX12A/2

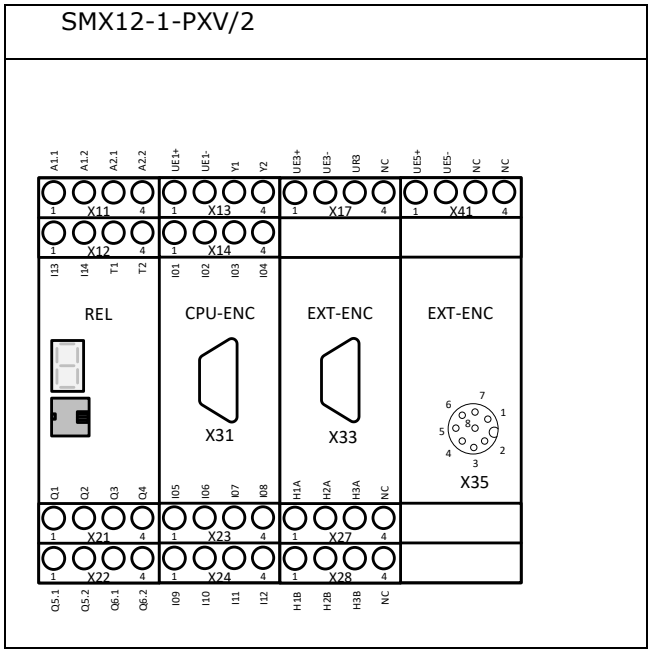


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	***X11***	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
ENC-ANALOG	**X15**	1 – UE2+	Voltage supply encoder +24V DC X32	
		2 – UE2-	Voltage supply encoder 0V DC X32	
		3 – NC	No function	
		4 - NC		
	X25	1 – AIN 1+	Safe analog input	
		2 – AIN 1-		
		3 – AIN 2+		
		4 – AIN 2-		
	X26	1 – AIN 3+	Safe analog input	
		2 – AIN 3-		
		3 – AIN 4+		
		4 – AIN 4-		

5.6.6 Terminal assignment SMX12-1-PXV/2



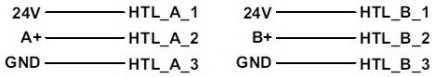
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	***X11***	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 – Q6.2		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

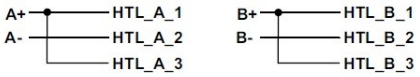
Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
EXT-ENC	**X17**	1 – UE3+	Voltage supply encoder +24V DC X33	
		2 – UE3-	Voltage supply encoder 0V DC X33	
		3 – UR3	Reference voltage encoder X33	
		4 - NC	No function	
	X27	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X28	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
EXT-ENC	**X41**	1 – UE5+	Voltage supply sensor +24 VDC	
		2 – UE5-	Voltage supply sensor 0 VDC	
		3 – NC	No function	
		4 – NC		

HTL encoder connection: A+/B+

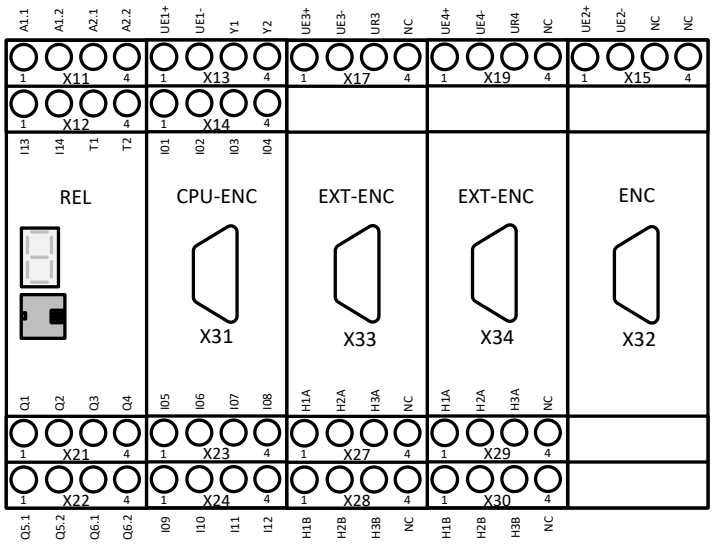


HTL encoder connection: A+, A-/B+, B-



5.6.7 Terminal assignment SMX12-2/2

SMX12-2/2



Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	***X11***	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

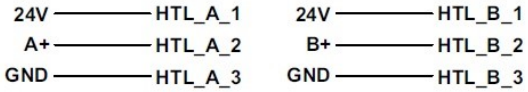
Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
EXT-ENC	**X17**	1 – UE3+	Voltage supply encoder +24V DC X33	
		2 – UE3-	Voltage supply encoder 0V DC X33	
		3 – UR3	Reference voltage encoder X33	
		4 - NC	No function	
	X27	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X28	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

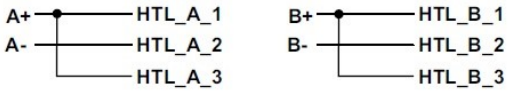
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-ENC	***X19***	1 – UE4+	Voltage supply encoder +24V DC X34	
		2 – UE4-	Voltage supply encoder 0V DC X34	
		3 – UR4	Reference voltage encoder X33	
		4 - NC	No function	
	X29	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X30	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
ENC	***X15***	1 – UE2+	Voltage supply encoder VDC X32	
		2 – UE2-	Voltage supply encoder GND X32	
		3 – NC	No function	
		4 - NC		

HTL encoder connection: A+/B+

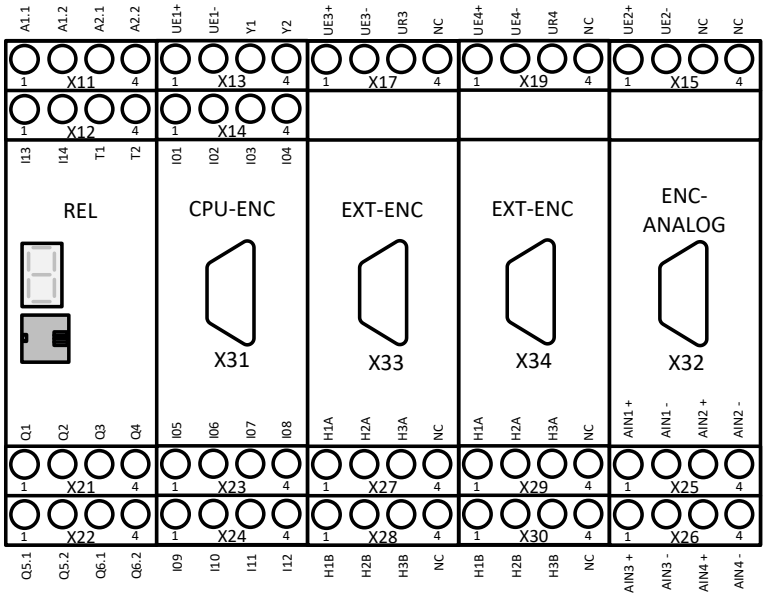


HTL encoder connection: A+, A-/B+, B-



5.6.8 Terminal assignment SMX12-2A/2

SMX12-2A/2



Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
REL	***X11***	1 - A1.1	Voltage supply device +24 VDC	
		2 - A1.2	Voltage supply device +24 VDC Outputs	
		3 - A2.1	Voltage supply device 0 VDC	
		4 - A2.2		
	X12	1 - I13	Safe digital inputs	
		2 - I14		
		3 - T1	Clock outputs	
		4 - T2		
	X21	1 - Q1	Output of the pn-switching Q1_PP / pp-switchingQ1	alternatively via SafePLC2 parameterizable
		2 - Q2	Output of the pn-switching Q2_PN / pp-switchingQ2	
		3 - Q3	Output of the pn-switching Q3_PP / pp-switchingQ3	
		4 - Q4	Output of the pn-switching Q4_PN / pp-switchingQ4	
	X22	1 - Q5.1	Safe relay output	
		2 - Q5.2		
		3 - Q6.1	Safe relay output	
		4 - Q6.2		

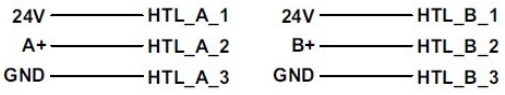
Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU-ENC	**X13**	1 – UE1+	Voltage supply encoder +24V DC X31	
		2 – UE1-	Voltage supply encoder 0V DC X31	
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
EXT-ENC	**X17**	1 – UE3+	Voltage supply encoder +24V DC X33	
		2 – UE3-	Voltage supply encoder 0V DC X33	
		3 – UR3	Reference voltage encoder X33	
		4 - NC	No function	
	X27	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X28	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

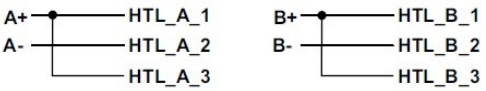
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-ENC	***X19***	1 – UE4+	Voltage supply encoder +24V DC X34	
		2 – UE4-	Voltage supply encoder 0V DC X34	
		3 – UR4	Reference voltage encoder X34	
		4 - NC	No function	
	X29	1 – H1A	Encoder 24V	
		2 – H2A	Encoder A+	
		3 – H3A	Encoder Ground	
		4 – NC	No function	
	X30	1 – H1B	Encoder 24V	
		2 – H2B	Encoder B+	
		3 – H3B	Encoder Ground	
		4 – NC	No function	

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
ENC-ANALOG	***X15***	1 – UE2+	Voltage supply encoder +24V DC X32	
		2 – UE2-	Voltage supply encoder 0V DC X32	
		3 – NC	No function	
		4 - NC		
	X25	1 – AIN 1+	Safe analog input	
		2 – AIN 1-		
		3 – AIN 2+		
		4 – AIN 2-		
	X26	1 – AIN 3+	Safe analog input	
		2 – AIN 3-		
		3 – AIN 4+		
		4 – AIN 4-		

HTL encoder connection: A+/B+

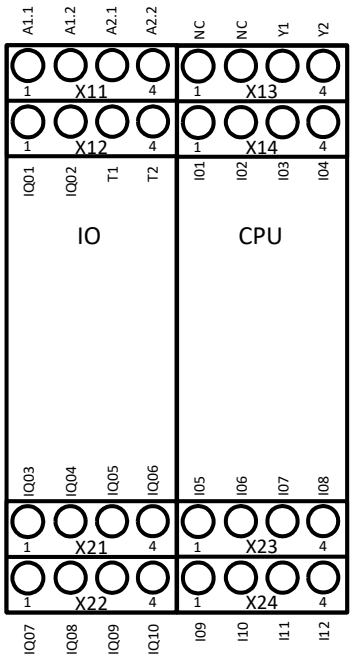


HTL encoder connection: A+, A-/B+, B-



5.6.9 Terminal assignment SMX31/2

SMX31/2

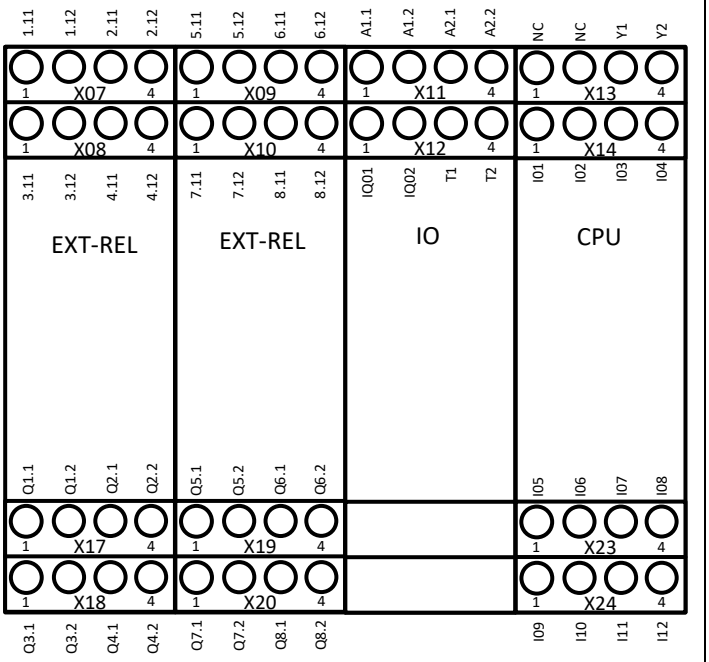


Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
IO	***X11***	1 - A1.3	Voltage supply device +24V DC outputs	
		2 - A1.4		
		3 - A2.3	Voltage supply device 0V DC	
		4 - A2.4		
	X12	1 - IQ01	Safe digital inputs, outputs pp-switching	
		2 - IQ02		
		3 - Y3	Clock outputs	
		4 - Y4		
	X21	1 - IQ03	Safe digital inputs, outputs pp-switching	
		2 - IQ04		
		3 - IQ05		
		4 - IQ06		
	X22	1 - IQ07		
		2 - IQ08		
		3 - IQ09		
		4 - IQ10		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU	***X13***	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.10 Terminal assignment SMX31R/2

SMX31R/2



Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-REL	***X07***	1 – 1.11	Read back contact Relais 1	
		2 – 1.12		
		3 – 2.11	Read back contact Relais 2	
		4 – 2.12		
	X08	1 – 3.11	Read back contact Relais 3	
		2 – 3.12		
		3 – 4.11	Read back contact Relais 4	
		4 – 4.12		
	X17	1 – Q1.1	Safe relay output 1	
		2 – Q1.2		
		3 – Q2.1	Safe relay output 2	
		4 – Q2.2		
	X18	1 – Q3.1	Safe relay output 3	
		2 – Q3.2		
		3 – Q4.1	Safe relay output 4	
		4 – Q4.2		

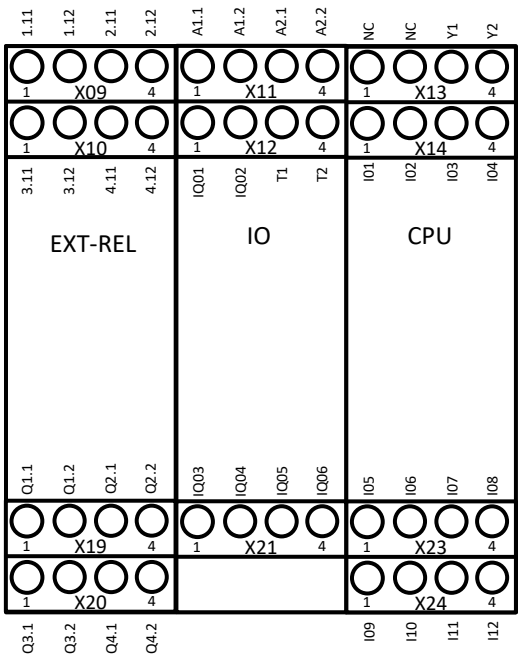
Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
EXT-REL	**X09**	1 – 1.11	Read back contact Relay 5	
		2 – 1.12		
		3 – 2.11	Read back contact Relay 6	
		4 – 2.12		
	X10	1 – 3.11	Read back contact Relay 7	
		2 – 3.12		
		3 – 4.11	Read back contact Relay 8	
		4 – 4.12		
	X19	1 – Q5.1	Safe relay output 5	
		2 – Q5.2		
		3 – Q6.1	Safe relay output 6	
		4 – Q6.2		
	X20	1 – Q7.1	Safe relay output 7	
		2 – Q7.2		
		3 – Q8.1	Safe relay output 8	
		4 – Q8.2		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
IO	**X11**	1 - A1.3	Voltage supply device +24V DC outputs	
		2 - A1.4		
		3 - A2.3	Voltage supply device 0V DC	
		4 - A2.4		
	X12	1 - IQ01	Safe digital inputs, outputs pp-switching	
		2 - IQ02		
		3 - Y3	Clock outputs	
		4 - Y4		

Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
CPU	***X13***	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.11 Terminal assignment SMX31R-4/2

SMX31R-4/2



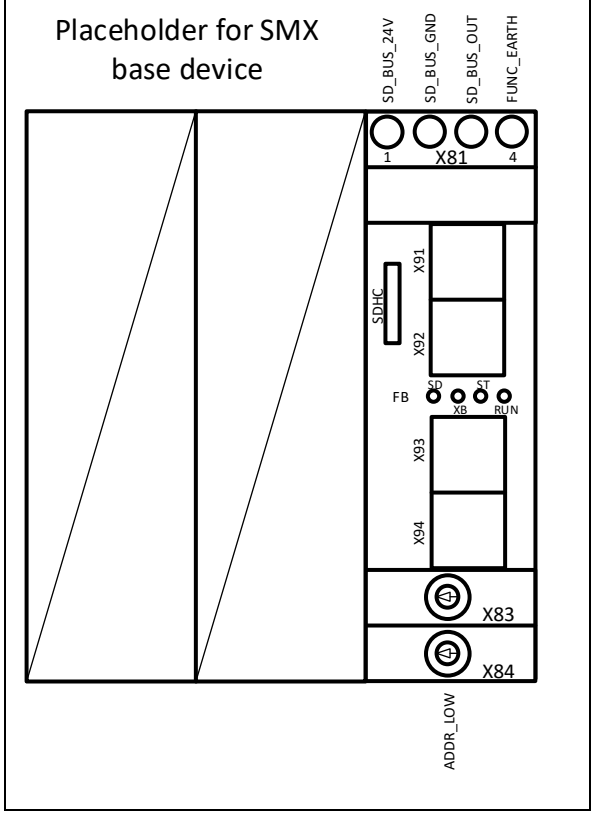
Terminal assignment				
Unit	***Terminal***	***Pin***	***Description***	***Note***
EXT-REL	***X09***	1 – 1.11	Read back contact Relay 1	
		2 – 1.12		
		3 – 2.11	Read back contact Relay 2	
		4 – 2.12		
	X10	1 – 3.11	Read back contact Relay 3	
		2 – 3.12		
		3 – 4.11	Read back contact Relay 4	
		4 – 4.12		
	X19	1 – Q1.1	Safe relay output 1	
		2 – Q1.2		
		3 – Q2.1	Safe relay output 2	
		4 – Q2.2		
	X20	1 – Q3.1	Safe relay output 3	
		2 – Q3.2		
		3 – Q4.1	Safe relay output 4	
		4 – Q4.2		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
IO	X11	1 - A1.3	Voltage supply device +24V DC outputs	
		2 - A1.4		
		3 - A2.3	Voltage supply device 0V DC	
		4 - A2.4		
	X12	1 - IQ01	Safe digital inputs, outputs pp-switching	
		2 - IQ02		
		3 - Y3	Clock outputs	
		4 - Y4		
	X21	1 - IQ03	Safe digital inputs, outputs pp-switching	
		2 - IQ04		
		3 - IQ05		
		4 - IQ06		

Terminal assignment				
Unit	**Terminal**	**Pin**	**Description**	**Note**
CPU	X13	1 - NC	No function	
		2 - NC		
		3 - Y1	Auxiliary outputs	
		4 - Y2		
	X14	1 - I01	Safe digital inputs	
		2 - I02		
		3 - I03		
		4 - I04		
	X23	1 - I05		
		2 - I06		
		3 - I07		
		4 - I08		
	X24	1 - I09		
		2 - I10		
		3 - I11		
		4 - I12		

5.6.12 Terminal assignment COM

SMXxx/2/xxx



Terminal assignment				
Unit	***Terminal***	***Pin Release /2***	***Description***	***Note***
COM	***X81***	1 – SD_BUS_24V	Voltage supply SD-BUS +24 VDC	Only available for fieldbus variants
		2 – SD_BUS_GND	Voltage supply SD-BUS 0 VDC	
		3 – SD_BUS_OUT	SD-BUS output	
		4 – FUNC_EARTH	Functional Earth	
	X83	ADDR_HIGH	Address switch	Address switch for CAN-based fieldbuses
	X84	ADDR_LOW		

Terminal assignment				
Unit	***Terminal***	***Pin Release /2***	***Description***	***Note***
COM	***X91***	SDDC ETH SMMC	Ethernet connection for SDDC ETH and SMMC	The configuration of the individual ports can be carried out in the SafePLC2.
	X92			
	X93	Fieldbus connection, Ethernet-based	Ethernet connection for fieldbus	The configuration of the fieldbus can be carried out in the SafePLC2.
	X94			

For a more detailed description, please refer to the "COM Installation Manual".

5.7 External 24 VDC – voltage supply

The **SMX module** requires an external power supply of DC 24 V (SELV or PELV, EN50178).

Nominal voltage	***DC 24 V***
Minimum: 24 VDC – 15%	20,4 VDC
Maximum: 24 VDC + 20%	28,8 VDC

Observe the following boundary conditions when planning and installing the intended power supply unit:

It is essential to observe the minimum and maximum tolerance of the supply voltage.

In order to achieve the lowest possible residual ripple in the supply voltage, we recommend using a 3-phase power supply unit or an electronically regulated device. The power supply unit must meet the requirements of EN 61000-4-11 (voltage dip).

Safe electrical isolation from the power supply network (e.g. AC 230 V) must be ensured in all cases. For this purpose, select power supply units that comply with EN 60950. In addition to selecting a suitable device, ensure potential equalization between PE and DC 0 V on the secondary side.

Protect the SMX externally with a fuse if the current is outside the permitted range. Observe the local regulations when designing the connection cables. The minimum and maximum tolerance of the supply voltage must be observed.

The external voltage resistance of the SMX module is 32 VDC (protected by suppressor diodes at the input).

WARNING

Risk of personal injury due to electric shock!

Only supply the device from voltage sources with safety extra-low voltage (e.g. SELV or PELV in accordance with EN 61131-2). If a SELV voltage source is used, it may become PELV due to the design of the module and the connections (earth leakage!). Protective extra-low voltage circuits must always be safely isolated from circuits with dangerous voltages..

CAUTION

Fire hazard in the event of component failure!

Based on the cable and connector specifications, appropriate external fuses must be used in the end application.

ATTENTION

If using external power supply units, it must be ensured that no higher voltage than 60 V can occur in the event of a fault. The actual behavior of the power supply unit used must be checked with the respective manufacturer, as the EN 60950 standard permits up to 120 V in the event of a fault.

SAFETY NOTE

The SMX module must be individually fused externally with a 3.15A (min. 30 VDC) back-up fuse. The fuse must be located near the terminals.

Recommended fuse type:
3.15A circuit breaker (class B) or fuse (slow-blow).

SAFETY NOTE

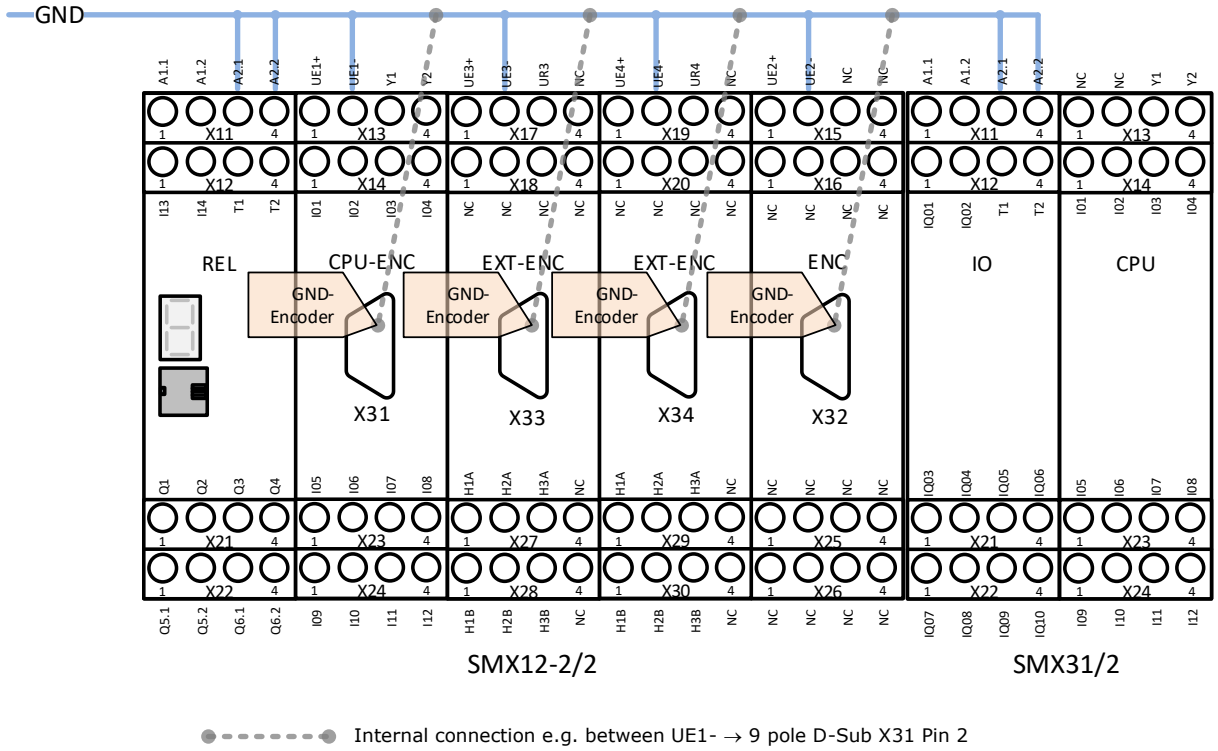
All GND connections of the devices, which are connected to the inputs of the SMX module must be connected to the GND of the SMX (voltage supply).

Input of the SMX are:

- Digital inputs
- Digital I/Os
- Analog inputs
- Encoder connections

Note:

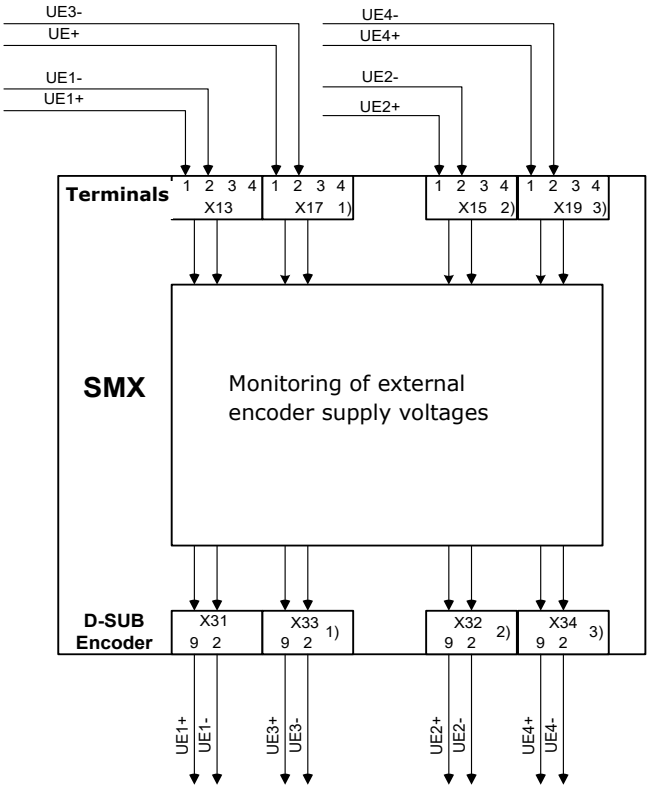
The GND_ENC and AIN connections are not internally connected to GND!



Internal connection e.g. between UE1- → 9 pole D-Sub X31 Pin 2

5.8 Connection of external encoder supply

5.8.1 Incremental, HTL, SIN/COS, SSI



1) Only SMX 11-2/2, SMX 12-2x/2 and SMX12-1-PXV/2

2) Only SMX 12x/2 and SMX 12-2x/2

3) Only SMX 12-2x/2

The SMX module supports encoder voltages of 5V, 8V, 10 V, 12V and 24V, which are internally monitored in accordance with the chosen configuration.

If an encoder system is not supplied via the SMX module, a supply voltage must still be connected to terminal X13, X17 or X15, X19 or X41 (WCS, PXV) and configured accordingly.

The encoder supply must be protected with a fuse of max. 2A.

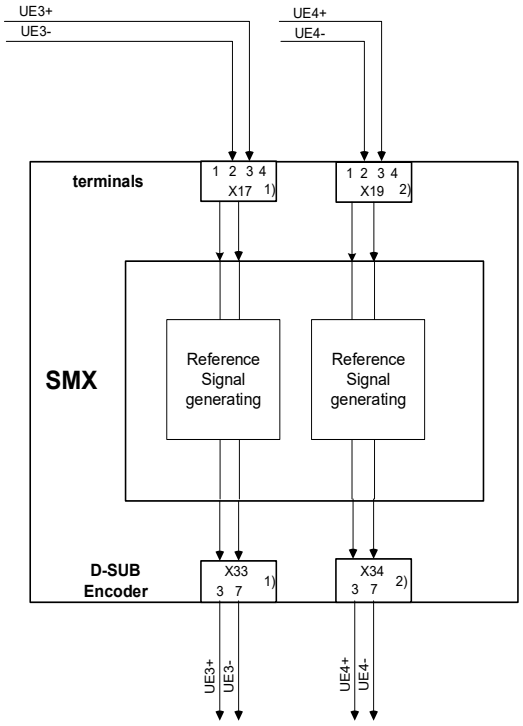
SAFETY NOTE

➲ The GND-connection of the encoder must be connected to the GND of the SMX.

Monitoring of the supply voltage in accordance with the chosen nominal voltage:

Nominal voltage	***Minimum voltage***	***Maximum voltage***
5 VDC	4,4 VDC	5,6 VDC
8 VDC	7 VDC	9 VDC
10 VDC	8 VDC	12 VDC
12 VDC	10 VDC	14 VDC
20 VDC	16 VDC	24 VDC
24 VDC	20 VDC	29,5 VDC

5.8.2 Resolver



1) Only SMX 11-2/2), SMX 12-2/2 and SMX12-1-PXV/2

2) Only SMX 12-2/2

When using resolvers in Master-Mode an additional 24V DC power supply is required for generating the reference signal.

NOTICE

- Ensure that no power supply is connected to PIN 1 at power supply terminals X17 and X19.
- The encoder supply must be protected with a fuse of max. 2A.

Supply voltage monitoring:

Nominal voltage	***Minimum voltage***	***Maximum voltage***
24 VDC	20 VDC	29 VDC

5.9 Connection of digital inputs

The SMX has 14 (SMX10/2, SMX11/2, SMX12/2) or 12 (SMX3x/2) safe digital inputs. These are suitable for connecting single or two-channel signals with and without cycling, or without cross-shorting test.

The connected signals must have a "High"-level of DC 24 V (DC +15 V..+ DC +30 V) and a "Low"-level of (DC -3 V... DC +5 V, Type1 acc. to IEC 61131-2). The inputs are provided with internal input filters.

A device internal diagnostic function cyclically tests the correct function of the inputs including the input filters. A detected fault will set the SMX into an alarm status. At the same time all outputs of the SMX are rendered passive.

Besides the actual signal inputs, the SMX- module holds two clock inputs T1 and T2 available. The clock outputs are switching-type 24 VDC outputs.

The clock outputs are intended exclusively for monitoring external switching elements and cannot be used for any other functions within the application. This monitoring can only be used in conjunction with the safe digital inputs of the same module. The clock outputs of the basic module and the extension are not synchronized!!

The switching frequency is 125 Hz for each output. When planning the project, please note that the outputs may only be loaded with a maximum total current of 250 mA.

Furthermore, approved OSSD outputs can be connected to inputs I01-I14 without restriction.

With single-channel use of the inputs, the achievable safety level is limited to SIL 2 or PL d if the safety function is requested at regular intervals.

In principle, the inputs are only intended for safety-related use in conjunction with the clock (pulse) outputs.

If clock outputs are not used, short circuits in the external wiring between different inputs and against the supply voltage for the SMX must be ruled out by external measures, appropriate routing of cables in particular.

Each input of the SMX module can be configured individually for the following signal sources:

Input is assigned to clock cycle T1

Input is assigned to clock cycle T2

Input is assigned to continuous voltage DC 24 V

5.10 Connection of analog inputs

With the executions with analog processing. max. 2 analog signals to be processed safely:

The analog inputs can be connected as follows:

	min	***max.***
Voltage	-10 VDC	+10 VDC

NOTICE

Assemblies with analog inputs

The modules can optionally be equipped with voltage and, or current inputs

SAFETY NOTICE

➲ The GND connection AIN must be connected to the GND of the SMX module.

5.11 Connection of position and speed sensors

5.11.1 General notes

Depending on module type the SMX module (SMX11/12) has external encoder interfaces for the connection of industrial incremental and absolute encoders. The encoder interfaces can be configured as incremental, SIN/COS, or as absolute SSI-encoders.

It is also possible to connect 2 incremental signal generating sensors (e.g. proximity switches) to the counting inputs of the SMX module. The signals must each be read in with normal and complementary track.

IMPORTANT

The encoder system is supplied with power via the terminals specified on the SMX module. This voltage is fed to the encoder plug and monitored by an internal diagnostic process.

- When the sensor is supplied with an external voltage, this voltage must be supplied through the encoder plug. The corresponding terminal (encoder supply voltage) on the SMX module remains unoccupied.
- If an external sensor voltage supply is not recirculated through the encoder plug, any failure of this supply must be included in the fault examination of the overall system. This, in particular, requires evidence that this fault is detected or can be excluded when the specified operating voltage of the overall system is fallen short of / exceeded.

EMC - measures such as shielding etc. must be observed.

The two encoders must be non-interacting to each other. This applies for both the electrical as well as the mechanical part.

If both encoders are coupled to the facility to be monitored via common mechanical parts, the connection must be positively designed and should not have any parts that are susceptible to wear (chains, toothed belts, etc.). Should this be the case, additional monitoring features for the mechanical connection of the sensors (e.g. monitoring of a toothed belt) are required).

In case of an active position processing at least one absolute value encoder must be used.

When using two equivalent sensors one must make sure that the sensor with the higher resolution is configured as sensor 1 (process sensor) and the sensor with the lower resolution as sensor 2 (reference sensor).

SAFETY NOTICE

- The GND connections of the encoders must be connected to the GND of the SMX. This applies in the same way also to resolvers.

ATTENTION

Sensor connections

The sensor connections must neither be plugged on nor pulled off during operation. This could cause damage to electrical components of the encoder.

- Always de-energize connected encoders and the SMX module before plugging on or pulling off encoder connections. With externally supplied encoders, pay attention to switching off the external supply voltage (e.g. converter).
- Lines twisted in pairs for signal transmission acc. to RS485 standard must be used for data and clock signals or track A and track B. The wire cross-section must in each individual case be chosen in compliance with the current consumption of the encoder and
  the cable length required for the installation.

The following applies when using absolute encoders:

In Slave-mode the clock signal is generated by an external process and is read in by the SMX module together with the data signal. This type of reading causes a beat which results in a reading fault of the following magnitude:

F = (Sampling time of the encoder by external system[ms] / 8 [ms]) * 100 %

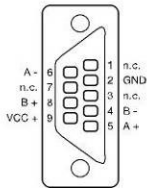
The size of the resulting reading fault F must be taken into account when determining the thresholds in the applied monitoring functions, because this fault cannot be compensated!

5.11.2 Assignment of encoder interfaces

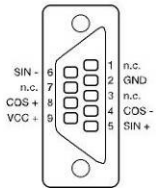
5.11.2.1 X31/X32 [1)]

Sensor assignment

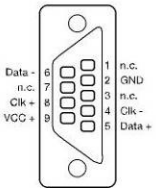
Incremental - Encoder



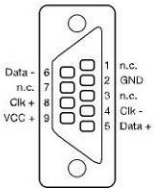
SIN/COS



Absolut - Encoder



SSI - Listener

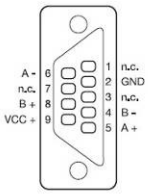


[1)] only SMX12/2

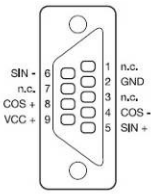
5.11.2.2 X33/X34 [2)]

Sensor assignment

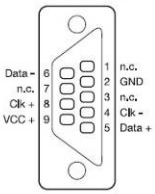
Incremental - Encoder



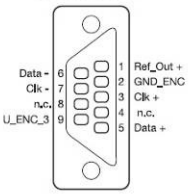
SIN/COS



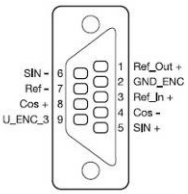
SSI - Absolut X 31/X 32



SSI - Absolut X 33/X 34



Resolver



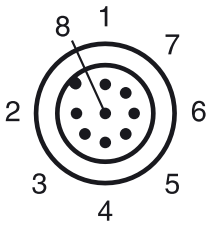
[2)] only SMX11-2, SMX12-2/2

NOTICE

With the terminals X33/X34 of the modules SMX11-2(/2) and SMX12-2(/2), the connection is inverse to the presented and to X31/X32 with application of a incremental counting system.

With encoders not connected inversely to X33/X34, the direction of rotation is thus indicated inversely. The indicated direction of rotation can be corrected in the software. (see. programming manual S. 90 FF - "Direction UP/down“)

5.11.2.3 X35

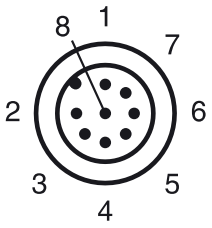


Pin No.	*Description*	
1	I/O2 (Enable Blue)	Blue lighting control
2	+ U_B	Supply voltage
3	Data + / TX / 485+	Data channel Transmit
4	Data - / RX / 485-	Receive data channel
5	O1 (Sync. Out)	SYNC Signal of Sensor
6	I1 (Enable Red)	Red lighting control
7	- U_B / GND	Ground
8	NC	Not assigned

Shielding is a measure to attenuate electromagnetic interference.
Please only use connection cables with braided shielding.
Avoid connecting cables with a foil shield.

NOTICE The shielding is connected on both sides, i.e. on the control unit **and** on the read head. The earthing terminal (PCV-SC12-BBH), which is available as an accessory, enables simple inclusion in the equipotential bonding.

5.11.2.4 X35-1/X35-2



Pin No.	Description	
1	NC	Not assigned
2	+ U_B	Supply voltage
3	Data +	Data channel Transmit
4	Data -	Data channel Receive
5	NC	Not assigned
6	NC	Not assigned
7	- U_B / GND	Ground
8	NC	Not assigned

Shielding is a measure to attenuate electromagnetic interference.
Please only use connection cables with braided shielding.
Avoid connecting cables with a foil shield.

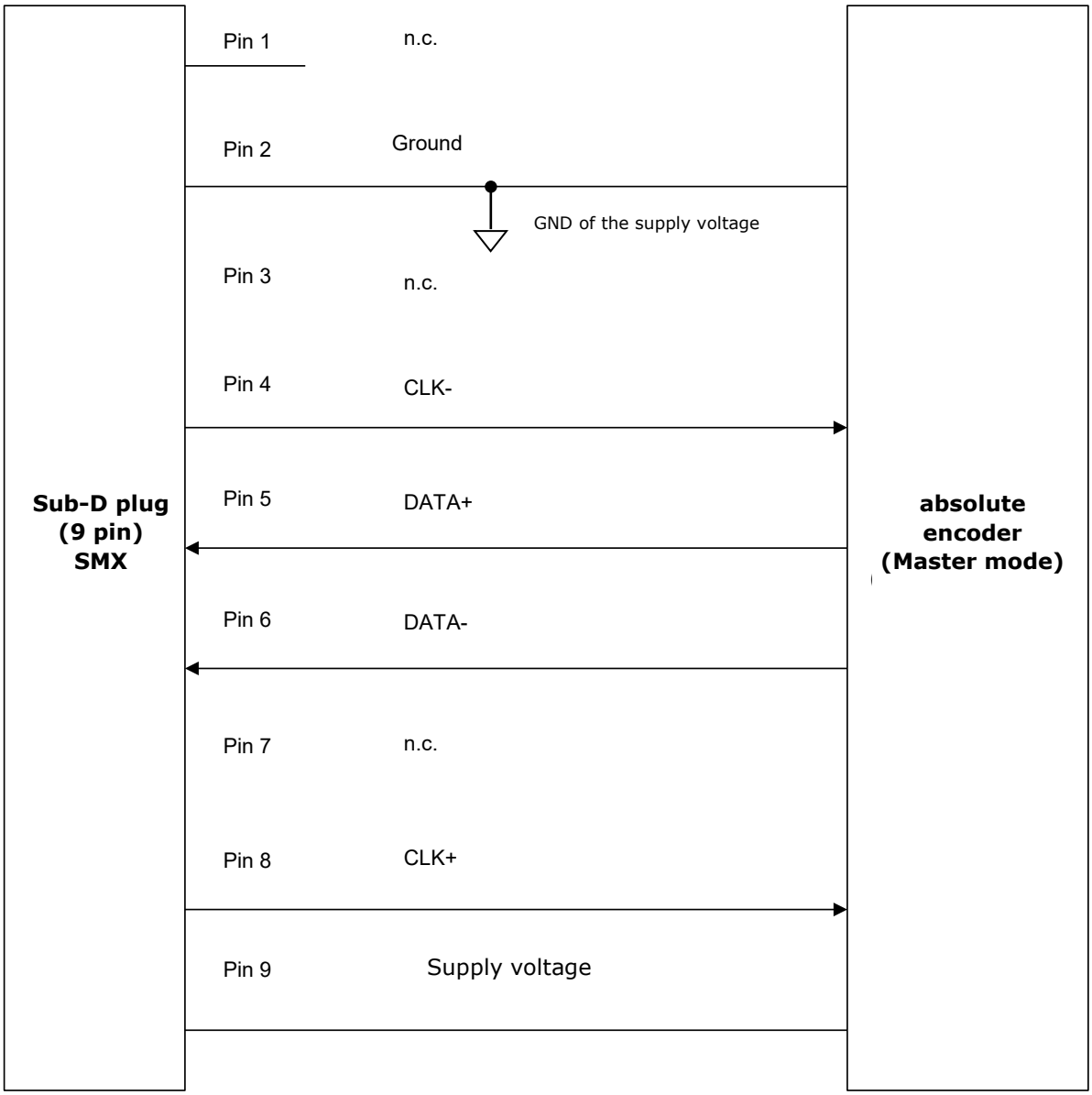
NOTICE

The shielding is connected on both sides, i.e. on the control unit **and** on the path coding system.

The earthing terminal (PCV-SC12-BBH), which is available as an accessory, enables simple inclusion in the equipotential bonding.

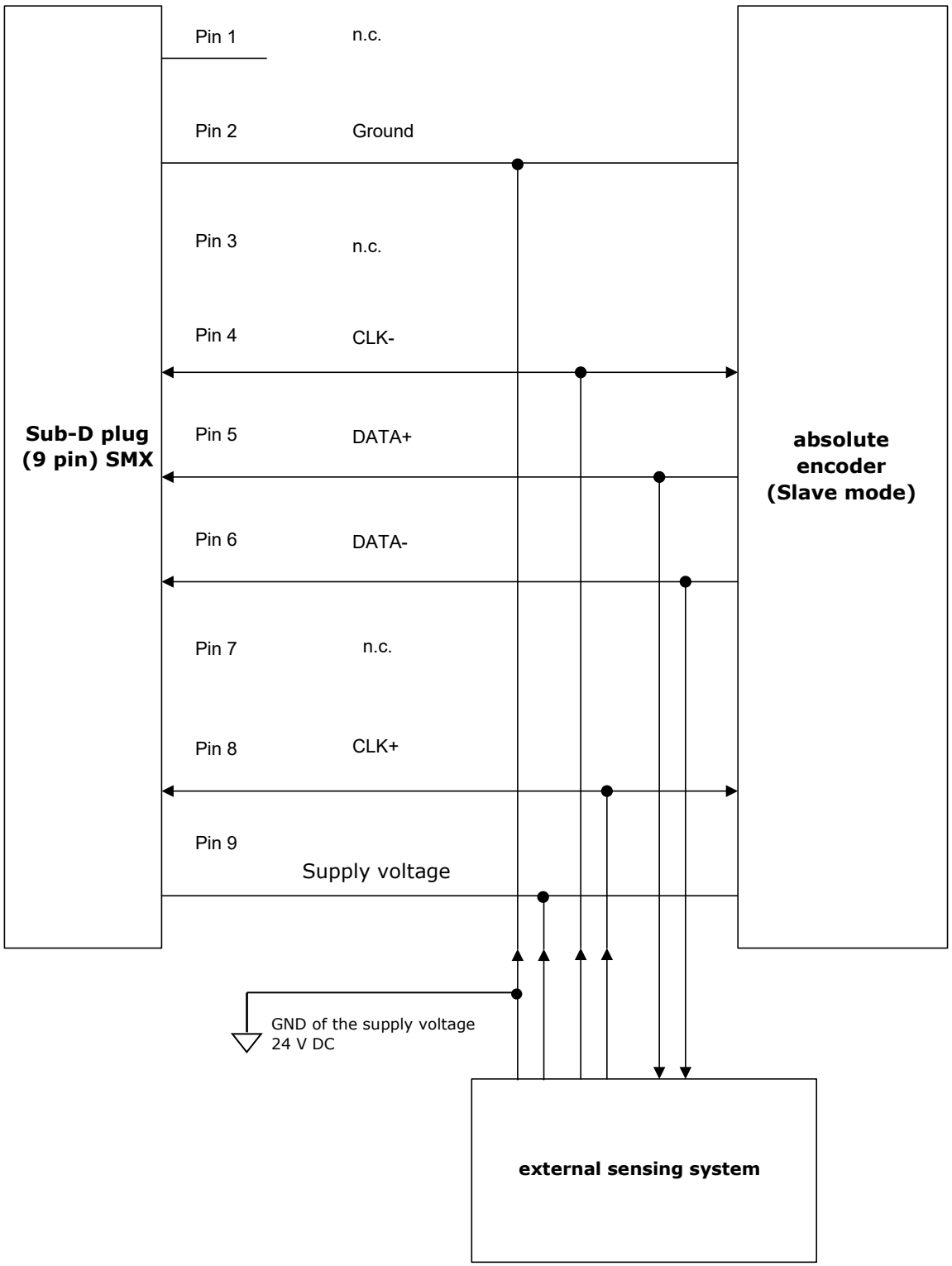
5.11.3 Connection variants

5.11.3.1 Connection of an absolute encoder as master



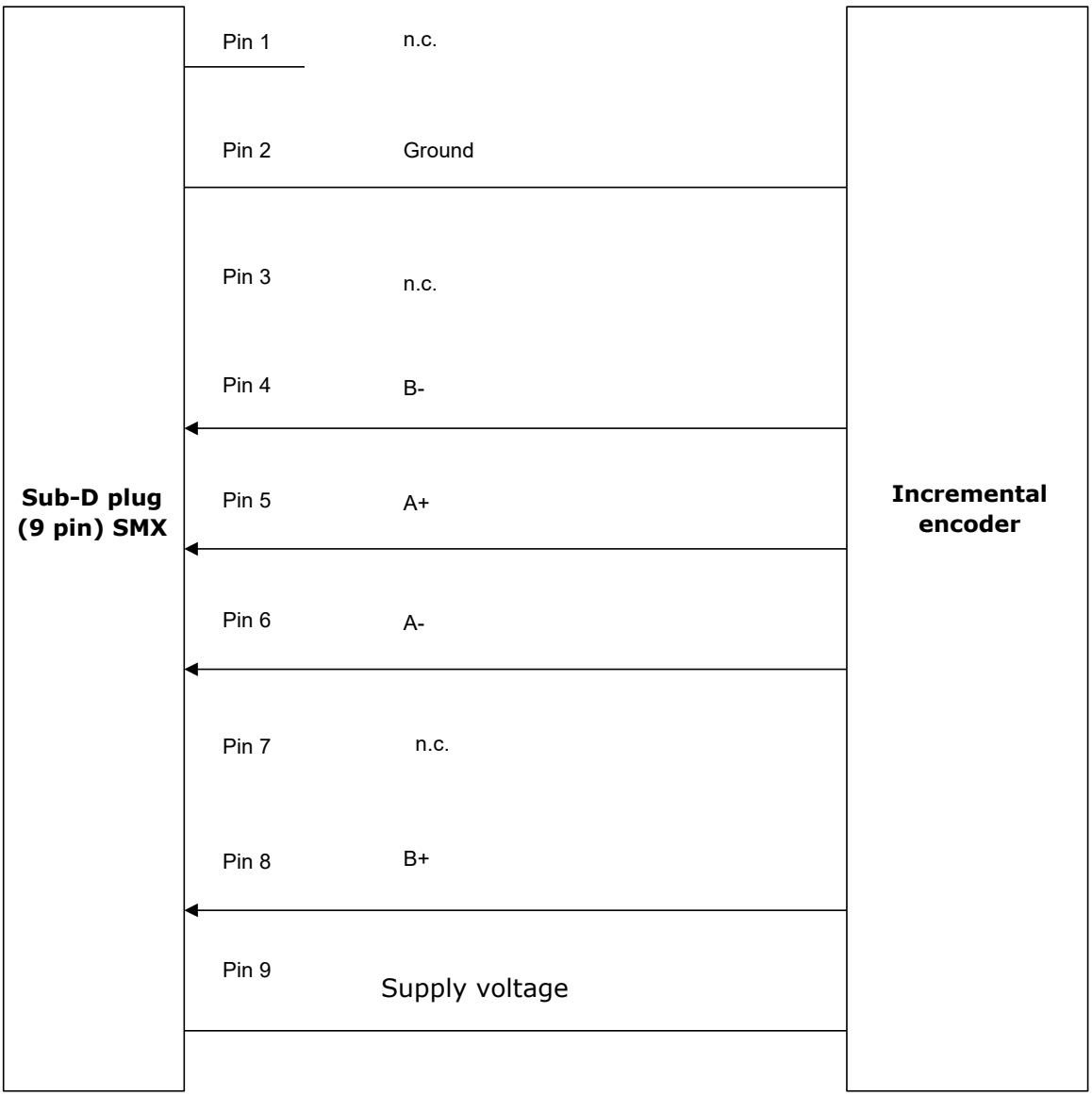
B With this type of the connection the clock pulses of the module SMX run to the absolute encoder and the data from the encoder to the SMX.

5.11.3.2 Connecting an absolute encoder as slave



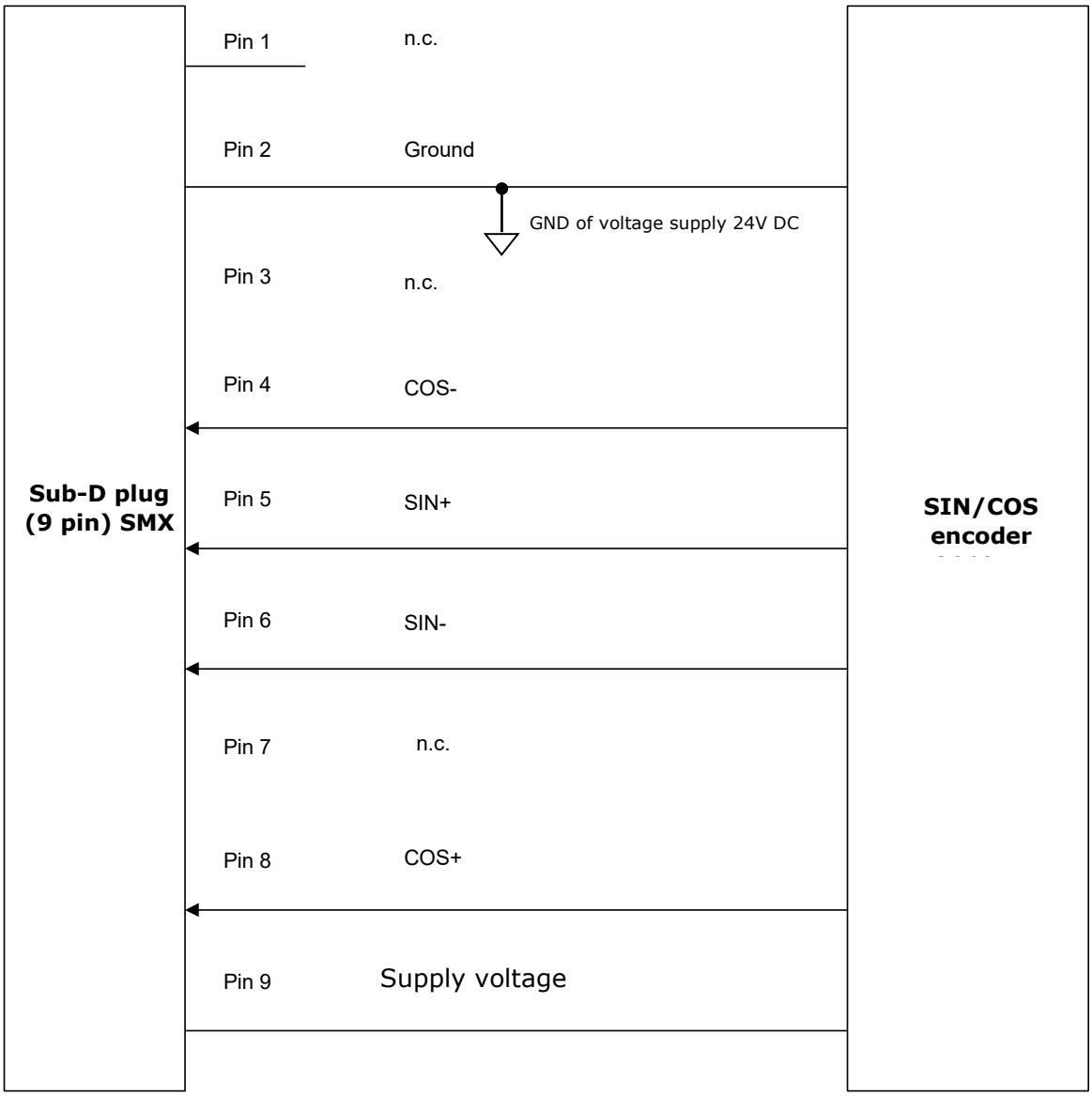
With this type of connection both clock signals and data are read in. In this example the module does not supply the encoder with voltage.

5.11.3.3 Connecting a incremental encoder with TTL-signal level



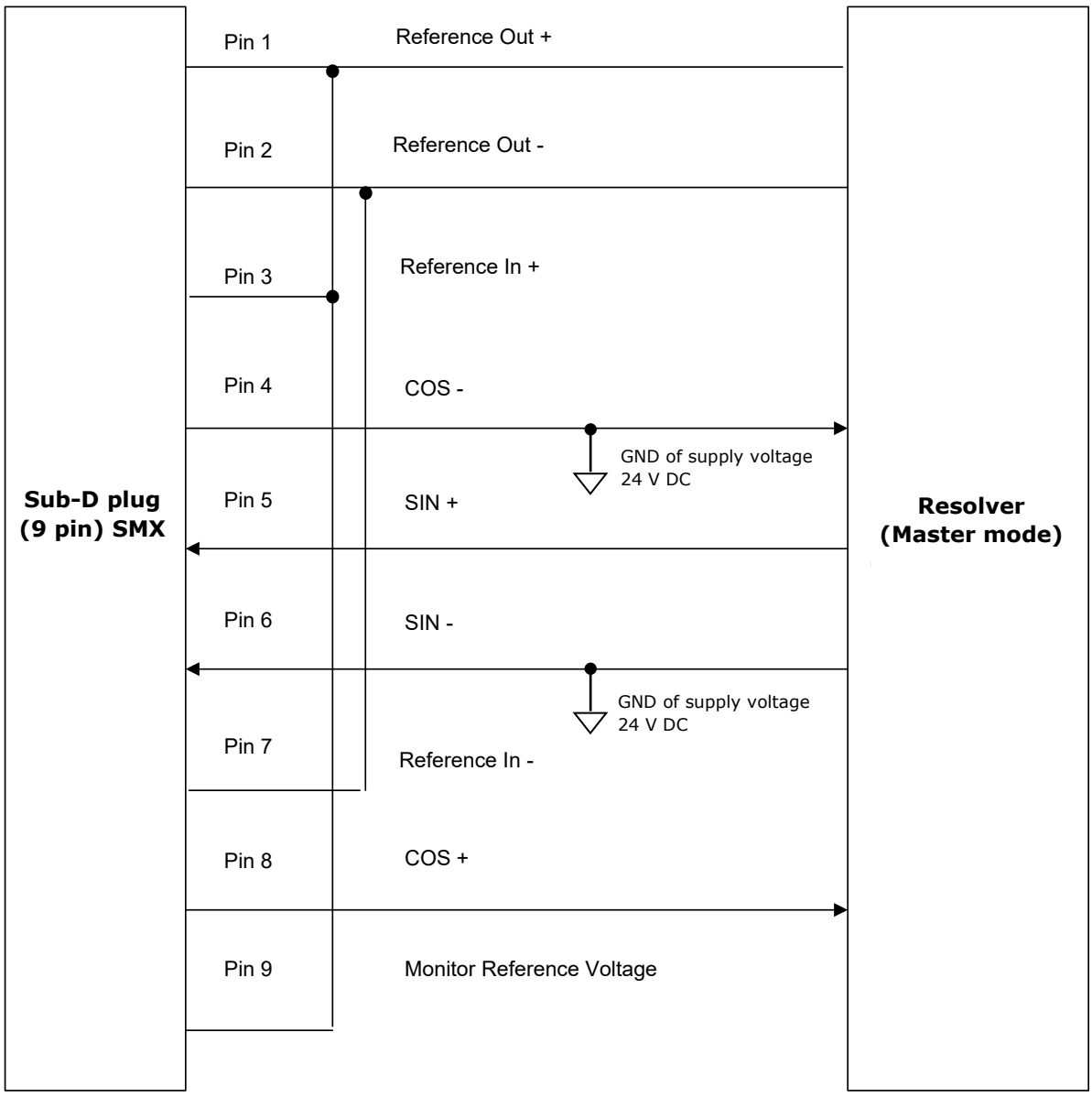
Pins 1, 3 and 7 stay open and are reserved for later expansions.

5.11.3.4 Connecting an SIN/COS encoder



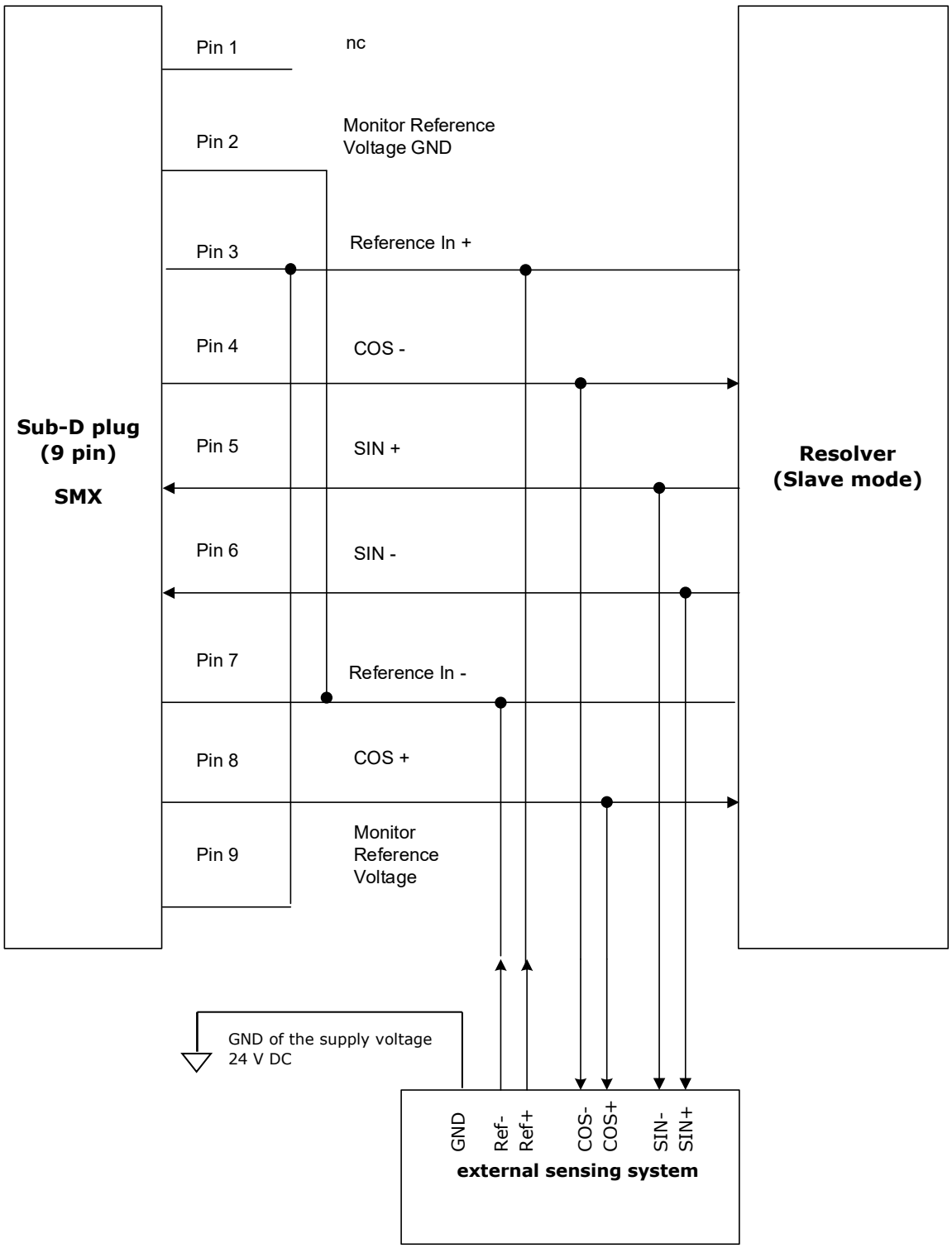
Pins 1, 3 and 7 stay open and are reserved for later expansions.

5.11.3.5 Connecting a resolvers as master



With this type of connection the clock signals are submitted from the SMX module to the absolute encoder and the data from the encoder to the SMX.

5.11.3.6 Connecting a resolver as slave



With this type of connection, the clock signals and data are also read. In this example, the encoder is not supplied with voltage from the module.

5.11.3.7 Connection of proximiy switch SMX1x/2

Connection is made via connector X23 at the digital inputs I5 ...I8.

The exact pin assignment depends on which encoder type is used and is displayed in the wiring scheme in the programing interface.

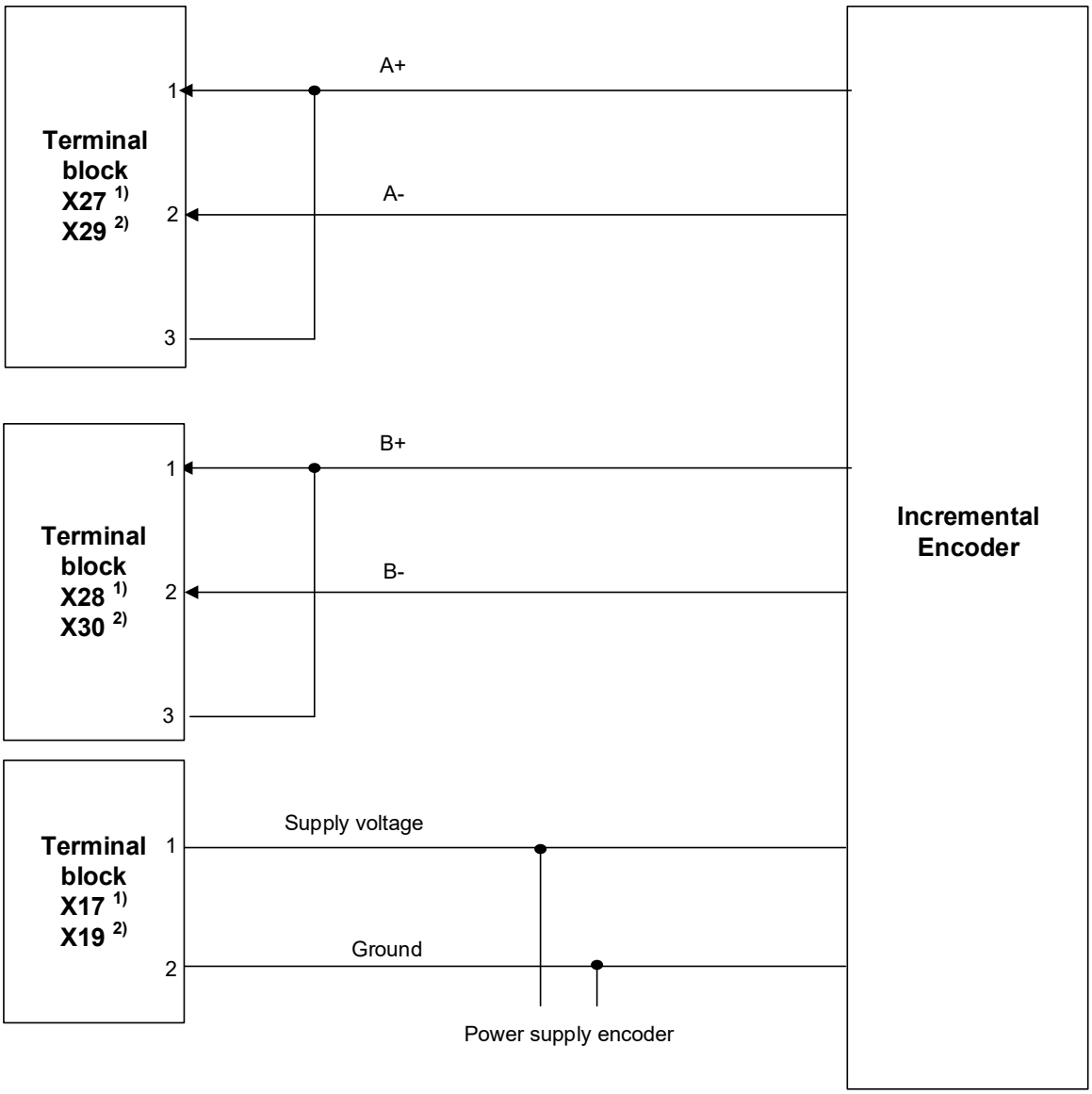
NOTICE

When using HTL encoders, please note that tracks A+ and B+ or A- and B- must be combined accordingly.

5.11.3.8 Connection of HTL/proximity switch SMX11-2/2, SMX12-2/2

Connection via plug connectors X27 and X28, or X29 and X30.

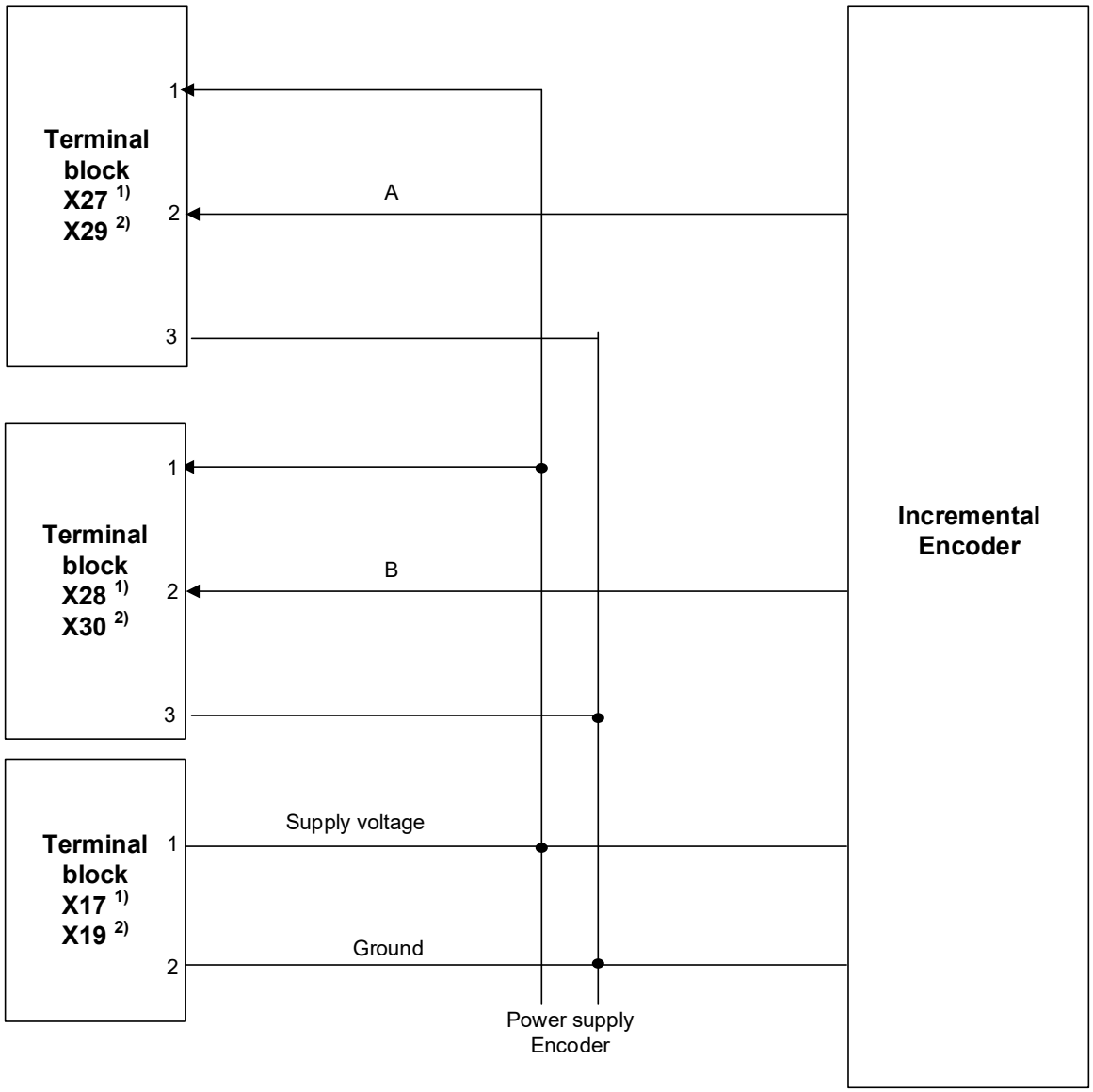
5.11.3.8.1 HTL-encoder with A+/A- or B+/B- signal



1)SMX11-2/2 encoder 3

2)SMX12-2/2 encoder 4

5.11.3.8.2 HTL-encoder with A+ or B+- signal



1)SMX11-2/2 encoder 3

2)SMX12-2/2 encoder 4

5.12 Configuration of measuring distances

5.12.1 General description of encoder configuration

The most important input variables for the monitoring functions of the module are safe position, speed and acceleration. These are obtained by dual-channel generation from the connected sensor system. A category 4 compliant architecture, i.e. continuous dual-channel recording with high degree of diagnostic coverage, is required for Pl e acc. to EN ISO 13849-1. For possible single-channel components (e.g. mechanical connection of the sensors/encoders with only one shaft/fastening) fault exclusions acc. to EN ISO 13849-2 may be used, if this should be necessary. For Pl d acc. to EN ISO 13849-1 one may work with a reduced degree or diagnostic coverage. Simple design sensor systems (speed monitoring only) may under certain circumstances be sufficient under due consideration of the permissible fault exclusions acc. to EN ISO 13849-2.

See also Appendix A – Classification of switch types

Further configuration is descripted in the programming manual:

HB-37480-820-01-xxF-EN Programing manual SafePLC2.pdf

5.12.2 Sensor type diagnostics

Absolute encoder and incremental measuring systems are possible, as well as counting pulse generating proximity switches.

5.12.2.1 Absolut encoder

5.12.2.1.1 SSI

Data interface: Serial Synchronous Interface (SSI) with variable data length from 12 to 28 Bit.

Data format: Binary or Gray code

Physical Layer: RS-422 compatible

SSI-Master operation:

Clock rate: 150kHz

SSI-Listener operation (slave mode):

Max. external clock rate 250 KHz [1] or 350 kHz [2].

Min. clock pause time 150 µsec

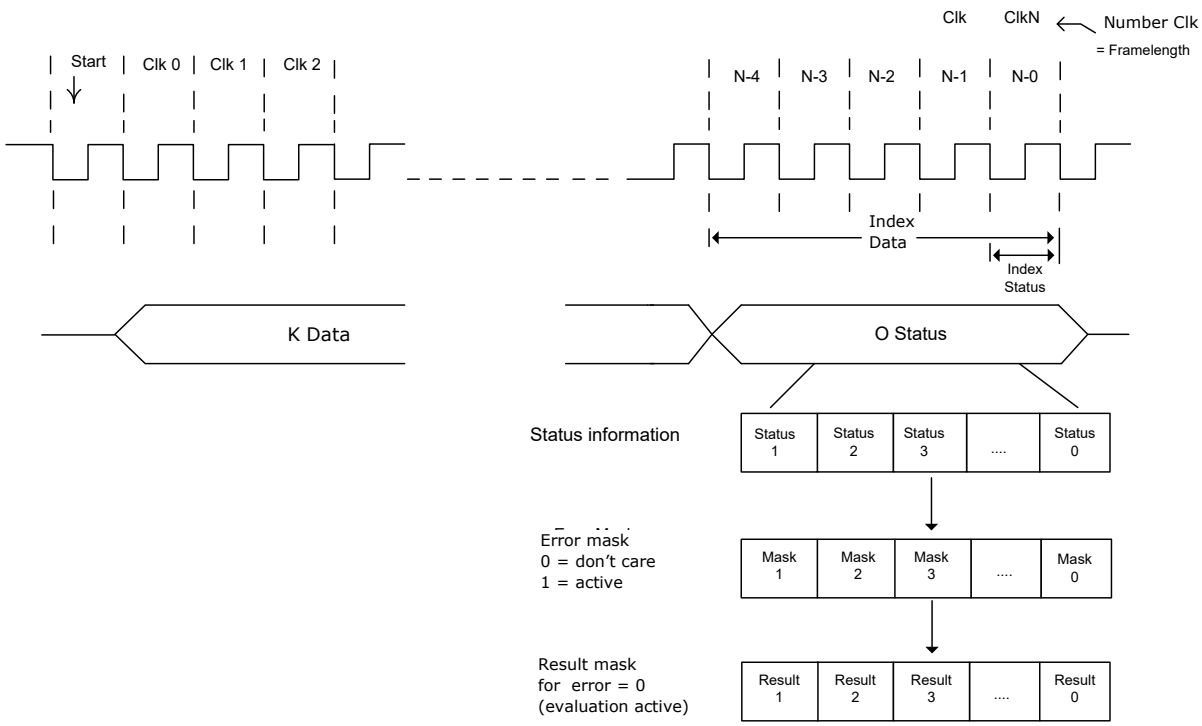
Max. clock pause time 1 msec

[1] on X31/32
[2] on X33/34

Diagnostics:

Diagnostic	***Parameters***	***Fault threshold***
Supply voltage monitoring	Fixed values 5 V, 8V, 10V, 12V, 20V, 24V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of differential level on input	Fixed values RS 485-level	+/- 20% +/-2% (Measuring tolerance)
Monitoring of Clk-frequency	Fixed values	100 kHz < f < 350 kHz
Plausibility of speed versus position	Fixed values	DP < 2 * V * T with T = 8 ms

Parameterization of SSI format:

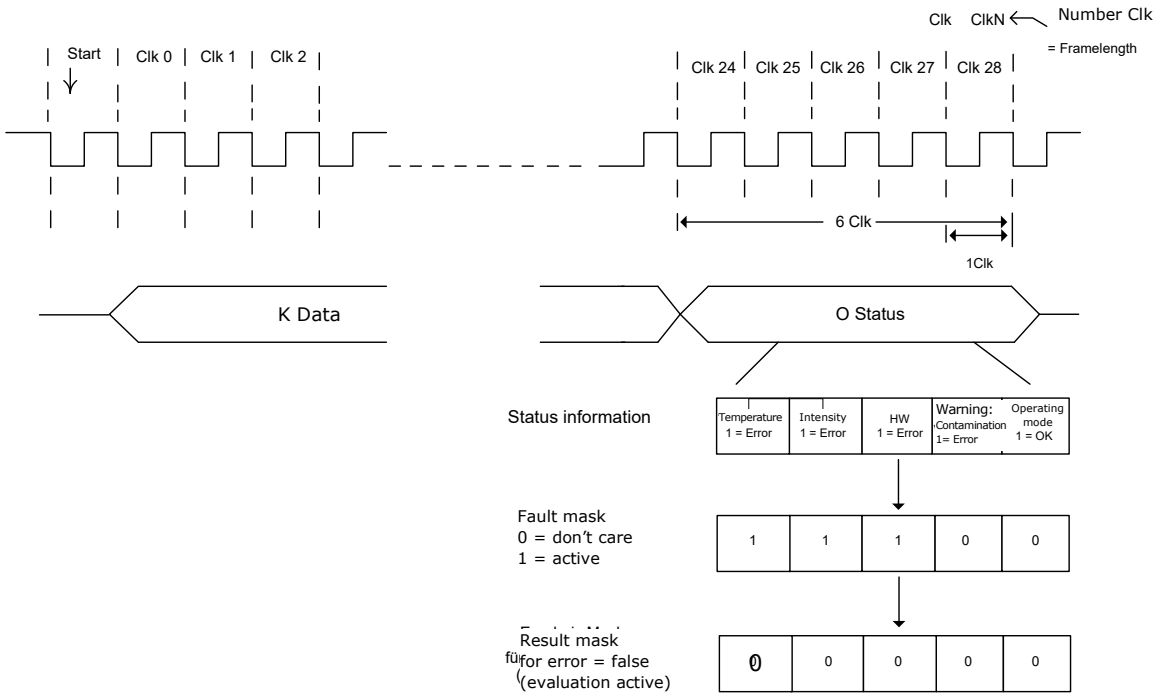


Example:

SSI-Frame length: 28 cycles

Data-Length: 22 Bit

Status: 5 Bit, 3 Bit Error + 2 Bit Warning/ready for operation



5.12.2.1.2 WCS (WCS3B-LS2xx)

Data interface: RS-485 interface

Data format: Binary code (forward/backward)

Protocol: Data protocol 2

Transmission rate: 62,5 kBits/s or 187,5 kBit/s (configurable)

Measuring length: max. 314,563 m (393204 lines)

Resolution: +/- 0,4 mm (1250 positions/m)

[1] On X35-1, X35-2

	Parameters	***Fault threshold***
Overrun speed v	≤ 12,5 m/s	+/- 15,5 mm tolerance, Y-axis +/- 14 mm tolerance, X-axis
Cycle time	Fixed value T = 8 ms	

SAFETY NOTE

- For the WCS system, two diverse read heads must be used at a fixed distance with the following parameters:
- Read head 1: Positions output in upward direction
- Read head 2: Position output in reverse directions in
- The WCS read heads must be operated with different addresses.

5.12.2.2 Incremental encoder

Physical Layer: RS-422 compatible

Measuring signal A/B: Track with 90 degree phase difference

Maximum frequency of input cycles: 200 KHz [1] or. 250 kHz [2]

[1] on X31/32
[2] on X33/34

Diagnostics:

Diagnostic	Parameters	Fault threshold
Supply voltage monitoring	Fixed values 5 V, 8V, 10V, 12V, 20V, 24V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of differential level on input	Fixed value RS 485-level	+/- 20% +/-2% (Measuring tolerance)
Monitoring of the counting signal separated for each track A/B	Fixed value	DP > 4 Increments

5.12.2.3 SineCosine encoder – standard mode

Physical Layer: +/- 0.5 Vss (without voltage offset)

Measuring signal A/B: Track with 90 degree phase difference

Maximum frequency of input clock pulses: 200 KHz [1] or 250 kHz [2]

[1] on X31/32
[2] on X33/34

Diagnostics:

Diagnostic	Parameters	Fault threshold
Supply voltage monitoring	Fixed values 5 V, 8V, 10V, 12V, 20V, 24V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of amplitude SIN^2+COS^2	Fixed value $1V_{SS}$	65% of 1 V_{SS} +/- 2,5% (Measuring tolerance)
Monitoring of phases A/B	Fixed value 90°	+/- 30° +/-5° (Measuring tolerance)

5.12.2.4 SineCosie encoder – high resolution mode

Physical Layer: +/- 0.5 Vss (without voltage offset)

Measuring signal A/B: Track with 90 degree phase difference

Maximum frequency of input clock pulses: 15 kHz [2)]

Diagnostics:

Diagnostic	Parameters	Fault threshold
Supply voltage monitoring	Fixed values 5 V, 8V, 10V, 12V, 20V, 24V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of amplitude SIN^2+COS^2	Fixed value $1V_{SS}$	65% of 1 V_{SS} +/- 2,5% (Measuring tolerance)
Monitoring of phases A/B	Fixed value 90°	+/- 30° +/-5° (Measuring tolerance)
Monitoring of counting signal / signal phase quadrant	Fixed value	+/- 45°

5.12.2.5 Proxi – Switch

Signal level: 24V / 0V

Max. counting frequency: 10kHz

Circuit logic: de-bounced

Diagnostics:

Diagnostic	Parameters	Fault threshold
Supply voltage monitoring	Fixed value 24 V	+/- 20% +/-2% (Measuring tolerance)

5.12.2.6 Extended monitoring proximity switch / proximity switch

The extended monitoring uncovers the following faults:

a) Supply voltage failure

b) Failure of the output signal in the driver direction

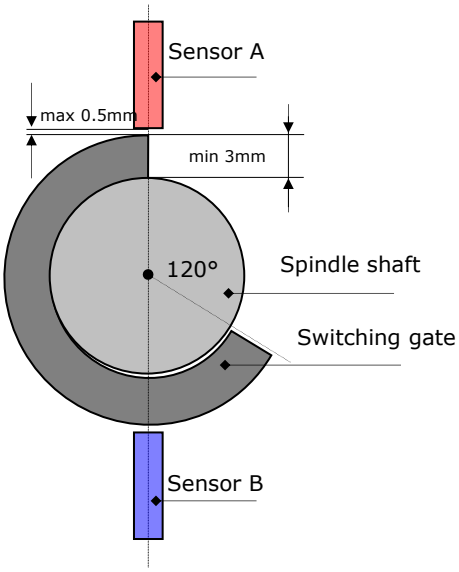
c) Malfunction Proxi for high signal

d) Interruption of signal path

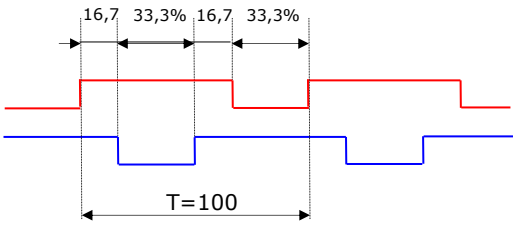
Mechanical de-adjustment of proximity switch / excessive switching distance of proximity switch

For diagnostic purposes, the two status states of the counter signals are also recorded synchronously and compared logically. An attenuation of at least one of the two signals must be ensured by the switching circuit. The logic evaluates this arrangement rule.

Design of switching gate with radial sensor arrangement



Intended theoretic signal form



The diagnose must be designed for at least the following limiting values:

Max. counting frequency: 4 kHz

Max. blanking 0-signal: 50 %

Min. coverage: 10 %

The following evaluation must be carried out in both channels:

Signal A	***Signal B***	***Result***
Low	Low	False
High	Low	True
Low	High	True
High	High	True

5.12.2.7 HTL – Sensor

Signal level: 24V/0V

Physical Layer: Push/Pull

Measuring signal A/B : Track with 90° phase difference

Max. counting pulse frequency: 200 kHz on X27/28 or X29/30

(only SMX11-2/2, SMX12-2/2)

Diagnostics:

Diagnostic	***Parameters***	***Fault threshold***
Supply voltage monitoring	Fixed value 24 V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of differential level on input	Fixed value 24 V	+/- 20% +/-2% (Measuring tolerance)
Monitoring of the counting signal separated for each track A/B	Fixed value	DP > 4 increments

5.12.2.8 Resolver

Measuring signal: SIN/COS – track with 90° phase difference

Max. counting pulse frequency: 2 kHz/pole

Resolution: 9 Bit / pole

Master-Mode:

Frequency reference signal: 8 kHz

Slave-Mode

Frequency reference signal: 6 - 16 kHz

Reference signal form: Sine, triangle

Diagnostics:

Diagnostic	***Parameters***	***Fault threshold***
Monitoring of ratio	Fixed values 2:1, 3:2, 4:1	+/- 20% +/- 2% (Measuring tolerance)
Monitoring of signal amplitude SIN^2+COS^2	Fixed value	<2,8V +/- 5% (Measuring tolerance)
Monitoring of phases A/B	Fixed value 90°	+/- 7° +/-2° (Measuring tolerance)
Monitoring of reference frequency	Fixed values in steps from 1 kHz ..12 kHz, 14 kHz, 16 kHz	+/- 20% +/-5% (Measuring tolerance)
Form of reference signal	Sine, triangle, no monitoring	40% Form deviation
Monitoring of counting signal / signal phase quadrant	Fixed value	+/- 45°

6 Response time of the SMX

The response time is a very important safety related characteristic and must be strictly observed for each application / application related safety function. The following chapter lists the response times for individual functions, probably also in dependence on further parameters. If these data are insufficient for a specific application you should validate the actual time behavior against the nominal behavior by means of separate measurements. This applies also for the use of filter functions in particular.

SAFETY NOTICE

- The response times must be determined for each application related safety function in nominal behavior and must then be compared with the actual value by using the following data.
- Special care must be taken when using filter functions. Depending on the filter length / time the response time may be extended, which must be taken into account in the safety related design.
- In case of particularly critical problem formulations the temporal behavior must be validated by means of measurements.
- During start-up of the device / alarm or fault reset the outputs may (depending on the application program) become active over the response time period. This must be taken into consideration when planning the safety function.
- When using safe field bus connections (e.g. PROFIsafe, FSoE), the system run-time (watchdog) must also be included in the calculation.

6.1 Response time in standard operation

The cycle time of the SMX system serves as the basis for calculating response times. In operation, this is **T_cycle = 8 ms.** The specified response times comply with the corresponding maximum runtime for the specific application within the SMX module. Depending on the application, further application-dependent response times of the sensors and actuators used must be added to obtain the total runtime.

Function	***Response time [ms]***	***Explanation***
Activation of a monitoring function by means of ENABLE with subsequent shut-down via digital output	24 *)	Activation of a monitoring function by means of the ENABLE signal.
Activation of a monitoring function by means of ENABLE with subsequent shut-down via safety relay	47 *)	Activation of a monitoring function by means of the ENABLE signal.
Response of an already activated **monitoring function** including PLC processing in case of position and speed processing via digital output	16 *)	With a monitoring function that has already been activated via ENABLE, the module requires one cycle to calculate the current speed value. During the next cycle after calculation of the monitoring function the information is further processed and output by the PLC, i.e. according to the implemented logic this will lead to e.g. switching of an output.
Response of an already activated **monitoring function** including PLC processing in case of position and speed processing via safety relay	39 *)	With a monitoring function that has already been activated via ENABLE, the module requires one cycle to calculate the current speed value. During the next cycle after calculation of the monitoring function the information is further processed and output by the PLC, i.e. according to the implemented logic this will lead to e.g. switching of an output.
Activation of digital output via digital input	16	Activation of an input and switching of the output
Activation output relay via digital input	26	Activation of an input and switching of the output
Deactivation of digital output via digital input	16	Deactivation of an input and thus deactivation of the output
Deactivation output relay via digital input	47	Deactivation of an input and thus deactivation of the output
Average filter (setting see encoder dialog SafePLC^2)	0 - 64	Group running time of the average. This running time only effects the monitoring function in connection with position / speed / acceleration, but not the logic processing.
Analog filter • 1 (2Hz) • 2 (2Hz) • 3 (2Hz) • 4 (4Hz) • 5 (6Hz) • 6 (8Hz) • 7 (10Hz) • 8 (20Hz)	 • 760 • 760 • 760 • 512 • 268 • 143 • 86 • 56	The analog filter only affects the safe analog inputs of all modules with analog variants Response times of the analog input filters in relation to the input frequency

Notice:
*): When using an average filter the response time of this filter must also be added

6.2 Response time for FAST_CHANNEL

FAST_CHANNEL describes a characteristic of SMX to respond quicker to speed requirements than this would be possible with the execution of the safety programs in normal cycle (= 8 msec) The sampling time of FAST_CHANNEL is 2 msec.

The following response times can be specified:

- 4 msec (Worst Case condition)

SAFETY NOTICE

Using of FastChannel

When using FAST_CHANNEL you should bear in mind that shutting down within the time specified above for a given speed threshold is only possible, if the sensor information has a sufficient resolution. The smallest resolvable switching threshold of the FAST_CHANNEL requires at least 2 edge changes on the corresponding sensor system within a period of 2 msec.

➲ This function can only be used in connection with semi-conductor outputs.

➲ The FAST_CHANNEL may not act on SSI Listeners

6.3 Response time for Fault distance monitoring

The following calculation schematic applies for calculating the Worst Case condition:

System speed at the sampling time	V(t)
System speed at reaction of the SMX:	V_A
(threshold value for monitoring (SLS or SCA):	V_S = constant for all t
Parameterized filter value:	XF = constant for all t
Maximum possible acceleration of the application:	a_F = constant for all t
Deceleration after shut-down:	a_V = constant for all t
Sampling instant for occurrence of the Worst Case event:	T_{error}
Response time of the SMX-Systems:	t_{React}

For the Worst Case assessment it is assumed that the drive will initially move exactly to the parameterized threshold with a speed V(k) and then will accelerate to the maximum possible value a0.

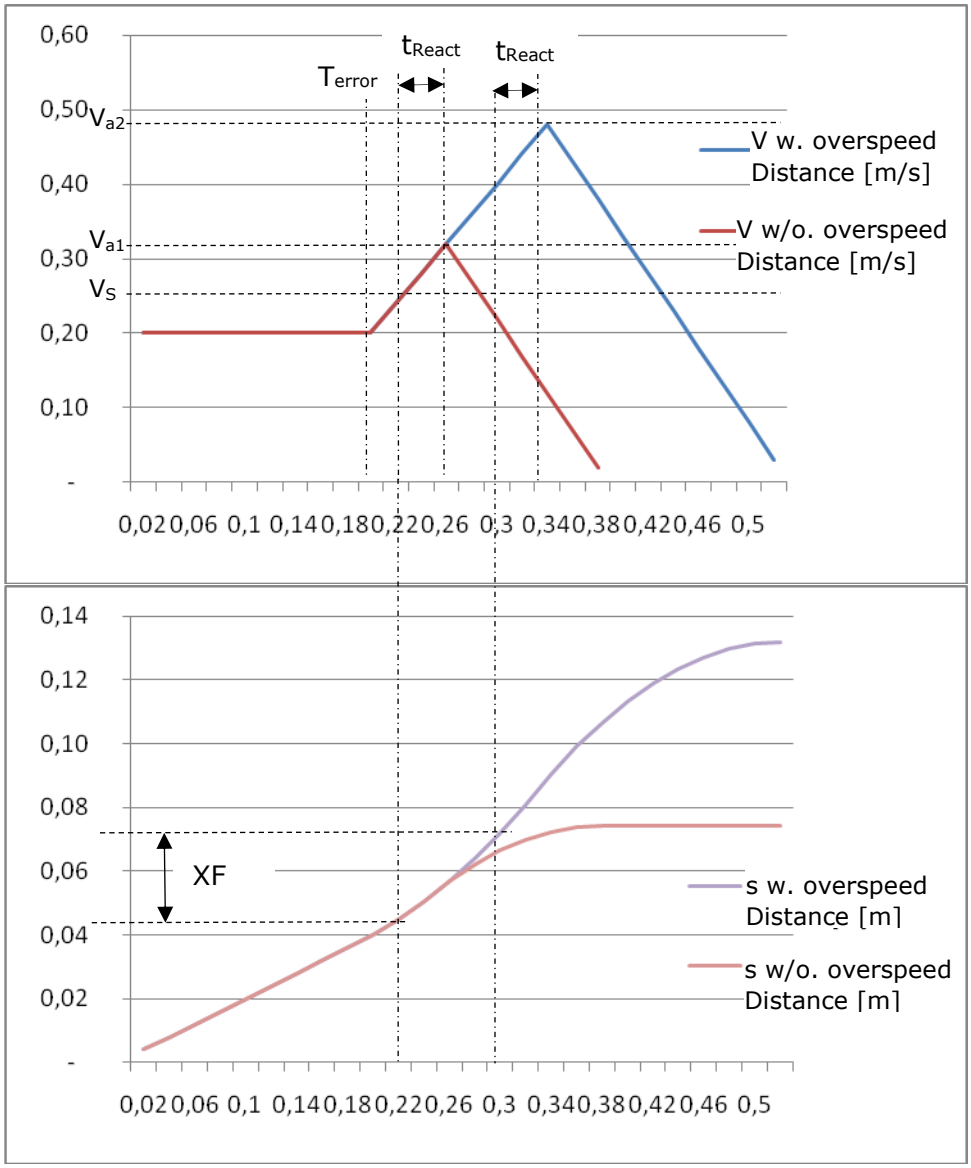


Diagram: Behavior of the drive with / without overspeed distance

Without overspeed distance the following connections result for the course of V and s.:

Parameters	Calculations methods	Comment
t_{React}	Value from the specified response time SMX + deceleration time in external shut-down chain	Deceleration time in external shut-off chain derived from relay/contactor and brake data, etc. issued by the manufacturer
a_F, a_V	n.a.	Estimation of the application
V_{a1}	= V_S + a_F * t_{React}	

With overspeed distance the following connections result for the course of V and s:

Parameters	***Calculations methods***	***Comment***
t_{React}	Value for response time data SMX + deceleration time in external shut-down chain	Deceleration time in external shut-off chain derived from relay/contactor and brake data, etc. issued by the manufacturer
a_F, a_V	n.a.	Estimation of the application
V_{a2}	$= a_F * t_{React} + (V_S^2 + 2 * a_F * XF)^{1/2}$	

With its effect the filter displaces the set speed threshold V_a upwards by the amount **delta_v_filter**. For the application one must consider the new response time values ($T_{react} = T_{smx} + T_{filter}$), as well as the speed at shut-down by SMX resulting from this.

6.4 Response time when using SMX31x/2

The cycle time of the SMX system serves as basis for calculating the response times. In operation this is **T_zyklus = 8 ms.** The specified response times comply with the corresponding maximum running time for the actual application within the SMX module. Depending on the application, further, application dependent response times of the sensors and actuators used must be added, in order to obtain the total running time.

Function	***Designation***	***Resonse time [ms]***	***Explanation***
Worst Case deceleration time inlet in basic module to PAE	T_{IN_BASE}	10	e.g. activation of a monitoring function by an input signal in the basic module
Worst Case deceleration time input SMX31 to PAE in basic module	T_{IN_31}	18	e.g. activation of a monitoring function by an input signal in the extension module SMX31
Processing time PAE to PAA in basic module	T_{PLC}	8	Shut-down by a monitoring function or an input in PAE
Activation / deactivation digital output in basic module from PAA	T_{OUT_BASE}	-	Activation or deactivation of an output in the basic module after changes to the PAA.
Activation / deactivation digital output in extension module via PAA in basic module	T_{OUT_31}	8	Activation or deactivation of an output in the extension module SMX31 after changes to the PAA in the basic module.

Determination of the total response time

$T_{TOTAL} = T_{IN} + T_{PLC} + T_{OUT}$

Example 1:

Input to extension module, activation of SLS and processing in PLC, output to base module

$T_{TOTAL} = T_{IN\_31} + T_{PLC} + T_{OUT\_Base} = 18\ ms + 8\ ms + 0\ ms = 24\ ms;$

Example 2:

Input to base module, activation of SLS and processing in PLC, output to extension module.

$T_{TOTAL} = T_{IN\_Base} + T_{PLC} + T_{OUT\_31} = 10\ ms + 8\ ms + 8\ ms = 26\ ms;$

Example 3:

Input to extension module, activation of SLS and processing in PLC, output to extension module.

$T_{TOTAL} = T_{IN\_31} + T_{PLC} + T_{OUT\_31} = 18\ ms + 8\ ms + 8\ ms = 34\ ms;$

6.5 Response time when using SCA Extended

With firmware version 05.00.04.19, 240 additional SCA modules are available. These can only be configured for the "Position monitoring" mode.

The internal processing of the additional SCA area is distributed over several cycles.

30 SCAs are processed per cycle. This means that when using the extended SCAs, the response time increases to (8+1) * module cycle time.

This increase in response time is independent of the number of SCAs used and must always be taken into account.

NOTICE

These standard SCA blocks are not affected here. They will continue to be processed in the standard assembly cycle.

7 Commissioning and start

7.1 Procedure

Commissioning must only be carried out by qualified personnel!
Strictly follow the safety regulations when commissioning!

7.2 Switch-on sequence

After each restart of the module, the following phases are run through and displayed on the seven-segment display on the front if the module is running correctly:

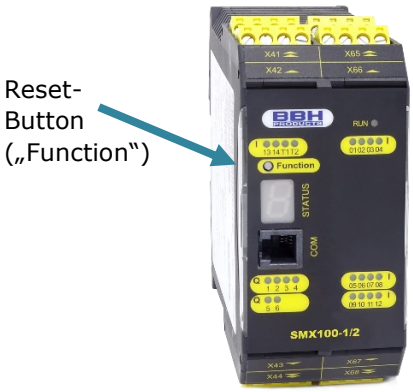
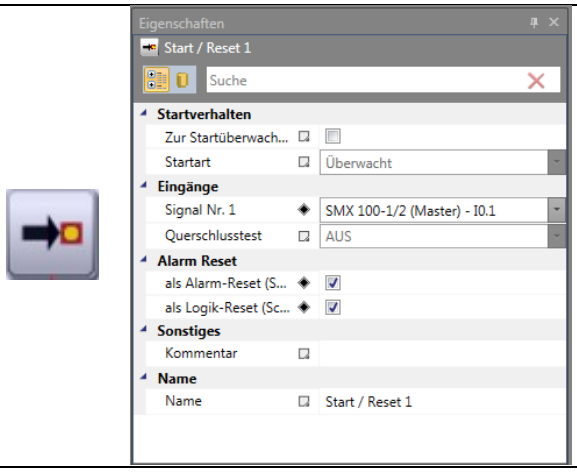
7 segment display	***Mode***	***Description***	
„1“	STARTUP	Synchronization between both processor systems and checking of configuration/firmware data	
„2“	SENDCONFIG	Distribution of configuration/firmware data and renewed checking of these data. Subsequent area checking of configuration data.	
„3“	STARTUP BUS	If available, initialization of a bus system	
„4“	RUN	Normal operation of the system. All outputs are switched according to the current state of the logic.	
„5“	STOP	In stop mode parameter and program data can be loaded externally.	
„A“	ALARM	The alarm can be reset via the digital input or the front side reset button.	
„E“	ECS-Alarm ICS-Alarm ACS-Alarm	The ECS alarm can be reset via the digital inputs or the front side reset button.	
„F“	Fault	Fault can only be reset via ON/OFF of the module.	
„.“	FBus Status	**Slave F-Bus (PROFIsafe/FSoE):**	
		Off:	F-Bus does not use
		Slow flashing:	F-Bus configured, no connection to the master
		Fast flashing:	Connection to the master, F-Bus activation pending
		On:	F-Bus connected

7.3 Reset Function

The reset function is divided into a start-up function after voltage recovery = general reset and a status/alarm reset = internal reset function. The latter is triggered via the button on the front or a correspondingly configured input = reset element with activated "alarm reset" function.

The following table provides an overview of the reset functions and their effect.

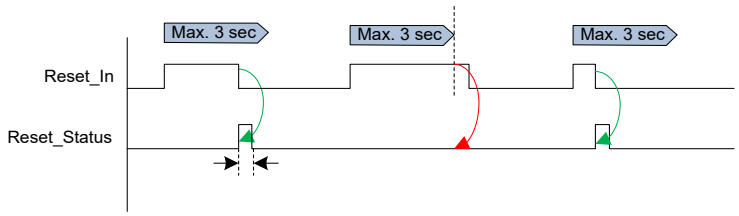
7.3.1 Reset types and triggering element

Reset-Type	Triggering element	Comment
General Reset	Voltage recovery / device start-up	Reset-function after a complete power off / on of the device
Internal Reset		Internal reset triggered using the reset button on the SMX front
		Configuring of a Reset-element

7.3.2 Reset-Timing Reset

The reset-input for an internal reset is time monitored in „RUN"-mode. A internal reset is called by a falling edge of the reset-input under the pre-condition of

T<3 sec between raising / falling edge.

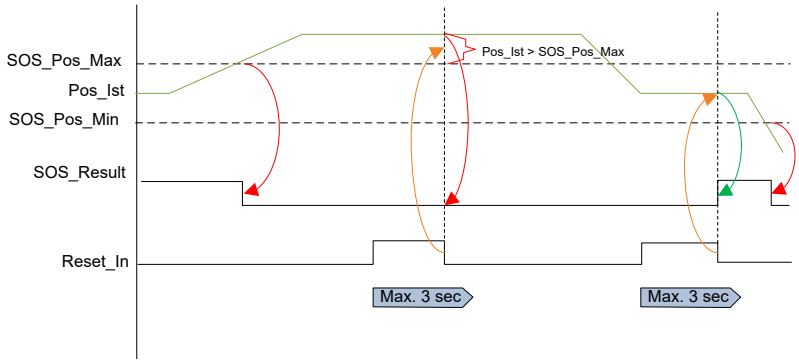


7.3.3 Reset-function

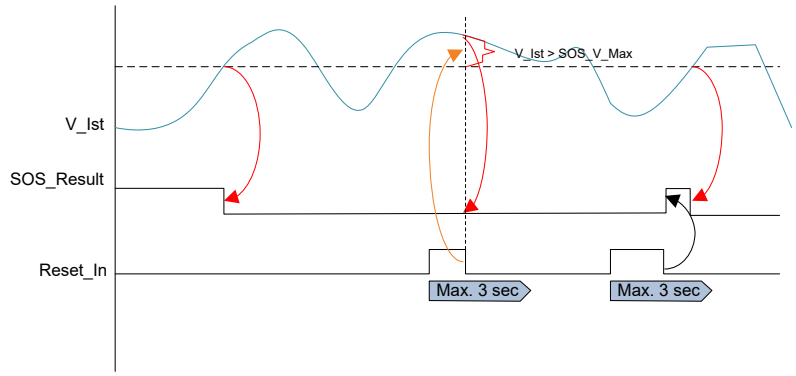
Function blockt	***Power-Reset (POR)***	***Internal Reset***	***Function***
Fatal Error	X		Failure reset
Alarm	X	X	Reset Alarm
Monitoring functions	X	X	Resetting a triggered monitoring function
Flip-Flop	X	X	Status = Reset
Timer	X	X	Timer = 0

After a reset, the status of the monitoring functions is recreated

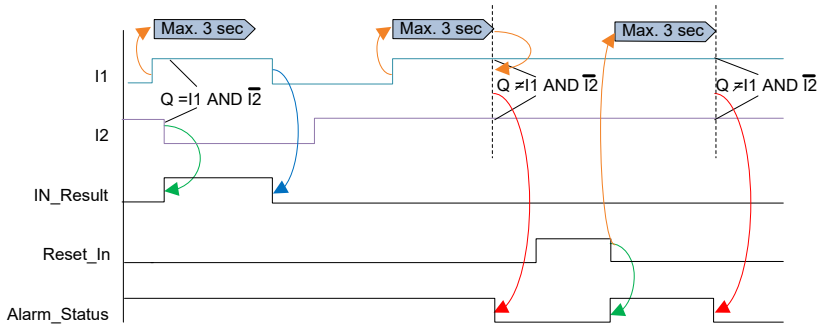
- ⇨ If process values are beyond the parameterized trigger points, the status of the safe monitoring functions is kept unchanged.
- ⇨ Time-based functions - Timers lead to a reset of the output status of the monitoring function. A response is only triggered if the parameterized limit values are exceeded again



Process value (position) => no change of the output status with reset in the alarm condition



Process value (speed) => no change of the output status with reset in the alarm condition



Time based function => Resetting the initial state, response when newly exceeding the limit

SAFETY NOTICE

- With time-based functions, e.g. time-based monitoring of complementary input signals, the initial status is reset and only when the (time) limit value is exceeded again is a status defined as faulty detected.
- For safeguarding of false utilization of the reset-function, e.g. reiterated call of the reset-function to bypass the alarm status, adequate measures in the application program (PLC-program) have to be implemented.

7.3.3.1 Example Reset-Function with safeguarding against false uitlization

Function:

On a machine for normal operation mode, the hazardous area shell be protected by a mechanical guard system. If in setup mode, the safety level is kept by a Confirm button in conjunction with standstill monitoring respective safe limited speed.

The guard closed position is monitored by a sensor. With the guard in open position movement is only possible when the confirm button is pressed.

On the application program this function is implemented by use of the function „Door Control" (2 channel mode with time monitoring) and the function "confirm button".

The logic signal „Door Control" is produced by computing of the input signals versus time monitoring. The time monitoring with an allowed difference on the expected input signals is fixed for 3 sec.

On the status "safety door open" (Signal "LOW" on switch output X23.1 and X23.2 (ID 369)) the axis can be moved with reduced speed if consent X14.1 and X14.2 (ID 318) is active.

Task:

If a faulty cross connection is detected, the SMX device will display the alarm 6701.

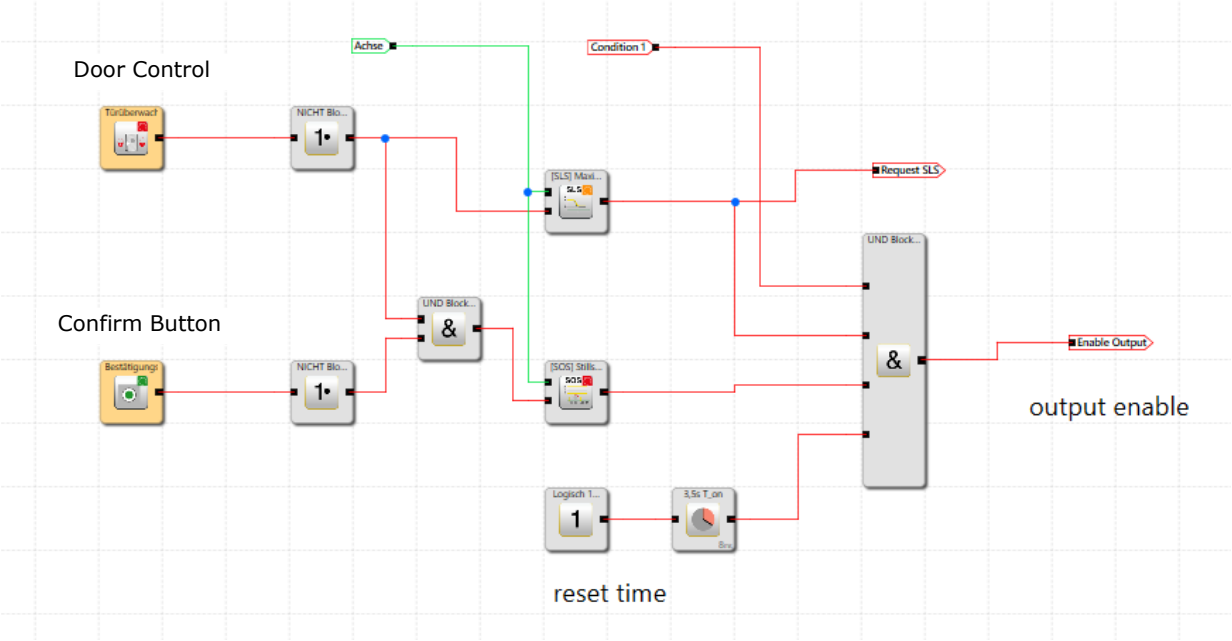
The alarm can be quit, in result the signal "Door Control" (ID 369) is kept correctly on "0" status.

If within this time frame the confirm button is activated, the axis can be moved – on reduced speed only, but moved – for max. 3 sec.

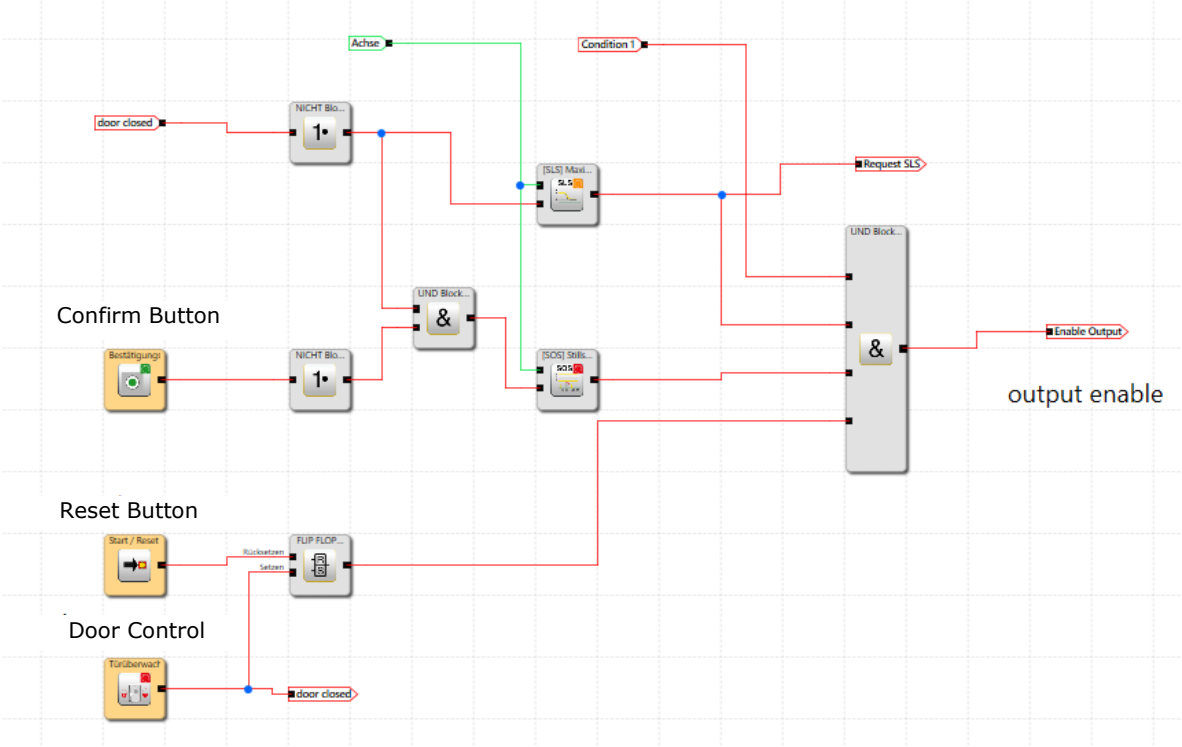
Applicative measure:

By linking within the PLC program, activation of the outputs by bypassing the alarm status is prevented.

Example 1: The enable function of the outputs (ID 88) is also linked to a "reset timer". This prevents activation of the outputs for t > 3 sec after a reset => the renewed effect of time monitoring is ensured.



Example 2: The enable function of the outputs (ID 88) is additional AND combined with an FF. This FF-element prevents the outputs from being activated after a reset and pending error in the input circuit. The outputs are only enabled after an error-free input signal has been applied once.



7.4 LED display

Colour	*Mode*	*Description*
green	„Flashing“	System OK, configuration validated
yellow	„Flashing“	System OK, configuration not yet validated
red	„ Flashing “	Alarm
red	„Permanent“	Fatal Fault
yellow - red	„ Flashing “	System OK, configuration not yet validated, SMMC configured however participant is missing
green - red	„ Flashing “	System OK, configuration validated, SMMC configured however participant is missing

NOTICE For all operating states except RUN the outputs are rendered passive by the firmware, i.e. safely switched off. In status RUN the state of the outputs depend on the implemented PLC-program.

7.5 Parameterization

Parameterization takes place via the program SafePLC^2. The transmission of these data to the module requires a programing adapter(SMX91), the drivers of which must first be installed by the user.

Parametrization is described in:

HB-37480-820-01-xxF-EN Programmierhandbuch SafePLC2.pdf

7.6 Function test

In order to guarantee safety of the module, the user must carry out a functional test of the safety functions at least once in a year. For this purpose the modules used in the parameterization (inputs, outputs, monitoring functions and logic modules) must be checked with respect to function or shut-down.

See:

HB-37480-820-01-xxF-EN Programing manual SafePLC2.pdf

7.7 Validation

In order to assure the implemented safety functions, the user must check and document the parameters and links after commissioning and parameterization. This is supported by the validation wizard in the programming interface (see chapter "Safety related examination ").

8 Safety related examination

To ensure the implemented safety functions, the user must check and document the parameters and links after commissioning and parameterization. This is supported by the parameterization software SafePLC2. (see HB-37480-820-01-xxF-EN Programing manual SafePLC2.pdf)

General information about the system can be entered on the first two pages. On the following pages of the validation report, all functions used are printed with their parameters as individual proof of the safety test.

The following entries must be made her:

• Serial number (identical to the serial number on the type plate)

• Identity to the assembly

Here the responsible inspector of the safety module confirms that the CRC displayed in the programming interface is identical to the CRC stored in the SMX module.

Once all header data has been entered, the validation report can be generated by clicking the "Save" button. The parameterization tool then generates a report (.PDF) with the file name of the program data set. The report contains the following information:

- The 3 pages of the header date edited above
- The configuration of the encoders
- The parameters of the existing monitoring functions
- PLC Program as an instruction list

After the transmission of the configuration and program data to the SMX module the status LED flashes yellow. This indicates that the configuration data have not yet been validated. Pressing the button "LOCK CONFIGURATION" at the end of the validation dialog highlights the data as "Validated" and the LED flashes in green.

9 Maintenance

9.1 Modification / Handling changes to the device

Maintenance work must only be carried out by qualified personnel.

Regular maintenance work does not have to be carried out.

NOTICE **Repair**

Devices must always be replaced completely.
The appliance can only be repaired at the factory.

ATTENTION **Warranty**

Unauthorized opening of the module voids the warranty.

ATTENTION **In case of unauthorized modification**

Modification of the assembly invalidates the safety approval!

9.2 Exchanging a module

The following should be noted when exchanging a module:

- Disconnect the electric power converter from the main supply.
- Switch off the electric power supply for the device and disconnect.
- Pull off the encoder plug.
- Disconnect any other pluggable connections.
- Take the module off the top hat rail and pack up EMC-compliant.
- Mount the new module on the top hat rail.
- Reconnect all connections.
- Switch on the electric power converter.
- Switch on the supply voltage.
- Configure the device

NOTICE No pluggable connection of the SMX module may be disconnected or reconnected under voltage. There is a risk of destroying the sensor, especially if position or speed sensors are connected.

9.3 Maintenance intervals

Module replacement	See “Technical data”
Function test	See chapter “Commissioning and start”

10 Technical data

10.1 Environmental conditions

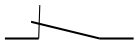
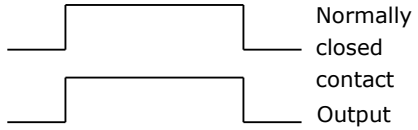
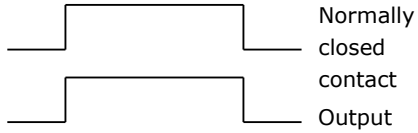
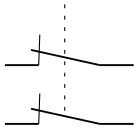
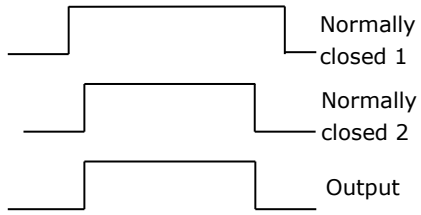
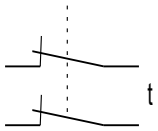
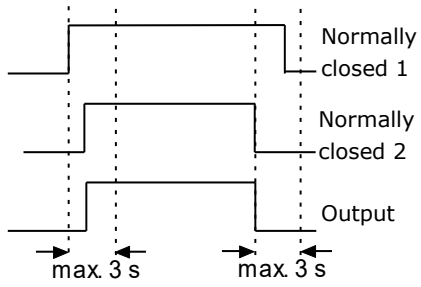
Class of protection	IP 20
Ambient temperature	0°C* ... +50°C
Climatic category	-25°C … +70°C
Min-, Maximum relative humidity (no condensation)	3k3 acc. to DIN 60 721
Overvoltage category	5% - 85%
Degree of contamination	III
Operating materials	2
Class of protection	2000m

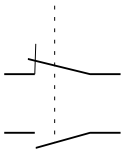
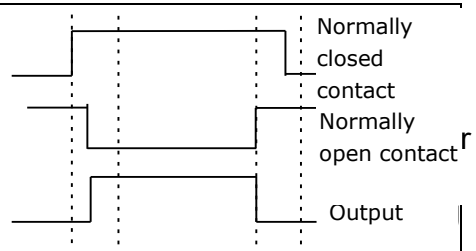
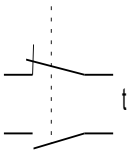
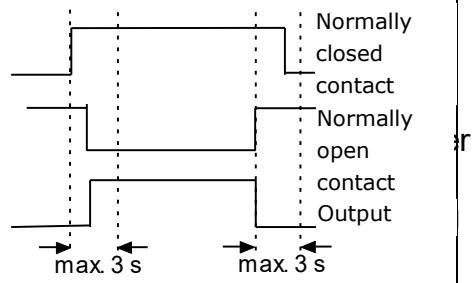
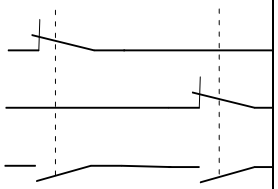
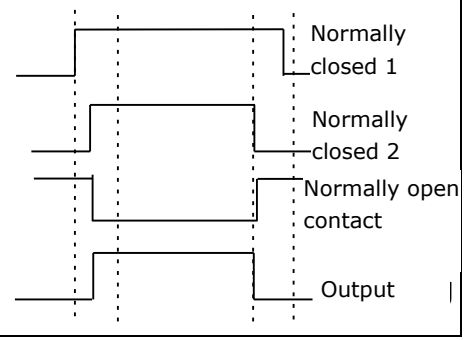
10.2 Safety related characteristic data

Max. obtainable safety class	SIL 3 acc. to IEC 61508 Category 4 acc. to EN ISO 13849-1 Performance level e acc. to EN ISO 13849-1	
System structure	2-channel with diagnosis (1002) acc. to IEC 61508 Architecture category 4 acc. to EN ISO 13849-1	
Rating of operating mode	„high demand“ acc. to IEC 61508 (high demand rate)	
Probability of an endangering failure per hour (PFH-value)	SMX1x/2	PFH = 12,6 FIT
	SMX3x/2	PFH = 9,2 FIT
	SMXxR/2 (1-channel)	PFH = 20 FIT
	SMXxR/2 (2-channel)	PFH = 1,0 FIT
Specific values acc. to table “Safety related characteristic data“	20 years, after this time the module must be replaced	
Proof-Test-Interval (IEC 61508)	20 years, after this time the module must be replaced	

SAFETY NOTICE The specific safety-related characteristics of the respective assemblies can be found in the technical characteristics in chapter 3.2.

11 Switch types

Type	Graphic symbols	Truth table	Logic function	Function block	Function	
1	 eSwitch_1o	Ö | A 0 | 0 1 | 1	LD E.1 ST IE.X		Closing contact (S), only in display opening contact (O)	
2	 sSwitch_1s	S | A 0 | 0 1 | 1	LD E.1 ST IE.X		Normally open, as type 1	
3	 eSwitch_2o	Ö1 | Ö2 | A 0 | 0 | 0 1 | 0 | 0 0 | 1 | 0 1 | 1 | 1	LD E.1 AND E.2 ST IE.X		AND operation of both inputs	
4	 eSwitch_2oT	Ö1 | Ö2 | A 0 | 0 | 0 1 | 0 | 0 0 | 1 | 0 1 | 1 | 1	LD E.1 OR E.2 ST META_EN.1 LD E.1 AND E.2 ST METB_EN.1 LD MET.1 ST IE.X	Time monitoring MET1..MET4	Like 3, but with time monitoring of state changes. In case of signal changes at S or Ö a complementary signal must follow within a period of t=3 s. If not, detect fault and A=0	

5	 eSwitch_1s1o	S Ö A 0 0 0 1 0 0 0 1 1 1 1 0	LD E.1 AND NOT E.2 ST IE.X		Monitoring for S=inactive and Ö=active	
6	 eSwitch_1s1oT	S Ö A 0 0 0 1 0 0 0 1 1 1 1 0	LD E.1 OR NOT E.2 ST META_EN.1 LD E1 AND NOT E2 ST METB_EN.1 LD MET.1 ST IE.X	Time Monitoring MET1..MET4	Like 5, but with time monitoring of state changes. In case of signal changes at S or Ö a complementary signal must follow within a period of t=3 s. If not, detect fault and A=0	
7	 eSwitch_2s2o	S1 Ö1 S2 Ö2 A 1 0 1 0 0 0 1 1 0 0 0 1 0 1 1 1 0 0 1 0	LD E.1 AND E.2 AND NOT E.3 ST IE.X		Monitoring for S1*S2=inactive and Ö1*Ö2=active	

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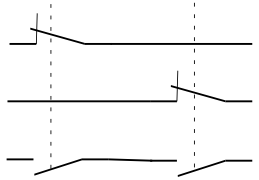
<td> 
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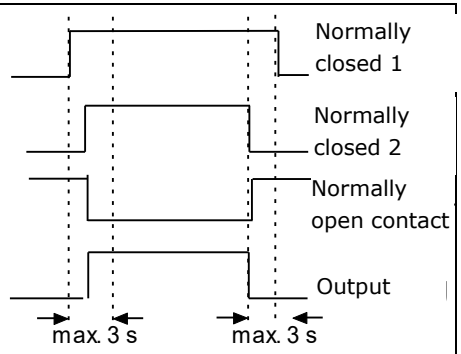
</td>
<td>LD E.1
OR E.2
OR NOT E.3
ST META_EN.1

LD E.1
AND E.2
AND NOT E.3
ST METB_EN.1

LD MET.1
ST IE.X</td>
<td>Time Monitoring

MET1..MET4</td>
<td>Like 6, but with time monitoring of state changes.

In case of signal changes at S (Attention: Bus line) or Ö a complementary signal must follow within a period of t=3 s. If not, detect fault and A=0</td>
<td> 
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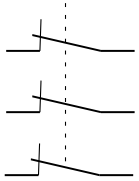
<td> 
eSwitch_3o</td>
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<tr><td>1</td><td>0</td><td>0</td><td>0</td></tr>
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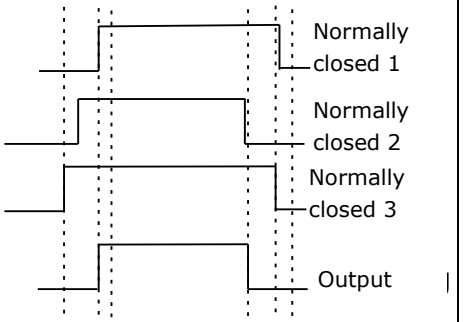
</td>
<td>LD E.1
AND E.2
AND E.3
ST IE.X</td>
<td></td>
<td>AND operation of both inputs</td>
<td> 
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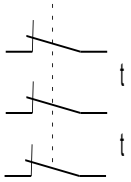
<td> 
eSwitch_3oT</td>
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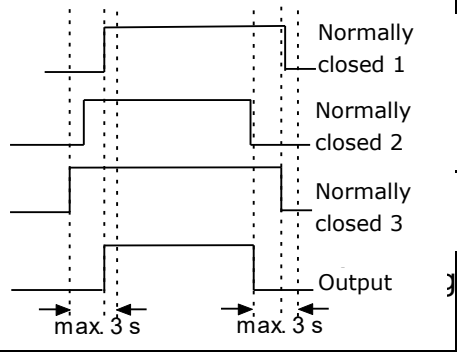
</table>
</td>
<td>LD E.1
OR E.2
OR E.3
ST META_EN.1

LD E.1
AND E.2
AND E.3
ST METB_EN.1
LD MET.1

ST IE.X</td>
<td>Time Monitoring

MET1..MET4</td>
<td>Like 8, but with time monitoring of state changes.

In case of signal change on one of the Ö-inputs the other inputs must follow within a period of t=3 s. If not, detect fault and A=0</td>
<td> 
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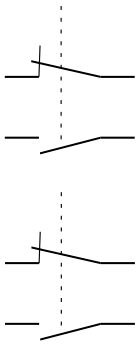
<td> 
eTwoHand_2o</td>
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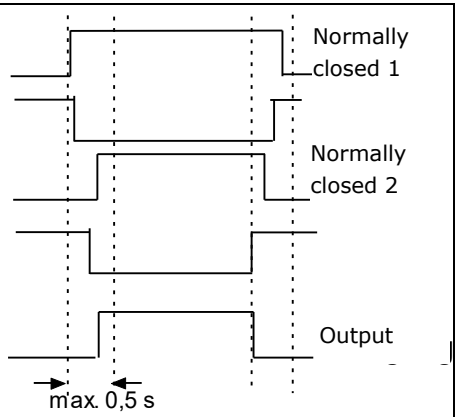
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td></tr>
</table>
</td>
<td>LD NOT E.1
OR E.2
OR NOT E.3
OR E.4
ST MEZ_EN.1

LD E.1
AND NOT E2
AND E3
AND NOT E4
ST MEZ_EN.2

LD NOT E1
AND E.2
AND NOT E3
AND E.4
ST MEZ_EN.3

LD MEZ.1
ST IE.X</td>
<td>Two-hand operation
MEZ</td>
<td>Monitoring for S1*S2=inactive and Ö1*Ö2=active + temporal monitoring <u>of this</u> status. This means that in case of a signal change of an S from 1->0 or Ö from 0->1, the other signals (i.e. further S=0 or Ö=1) must follow within a period of 0.5 s. If not, the output = 0.

No interference evaluation! No temporal monitoring when changing to inactive state.</td>
<td> 
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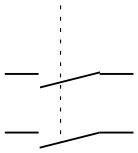
<td> 
eTwoHand_2s</td>
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<tr><td>0</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
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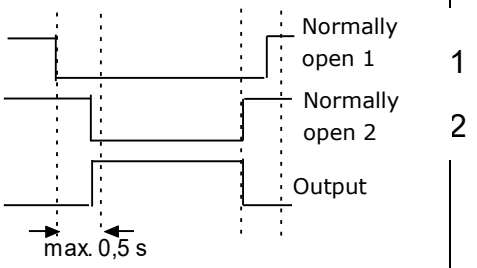
</td>
<td>LD E.1
OR E.2
ST MEZ_EN.1

LD NOT E.1
AND NOT E.2
ST MEZ_EN.2

LD E.1
AND E.2
ST MEZ_EN.3

LD MEZ.1
ST IE.X</td>
<td>Two-hand operation
MEZ</td>
<td>Monitoring for S1*S2=inactive + temporal monitoring <u>of this</u> status. This means that in case of a signal change of one S from 1->0 the other signal (i.e. another S=0) must follow within a period of 0.5 s. If not, the output = 0.

No interference evaluation! No temporal monitoring when changing to inactive state.</td>
<td> 
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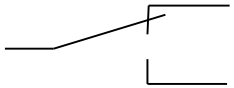
<td> 
eMode_1s1o</td>
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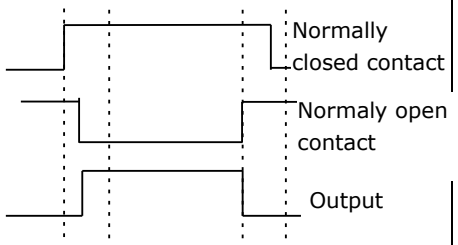
<tr><td>1</td><td>1</td><td>0</td><td>0</td></tr>
</table>
</td>
<td>LD E.1
AND NOT E.2
ST IE.X1

LD NOT E.1
AND E.2
ST IE.X2</td>
<td>Selector switch</td>
<td>Clear linkage of permissible switch positions</td>
<td> 
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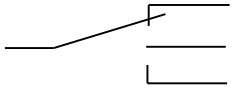
<td> 
eMode_3switch</td>
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<table>
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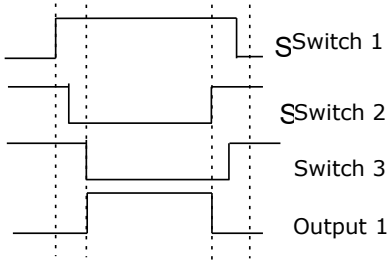
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td>
<td>LD E.1
AND NOT E.2
AND NOT E.3
ST IE.X1

LDN E.1
AND E2
AND NOT E.3
ST IE.X2

LDN E.1
AND NOT E.2
AND E.3
ST IE.X3</td>
<td>Selector switch</td>
<td>Clear linkage of permissible switch positions</td>
<td> 
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12 Notes on designing, programming, validating and testing safety related applications

The following notes describe the procedure for designing, programming, validating and testing safety related applications.

The information should help the user to classify, to easily understand and to use all steps from risk assessment all the way to the system test. For better understanding the respective subjects, the individual steps are explained by means of examples.

12.1 Risk assessment

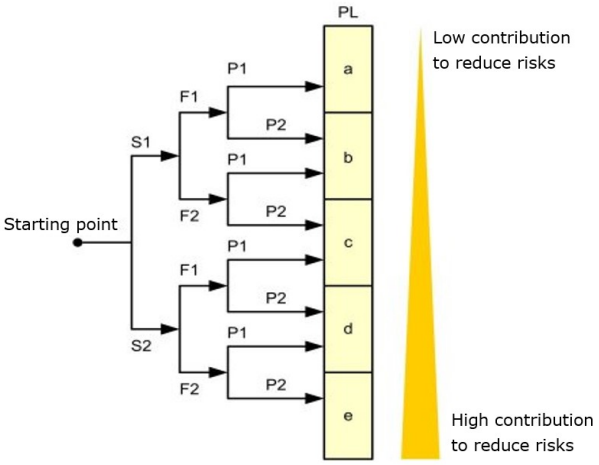
The manufacturer of a machine must generally guarantee the safety of any machine designed or delivered by him. The assessment of safety must be based on the applicable and appropriate regulations and standards. Objective of the safety assessment and the measures derived from this must be the reduction of risks for persons down to an acceptable minimum.

The risk analysis must account for all operating conditions of the machine, such as operation, setup work and maintenance or installation and decommissioning as well as predictable erroneous operation.

The procedure required for the risk analysis and the measures for reducing such risks can be found in the applicable standards

- EN ISO 13849-1 Safety of machines
- IEC 61508 Functional safety of safety related e/e/p e systems

Risk assessment as per EN ISO 13849-1



S – Severe physical injury

S1 = minor, reversible injury

S2 = severe, irreversible injury

F – Frequency and/or duration of exposure to danger

F1= rarely, not cyclic

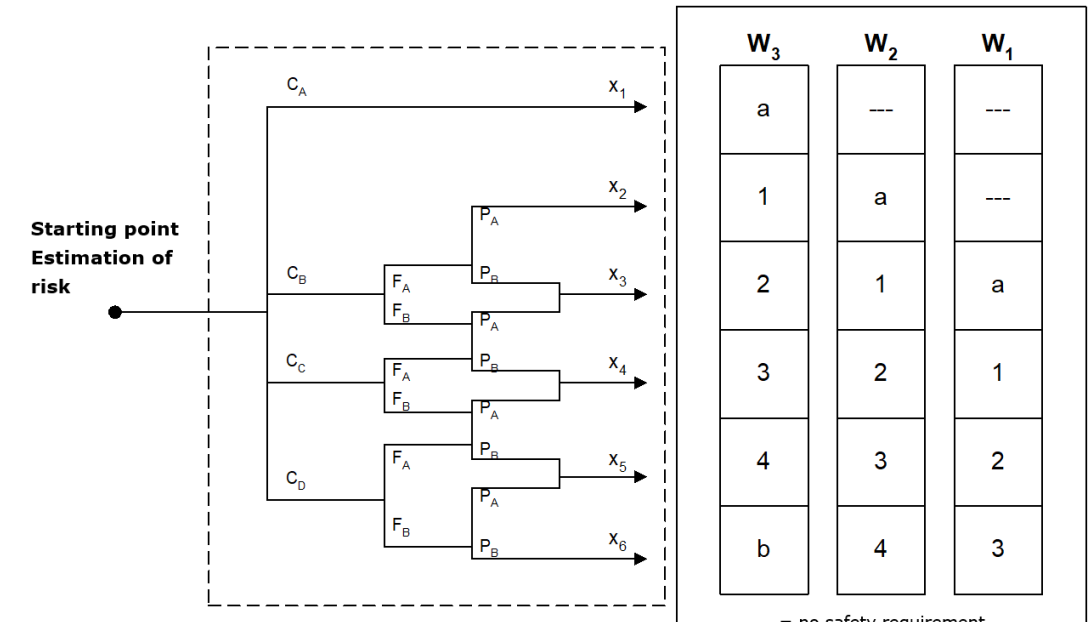
F2 = frequently up to permanent and/or long duration, cyclic operation

P – Possibility to avoid the danger

P1 = possible, slow movement / acceleration

P2 = hardly possible, high acceleration in case of a fault

Risk assessment as per IEC 61508



The risks to be examined can also be found in applicable regulations and standards, or must be considered separately by the manufacturer based on his specific knowledge of the machine.

For machines sold within the EU the minimum risks to be examined are specified in the EU machine directive 2006/42/EU or in the latest version of this directive.

Further information concerning the risk assessment and the safe design of machines can be found in the standards

- EN 14121 Safety of machines - risk assessment
- EN 12100 Safety of machines – basic terms, general design guidelines

Measures to be applied in order to reduce identified risks must at least be of the same level as the danger itself. The regulations and standards specified above contain examples of such measures and the associated requirements.

12.2 Required technical documents

The manufacturer is obliged to supply various technical documents. The minimum extent is also contained in the applicable regulations and standards.

The EU machine directive, for example, requires the delivery of the following documents:

1. The technical file shall comprise the following:
   a) a construction file including:
      - a general description of the machinery,
      - the overall drawing of the machinery and drawings of the control circuits, as well as the pertinent descriptions and explanations necessary for understanding the operation of the machinery,
      - full detailed drawings, accompanied by any calculation notes, test results, certificates, etc., required to check the conformity of the machinery with the essential health and safety requirements,
      - the documentation on risk assessment demonstrating the procedure followed, including:
        i) a list of the essential health and safety requirements which apply to the machinery,
        ii) the description of the protective measures implemented to eliminate identified hazards or to reduce risks and, when appropriate, the indication of the residual risks associated with the machinery,
      - the standards and other technical specifications used, indicating the essential health and safety requirements covered by these standards,
      - any technical report giving the results of the tests carried out either by the manufacturer or by a body chosen by the manufacturer or his authorised representative,
      - a copy of the instructions for the machinery,
      - where appropriate, the declaration of incorporation for included partly completed machinery and the relevant assembly instructions for such machinery,
      - where appropriate, copies of the EC declaration of conformity of machinery or other products incorporated into the machinery,
      - a copy of the EC declaration of conformity;
   b) for series manufacture, the internal measures that will be implemented to ensure that the machinery remains in conformity with the provisions of this Directive.

Source BGIA Report 2/2008

The documents must be easy to understand and should be written in the language of the corresponding country.

12.3 Necessary steps for draft, realization and testing

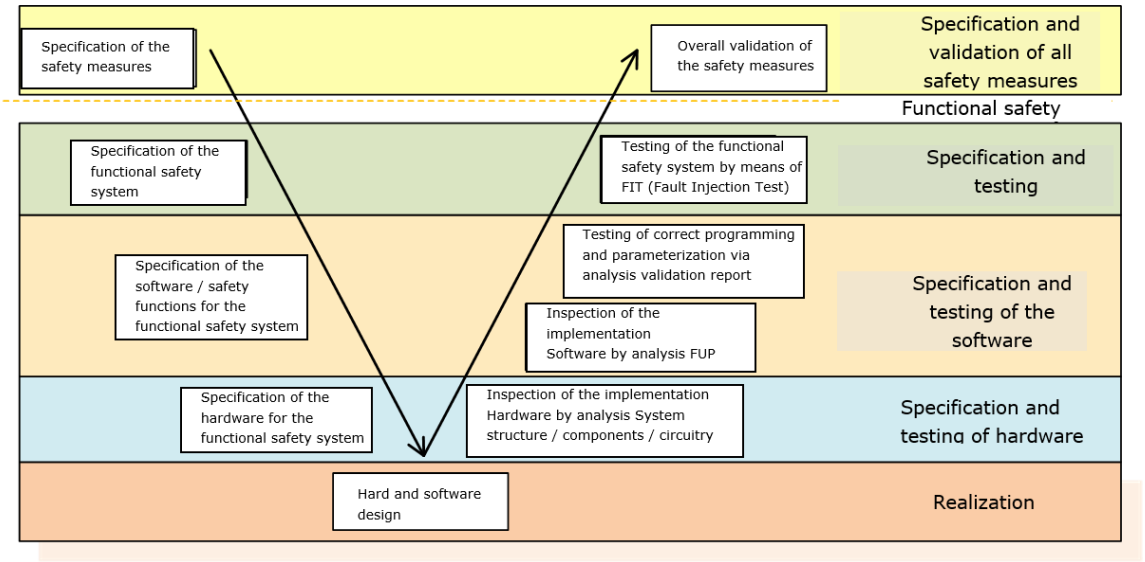
The realization of plant sections with safety related function requires special attention in planning, realization and testing. Also for this the standards (see ISO 13849-2 or EN ISO 61508) contain specific guidelines. The effort thereby is orientated on the complexity of the task for system components with safety related function

For the realization of such functions the SMX-series offers safety relevant control and monitoring functions to support the system architecture (architecture Cat. 4 acc. to EN ISO 13849-1) and, above all, also the programing language and tested safety functions. Programing uses the form FUP (function plan oriented programing) recommended by the safety standards. It fully meets the requirements on the programing language with limited scope of languages (LVM) for the essential simplifications in documentation and testing.

The individual steps in any case require careful planning and analysis of the methods and systems used. Furthermore, the individual steps must be documented in an understandable way.

V-model (simplified)

The implementation of safety related functions requires a structured approach, like the V-model that is exemplary described in applicable standards. The following shows an exemplary approach for applications with modules of the SMX-series.



12.3.1 Phase of the V-model

Designation	Description	
	Design phase	**Validation phase**
Specification and validation of all passive and active safety measures.	Specification of all safety measures to be applied, such as covers, barriers, max. machine parameters, safety related functions, etc.	Testing of all passive and active safety measures for correct implementation and effectiveness.
Specification of the functional safety systems	Specification of the active safety systems and their assignment to the risks to be reduced, such as e.g. reduced speed in setup operation, stop-mode, monitoring of access areas, etc. Specification of the PIr or the demanded SIL for each individual safety function	Testing of all active safety systems regarding effectiveness and compliance with specific parameters, such as e.g. erroneous increased speed, faulty stop, responding of monitoring facilities, etc. by means of practical tests
Specification of software / safety functions	Specification of the functionality of individual safety functions incl. the definition of the shut-down circuit, etc. Definition of parameters for individual safety functions, such as e.g. max. speed, stop ramps and -categories, etc.	Testing of correct implementation of specified functions by analysis FUP programming Validation of application programs and parameters by comparing the validation report with FUP or specifications for parameters
Specification of the hardware	Specification of the system structure and the functions of the individual sensors, command units, control components and actuators regarding their safety functions	Testing of the correct implementation of specifications. Determination of the failure probability or PI by means of analysis of the overall architecture and the characteristic data of all components involved, each related to the individual safety functions
Hard- and software design	Actual planning and implementation of system structure / wiring. Actual implementation of safety functions by programming in FUP	nil

12.3.2 Specification of safety requirements (structural schematic)

The safety requirements must be individually analyzed on the basis of applicable standards, e.g. product standard.

1	**General product and project information**
1.1	Product identification
1.2	Author, version, date, document name, file name
1.3	Contents
1.4	Terminology, definitions, glossary
1.5	Version history and changes
1.6	Directives, standards and technical rules relevant to development
2	**Functional information on the machine, where relevant to safety**
2.1	Intended use and reasonably foreseeable misuse
2.2	Process description (operating functions)
2.3	Operating modes (e.g. setup mode, automatic mode, operation of localized relevance or of parts of the machine)
2.4	Characteristic data, e.g. cycle times, response times, overrun distances
2.5	Other characteristics of the machine
2.6	Safe state of the machine
2.7	Interaction between processes (see also 2.2) and manual actions (repair, setup, cleaning, troubleshooting, etc.)
2.8	Emergency operations
3	**Required Performance Level(s) (PL_r)**
3.1	Reference to existing documentation concerning the hazard analysis and risk assessment for the machine
3.2	Results of the risk assessment for each identified hazard or hazardous situation and specification of the safety function(s) required in each case for risk reduction
4	**Safety functions (information applies to each safety function)**
	• Description of the function ("input – logic – output") including all functional characteristics (refer also to Tables 5.1 and 5.2)
	• Activation/deactivation conditions or events (e.g. operating modes of the machine)
	• Behaviour of the machine when the safety function is triggered
	• Conditions to be observed for re-starting
	• Performance criteria/performance data
	• Process (timing behaviour) of the safety function, including response time
	• Frequency of actuation (i.e. demand rate), recovery time following demand
	• Other data
	• Adjustable parameters (where provided)
	• Classification and assignment of priorities in the event of simultaneous demand for and processing of multiple safety functions
	• Functional concept for separation or independence/freedom of reciprocal action from non-safety functions and further safety functions
5	**Required information for the SRP/CS design**
5.1	Allocation of the SRP/CS and the form of technology by which the safety function is to be implemented; intended equipment
5.2	Selection of the Category, designated architecture (structure) in the form of a safety-related block diagram and description
5.3	Description of the interfaces (process interfaces, internal interfaces, user interfaces, control and display elements, etc.)
5.4	Behaviour at switch-on, implementation of the required starting and restarting behaviour
5.5	Performance data: cycle times, response times, etc.
5.6	Behaviour of the SRP/CS in the event of component failures and faults (achieve and maintain the safe state), including timing behaviour
5.7	Failure modes of components, modules or blocks which are to be considered; where applicable, reasoning for fault exclusions
5.8	Concept for implementation of the detection and control of random and systematic failures (self-tests, test circuits, monitoring arrangements, comparisons, plausibility tests, fault detection by the process, etc.)
5.9	Quantitative aspects
5.9.1	Target values for $MTTF_d$ and DC_{avg}

Source: General specification, excerpt from BGIA Report 2/2008 concerning EN ISO 13849-1

Example for an automatic handling machine:

Function description:

The automatic handling machine serves the purpose of automatically picking up truck cabins of different heights. After being picked up, the height of the cabin is correctly detected, so that within the working area the cabin cannot be lowered below a certain height. Within the working area the automatic machine must not exceed a maximum speed. Once the cabin has been completely finished, it is put down at the end of the processing line and the automatic handling machine moves along a return track back to the beginning of the track to pick up the next cabin…..

Limit of the machine:

Spatial limits: The working area must provide sufficient space for the workers, so that they are able to carry out all necessary work on the cabin..... In the return pass there must be sufficient space for the empty suspension gear of the automatic handler.

Temporal limits: Description of lifetime, description of ageing processes, which could cause changes of machine parameters, (e.g. brakes). Monitoring mechanisms must be implemented for such cases.

Limits of use: The automatic machine automatically fetches new cabins and moves these through a processing area. Workers work in the processing area .... etc.

The following operating modes are intended: Setup operation, automatic operation and service operation etc.

Identification of dangers:

The following dangers are of relevance with the automatic handling machine:

Danger 1: Crushing by cabin / lifting beam falling down

Danger 2: Impact by moving cabin / lifting beam

Danger 3: Crushing by too fast lowering of the cabin in case of a fault

Danger 4:.....

Risk analysis:

G1: The weight of cabin and lifting beam is so high, that it will cause irreversible crushing or even fatalities.

G2: The moving cabin/lifting beam may cause impacts that can lead to irreversible injuries.

G3: ….

Risk assessment

A risk reduction is required under due consideration of all operating conditions.

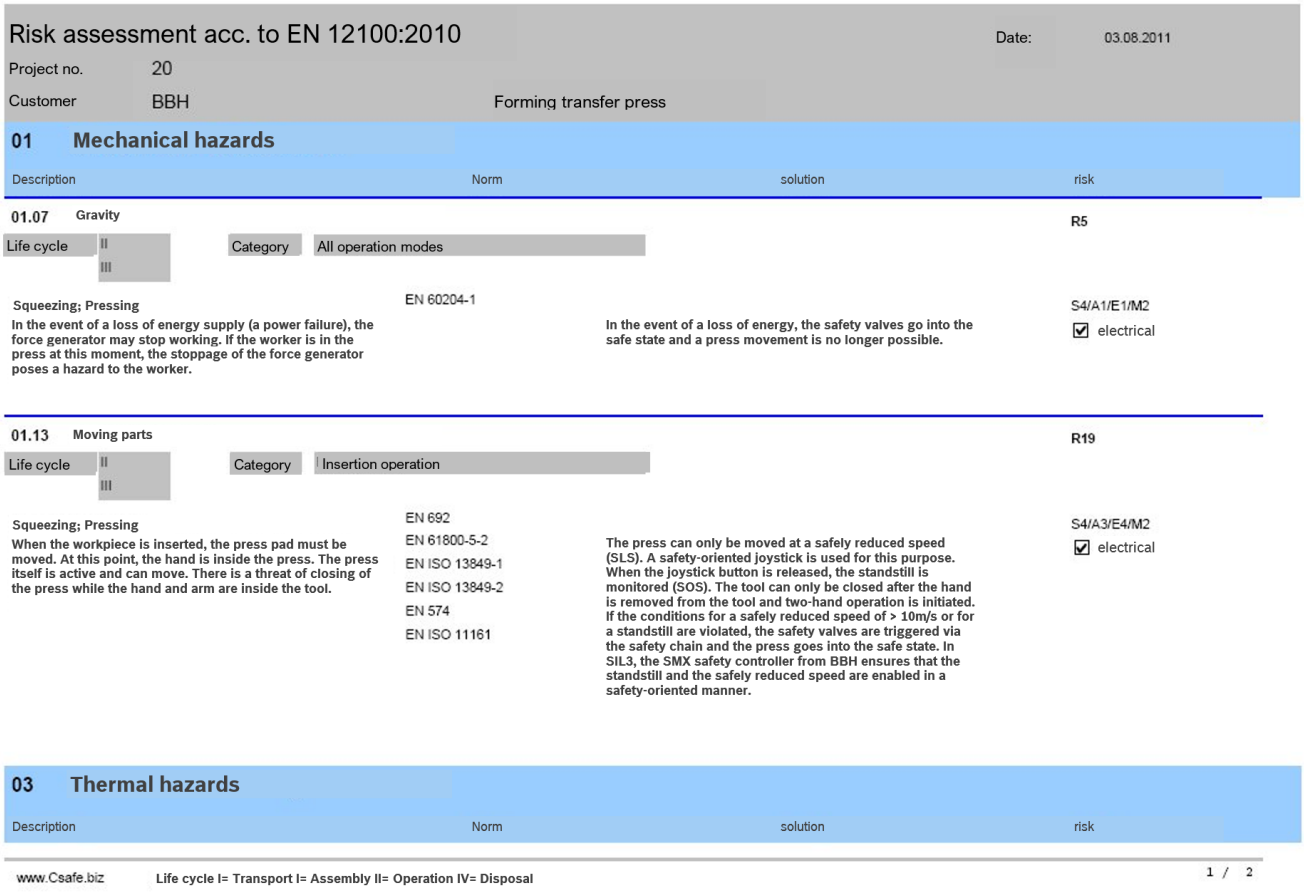
Inherently (risk from the project) safe design

Movement of the cabin in direction x and y within the working area cannot be avoided. In the processing area the cabin must be moved up/down ...

The following measures can be applied:

- Avoid dangers caused by too fast movements
- Avoid dangers caused by too small distances

Example for risk analysis:



Risk assessment acc. to EN 12100:2010 Date: 03.08.2011

Project no. 20

Customer BBH Forming transfer press

01 Mechanical hazards

Description	Norm	solution	risk
01.07 Gravity			R5
Life cycle II III — Category: All operation modes			
Squeezing; Pressing In the event of a loss of energy supply (a power failure), the force generator may stop working. If the worker is in the press at this moment, the stoppage of the force generator poses a hazard to the worker.	EN 60204-1	In the event of a loss of energy, the safety valves go into the safe state and a press movement is no longer possible.	S4/A1/E1/M2 ☑ electrical
01.13 Moving parts			R19
Life cycle II III — Category: Insertion operation			
Squeezing; Pressing When the workpiece is inserted, the press pad must be moved. At this point, the hand is inside the press. The press itself is active and can move. There is a threat of closing of the press while the hand and arm are inside the tool.	EN 692 EN 61800-5-2 EN ISO 13849-1 EN ISO 13849-2 EN 574 EN ISO 11161	The press can only be moved at a safely reduced speed (SLS). A safety-oriented joystick is used for this purpose. When the joystick button is released, the standstill is monitored (SOS). The tool can only be closed after the hand is removed from the tool and two-hand operation is initiated. If the conditions for a safely reduced speed of > 10m/s or for a standstill are violated, the safety valves are triggered via the safety chain and the press goes into the safe state. In SIL3, the SMX safety controller from BBH ensures that the standstill and the safely reduced speed are enabled in a safety-oriented manner.	S4/A3/E4/M2 ☑ electrical

03 Thermal hazards

Description	Norm	solution	risk

www.Csafe.biz Life cycle I= Transport I= Assembly II= Operation IV= Disposal 1 / 2

Risk assessment acc. to EN 12100:2010

Date: 03.08.2011

Project no. 20

Customer BBH Forming transfer press

03.03 Objects or materials of high or low temperature — R6

Life cycle III

Category: Insertion operation; Retooling; Cleaning and maintenance; Troubleshooting and fault elimination

Burning The preheating tool for the foaming unit is heated to a temperature of 120 There is a risk of contact or overtemperature in the event of a fault.	EN 60204-1 EN ISO 13849-1 EN ISO 13849-2	The Temperature of preheating unit is monitored that a dangerous temperature cannot be reached. In addition, a warning sign warns against contact. Temperature in normal operation is not so high that significant danger occurs. The Temperature is monitored via safe analog inputs and a heat sensor, so that in the event of a fault the preheating unit is switched off and protected against being switched on again.	S3/A2/E2/M1 ☑ electrical	

www.Csafe.biz Life cycle I= Transport I= Assembly II= Operation IV= Disposal 2 / 2

12.3.3 Specification of the functional safety system

Derived from the general danger and risk analysis for the machine, the active safety functions must be identified and specified.

Active safety functions are, e.g. safely reduced speed under certain system conditions, monitored stop and standstill functions, area monitoring facilities, processing of monitoring facilities like light grid, switching mats, etc.

The safety functions must each be delimited and the specific requirements in function and safety level must be defined.

12.3.3.1 Definition of safety functions

Definition of the safety function must:

- specify the risk to be covered,
- describe the exact function,
- list all sensors, command equipment involved,
- specify the control units and
- designate the shut-down circuit mentioned

The definition should serve as basis for the specification of the hardware and software design.

For each of the safety functions defined this way one may need to determine parameters to be used, like e.g. max. system speed in setup operation, etc.

Example for safety functions:

SF1: STO (safely switched off torque) to protect against safe starting

SF2: Safe speeds

SF3: Safe positions

SF4.:……

12.3.3.2 Required performance level (PLr) (additional emergency stop)

The required performance level must now be determined on basis of the safety functions SF1.... recognized above. The example below shows the decision path.

Example for SF1: Result PF = d (Source Sistema)

12.3.3.3 Example – specification of safety functions in form of a table

Cons.-No.	**Safety function**	**Ref from GFA**	**PL_r**	**Measuring value /sensor**	**Implementation of software**	**Nominal parameters**	**Input/activation**	**Response/ output**
1.1	Limitation of max. travel speed to limitation of the maximum speed	2.3	e	1 x WCS /SSI absolute encoder 1 x Incremental encoder on motor / drive wheel	Monitoring by means of tested safety function SLS for fixed limits	550mm/s Fault distance monitoring: 200mm	Permanently Reset: Acknowledge-ment button	Operation stop SF 1.7.1
1.2	Limitation of max. travel speed in working area of workers Monitoring of the maximum speed to < 0.33 m/s	2.4	e	1 x WCS /SSI absolute encoder 1 x Incremental encoder on motor / drive wheel	Monitoring by means of tested safety function SLS for fixed limits	60 mm/s Fault distance monitoring: 200mm	Identification of worker's work area via position of carriage AND NOT Setup Reset: Acknowledge-ment button	SF 1.7.1
1.3	Limitation of max. travel speed in setup operation Monitoring of the maximum speed to < 0.07 m/s	3.1	d	1 x WCS /SSI absolute encoder 1 x Incremental encoder on motor / drive wheel	Monitoring by means of tested safety function SLS for fixed limits	70mm/s Fault distance monitoring: 200mm	Operating mode Setup AND button "Bridge safety" Reset: Acknowledge-ment button	SF 1.7.1
1.4	Collision protection of carriage Monitoring of the distances between carriages for minimum distance by means of redundant laser distance measurement	2.5	d	2 x Laser distance measuring facilities	Monitoring of distances by means of tested SAC function. The analog distance measurements are reciprocally compared for max. tolerance (diagnose of analog sensor) Monitored for minimum value (SAC function) Min. distance value 25% of the max. value of the measuring device.		Carriage within worker work area Reset: Acknowledge-ment button	SF 1.7.1

1.6.1	Monitoring of carriage sensor system * the two sensors carriage	5.1	e	1 x WCS /SSI absolute encoder 1 x Incremental encoder on motor / drive wheel	Muting of diagnoses for both carriage sensors by means of tested SCA function Muting is started before each gap, a faulty encoder value will be temporarily suppressed. Within the gap an encoder value outside 2 to 160000mm will cause muting.		Pos 1 (7626 - 7850) Pos 2 (11030-1263) Pos 3 (75134-5338) Pos 4 (145562-145622) Pos 5 (143935-143995) Pos 6 (80000-80060)	SF 1.6.2

12.3.4 Software specification

The software specification refers to the previous specification of the safety functions. It can also be replaced by a correspondingly worked out specification of the safety functions, as far as this contains all specifications (see example 12.3.3.3).

However, it is recommended to prepare an extracted list. This list should contain the following data:

- Designation of safety function
- Description of function
- Parameters, as far as available
- Triggering event / operating status
- Response / output

The specification in detail should be suitable for later validation of the programming.

Example software specification

Cons.-No.	***Safety function***	***PLr***	***Measuring value/ sensor***	***Solution new***	***Input/ activation***	***Response/ output***
1.4	Monitoring V_Rope to V_Nominal Monitoring of differences between speed of main drive and rope drive for maximum value	d	Digital incremental encoder, tachometer generator rope sheave	Monitoring by means of tested function SLS + SAC with comparison of speed ranges /analog value ranges = comparison for diagnose of the speed detection Shut-down dual-channel new (see below)	Permanently Reset: Acknowledge-ment button	Operation stop SF 1.3.1
1.6	Backstop Monitoring for reversing	d	Mechanical Limit switch 22S2 Digital Incremental -encoder	Monitoring by means of tested function direction monitoring SDI	EMERGENCY (auxiliary contact 28K4 – reversing) Reset: Acknowledg-ement button	Operation stop SF 1.3.1
1.15	Step-by-step shut-down 3 Activation of the safety brake	e	-	Processing of SF in Safe PLC	SF 1.2 SF 1.3.2 SF 1.7 SF 1.8	Setting the safety brake
1.8	Standstill functional	d	Digital Incremental -encoder	Standstill monitoring by means of tested function SOS	Regulator lock OR Set service brake	SF 1.15/ Set safety brake
1.9	Direction monitoring	e	Digital incremental encoder	Monitoring by means of tested function direction monitoring SDI	28K1 = FORW. 28K2 = BACK = safe <signal of control „Frey‘‘‘‘‘	Operation stop SF 1.3.1

12.3.5 Hardware specification

The hardware specification should describe the entire system design and, in particular, the components used with their specific characteristic data. The hardware specification serves as basis for the determination of the achieved safety level based on the architecture and the characteristic data of all devices involved in a safety function.

Furthermore, the hardware specification should also specify the design measures applied for protecting against systematic and common cause faults.

12.3.5.1 Selection of SRP/CS and operating means

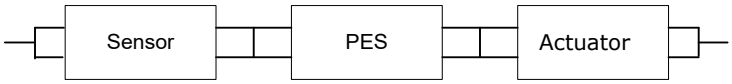
The selection of SRP/CS (Safety related parts of control system) is most suitable to achieve the intended safety level and should be made for any safety function. The components with safety relevant function must be designated in a total overview of the system structure and are to be assigned to the individual safety functions The safety related code numbers must be determined for these components.

The key figures include the following:

- MTTFd = mean time to failure, the mean time until a danger imposing failure
- DC avg = Mean diagnostic coverage
- CCF = common cause failure, a failure caused on a common cause

For an SRP/CS both the software and systematic faults must be taken into consideration.

An analysis of the SRP/CS participating in the safety function must generally be performed in accordance with the schematic Sensor / PES / Actuator



12.3.5.2 Example for default HW

Safety function		***Safe reduced speed***	***SF 2.2***	***Safe monitored limited speed with door open***							
Type	***Designation***	***Function***	***Design.***	***Characteristic data***							***Note***
				Architecture	MTTFD [years]	PFH [1/h]	B10d	Source	DC [%]	Source	
Sensor	Sensor 1	Door lock – Monitoring of the access door	A 3.1	4			100000	datasheet	99	Inst. Manual op. SMX	
	Sensor 2.1	Incremental encoder – Motor feedback SIN/COS	G 1.1	4	30			General specification	99	Inst. Manual op. SMX	Cat. 4 in connection with selection SMX
PES	Safety PLC	Central safety PLC for control and evaluation of safety relevant functions	A 4.1			1,4 E-8		Data sheet SMX			
Actuator	STO	Safe Torque Off on inverter	A 5.1	4	150			Data sheet inverter	99	Inst. Manual op. SMX	Cat. 4 in connection with dual-channel
	Main contactor	Contactor in mains line of inverter	K 5.1	4			20 E6	Data sheet contactor	99	Inst. Manual op. SMX	Cat. 4 in connection with dual-channel

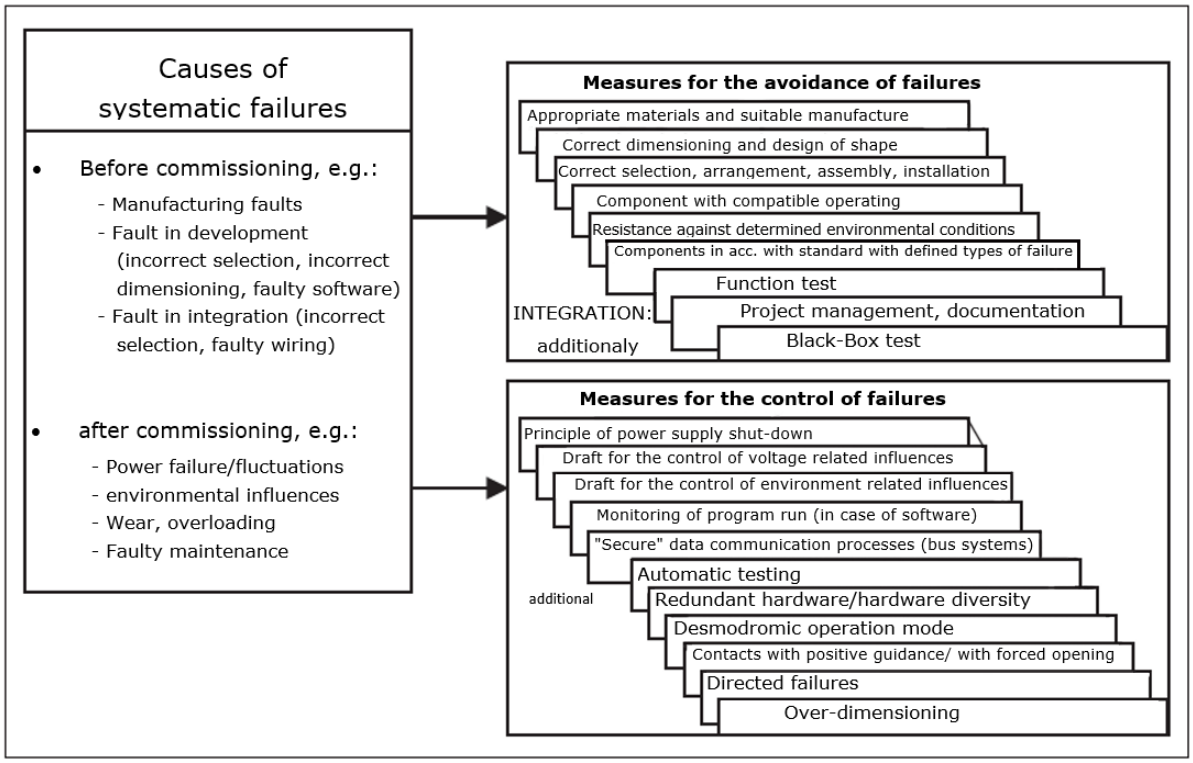
12.3.5.3 Consideration of systematic failures

Within the hardware specification one must also consider systematic failures.

Examples for measures against systematic failures:

Power drop during operation. If this causes a danger, a power drop must be considered a operating status. The SRP/CD must be able to cope with this condition, so that a safe state is maintained.

Measures against systematic failures acc. to appendix G DIN EN ISO 13849-9



Source BGIA Report 2/2008

Fault exclusions

If fault exclusions are made for certain devices or system components, these must be individually nominated and specified.

Fault exclusions may be e.g. mech. shaft breakage, sticking of switching contacts, short-circuits in cables and lines, etc.

The permissibility of fault exclusions must be justified, e.g. by referencing to permissible fault exclusions acc. to applicable standards, e.g. EN ISO 13849-1)

If these fault exclusions require special measures, these must be mentioned.

Examples for fault exclusions and associated measures:

- Positive connection for mechanical shaft connections
- Dimensioning based on sufficient theoretical bases in case of breakage of components in the safety chain.
- Positively guided connection with forced separation in case of sticking of switching contacts.
- Protected routing within switchgear in case of short-circuit in cables and lines, as well as routing of cables in cable ducts – especially for use in elevator technology acc. to EN 81-20/-50 resp. EN 81-1/-2

12.3.6 Hard and software design

The performance targets from the hardware and software specification are implemented in the actual system design.

The performance targets for the components to be used and their wiring from the hardware specification must also be met, the same applies for the performance targets for fault exclusions. Both must be achieved and documented with appropriate means.

In the software one must also account for and completely implement the targets from the software specification.

Furthermore one must consider the superimposed targets placed on the software by safety related programming. These are among others:

- Modular and clearly structured program structure
- Assignment of functions to the safety functions
- Comprehensible presentation of the functions by:
  - Unambiguous designations
  - Comprehensible comments
  - Use of tested functions / function modules, as far as this is possible
  - Defensive Programing

12.3.7 Testing of hardware designs

After completing the planning the hardware design must be examined for compliance with the targets from the hardware specification.

Furthermore, one must check the compliance with the specified safety level for each safety function by using suitable analyses. The analysis methods have been described in applicable standards (e.g. EN ISO 13849-1).

Analysis wiring scheme

Compliance with the targets set under safety related aspects can be checked by means of the wiring diagram and the bill of materials. The following must be checked in particular:

- the correct wiring of components as specified,
- the dual-channel structure, as far as specified
- the non-reactivity of parallel, redundant channels.
- The use of components as specified
- The checks should be made by understandable analysis.

12.3.7.1 Iterative testing of the achieved safety level

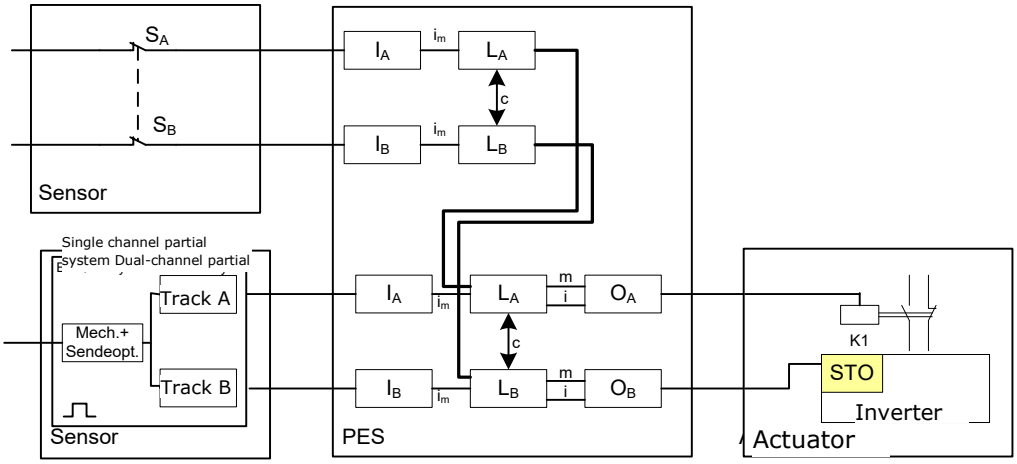
The achieved safety level must be determined by means of the circuit structure (= architecture single-channel (dual-channel / with or without diagnose), the characteristic device data (manufacturer's data or appropriate sources) and the diagnostic coverage (manufacturer's data PES or general sources). Appropriate measures can be taken from the underlying safety standard.

A calculation acc. to EN ISO 13849-1 shall serve as an example:

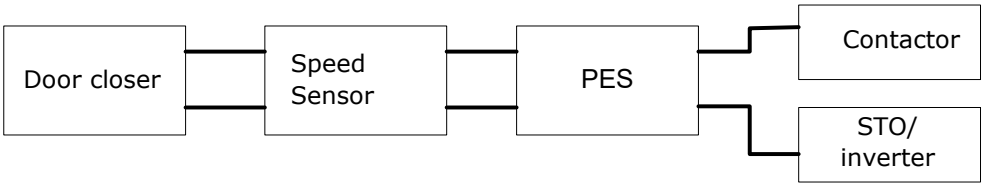
Safety function:

Safely reduced speed with access door open

Structural diagram:



Safety related structural diagram:



Calculation acc. to EN ISO 13849-1:

Channel A – Shut-down via main contactor:

Component	*$MTTF_d$ [years]*	*DC*
Door closer[1]	B_{10d} = 100000 n_{op} = 30/AT = 9270/year (309 AT/year) $MTTF_d = \frac{B_{10d}}{0{,}1 \cdot n_{op}} = 107{,}87$ years	DC_{Switch} = 99%
SIN/COS-Encoder	$MTTF_d$ = 30 years	$DC_{Encoder}$ = 99%
PES[2]	$\lambda_d = 1884{,}21$ fit $MTTF_d = \frac{10^9}{365 \cdot 24 \cdot \lambda_d} = 60{,}59$ years	DC_{PES} = 94,5%
Main contactor[3]	$B_{10d} = 1{,}3 \cdot 10^6$ N_{op} = 20/AT = 6180/year (309 AT/year) $MTTF_d = \frac{B_{10d}}{0{,}1 \cdot n_{op}} = 2103{,}56$ years	$DC_{Contactor}$ = 60%

$$MTTF_d^A = \frac{1}{\frac{1}{MTTF_d^{Switch}} + \frac{1}{MTTF_d^{Encoder}} + \frac{1}{MTTF_d^{PES}} + \frac{1}{MTTF_d^{Contactor}}} = 16{,}78 \text{ years}$$

[1] Value for $MTTF_d$ from EN ISO 13849-1, table C.1

[2] Value from in-house HW FMEA; assumption of an SMX12-2A with relay board, CPU board, processing subsystem and output subsystem with high-side/low-side combination

[3] Value for $MTTF_d$ from EN ISO 13849-1, Table C.1; assumption of "worst case" due to "contactor with nominal load"

Channel B – Shut-down via STO/inverter:

Component	*MTTF$_D$ [years]*	*DC*
Door closer (s.o.)	B_{10d} = 100000 n_{op} = 30/AT = 9270/year (309 AT/year) $MTTF_d = \frac{B_{10d}}{0{,}1 \cdot n_{op}} = 107{,}87$ years	DC_{Switch} = 99%
SIN/COS-Encoder (s.o.)	$MTTF_d$ = 30 years	$DC_{Encoder}$ = 99%
PES (s.a.)	$\lambda_d = 1884{,}21$ fit $MTTF_d = \frac{10^9}{365 \cdot 24 \cdot \lambda_d} = 60{,}59$ years	DC_{PES} = 94,5%
STO/inverter[4]	$MTTF_d$ = 150 years	DC_{STO} = 90%

$$MTTF_d^B = \frac{1}{\frac{1}{MTTF_d^{Switch}} + \frac{1}{MTTF_d^{Encoder}} + \frac{1}{MTTF_d^{PES}} + \frac{1}{MTTF_d^{STO}}} = 15{,}20 \text{ years}$$

[4] Value for $MTTF_{d\ from}$ EN ISO 13849-1, table C.1

Resulting PL for both channels:

Symmetry of both channels:	$$MTTF_d = \frac{2}{3}\left[MTTF_d^A + MTTF_d^B - \frac{1}{\frac{1}{MTTF_d^A} + \frac{1}{MTTF_d^B}}\right] = 16{,}00 \text{ years}$$
DC mean value	$$DC_{avg} = \frac{\sum_i \frac{DC_i}{MTTF_i}}{\sum_i \frac{1}{MTTF_i}} = 97{,}2\ \%$$
PL	$MTTF_d$ = 16,00 years (average) DC_{avg} = 97,4 % (average) PL =“d“ (from EN ISO 13849-1, tables 5,6, and 7) In this case, the MTTFd value of the sin/cos encoder is decisive for the PL. If a higher safety level is to be achieved, an encoder with a correspondingly higher quality must be used.

Note:
The characteristic values of the individual components used here have been selected as examples and must be adapted accordingly for user applications.

NOTICE	The PL can also be determined using the BGIA's "Sistema" program tool.

12.3.8 Verification Software (program) and parameters

Verification takes place in two steps:

1. Checking the FUP with respect to the specified functionality.
2. Checking the FUP against the AWL-listing of the validation report, or the default parameters against the one listed in the validation report.

12.3.8.1 Checking FUP

The programed FUP must be compared with the defaults in the specification.

NOTICE	The comparison is all the more efficient the more clearly the programing has been structured with respect to the safety functions.

Example:

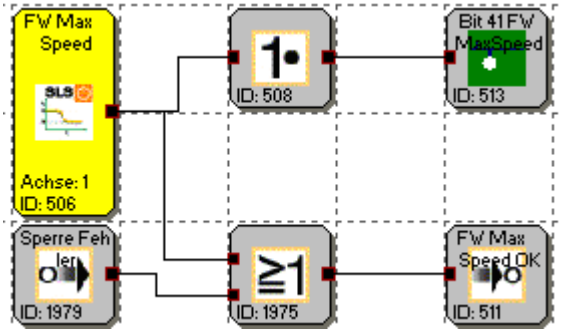
Safety function:

1.1 Limitation of the max. driving speed of the carriage to 1,1 VMax

Monitoring of the maximum speed to < 1,1 VMax

FW Max Speed OK (ID 548) (is bridged by available gap):

FW Max Speed is permanently activated and responds when a speed of 550 mm/s is exceeded..



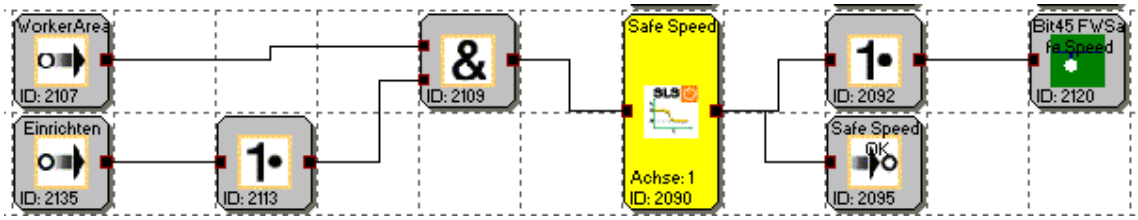
Safety function:

Limitation of max. travel speed in carriage in the worker's area:

Monitoring of the maximum speed to < 0.33 m/s

Safe Speed OK (ID 2124) (is bridged by available gap):

Safe Speed OK responds when the the safe speed SLS (ID 2090) is exceeded in the worker's area and during setup work.



Parameter SLS Safe Speed:

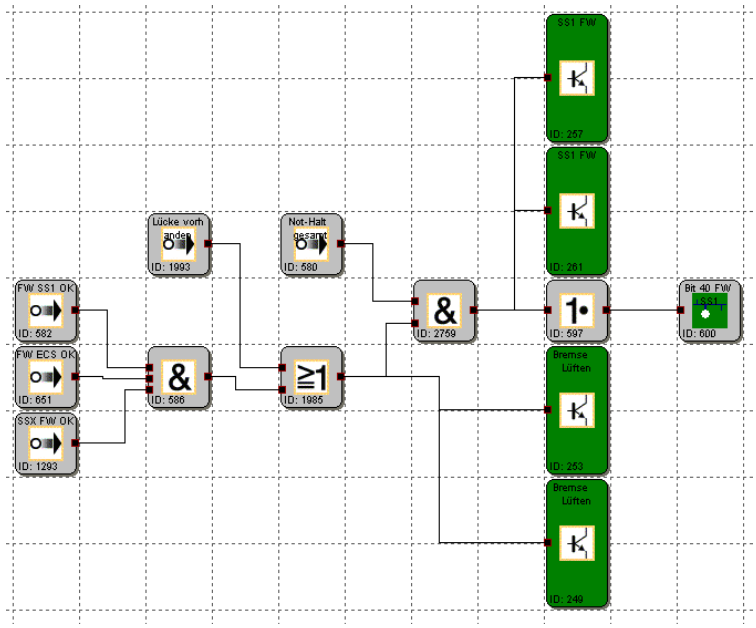
60mm/s, no further parameters

Safety function:

Carriage shut-down

Shut down of travel system and deactivation of brakes

Shut down on carriage



The carriage is switched off via two outputs (IQQ1.5 ID 257 and 1.6 ID 261).
The brakes are released via two outputs (IQQ1.3 ID 253 and 1.4 ID 249).
The PLC receives a message concerning bit 40 (ID 600).
In case of an emergency stop the shut-down takes place immediately.

Hoisting gear

Safety function

Emergency stop switch inputs and shut-down outputs

1.1 Emergency stop head control

Dual-channel emergency stop with pulse monitoring

If an emergency stop is triggered at the imposed control, this emergency stop can be bridgedif the approval 'Bridge safety' has been issued.

Emergency stop button head control

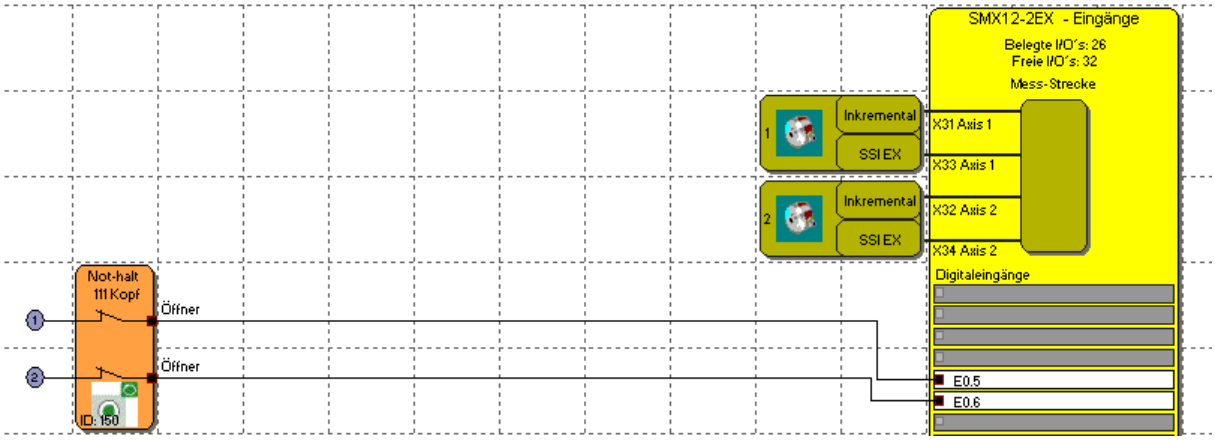


Fig. 32: Emergency stop contacts from emergency stop relay with pulsing from the SMX

12.3.8.2 Validation of FUP against AWL [IL] and parameters by means of validation report

The programing carried out in the FUP must be compared with the AWL [IL] listing of the validation report.

Example IL-Listing in validation report

Validation report

PLC program

Index	Command	Operand	validated
1	S1	SLI_EN.1	
2	S1	SLI_EN.2	
3	S1	SLI_EN.3	
4	S1	SCA_EN.1	
5	S1	SCA_EN.2	
6	S1	SCA_EN.3	
7	S1	SLS_EN.2	
8	S1	SCA_EN.4	
9	S1	SLS_EN.3	
10	S1	SLS_EN.4	
11	S1	SLI_EN.5	
12	SQH		
13	LD	E0.1	
14	ST	MX.2	
15	SQC		
16	SQH		
17	LD	E0.3	
18	AND	E0.4	
19	ST	MX.3	
20	SQC		

A step-by-step check is recommended. A more structured programming in the FUP makes the test more efficient.

After checking the program, the parameters must be checked against the requirements in the specification by comparison.

Example SLS:

Validation report

Safe Limited Speed (SLS)

Index	Parameters	Value		validated
SLS - 0	Chosen axis:	1		
	Speed threshold:	2	0	
SLS - 1	Chosen axis:	1		
	Speed threshold:	500	0	
SLS - 2	Chosen axis:	1		
	Speed threshold:	2	0	
	Acceleration threshold:	2	0	
SLS - 3	Chosen axis:	1		
	Speed threshold:	2	0	
	Assigned SSX ramp:	0		

Example encoder configuration:

Validation report				
Axis configuration / sensor interface				
Axis 1				
General parameters				
Measuring distance:	500	0		
Type:	Rotatory			
	No			
Position processing:	Active			
Maximum speed:	2000	0		
Incremtental shut-down:	10000	0		
Shut-down speed:	100	0		
Sensors	0		0	
Type:	SSI-standard		SSI-standard	
Format:	Binary		Binary	
Direction of rotatory:	Ascending		Ascending	
Supply voltage:	0		0	
Resolution:	1024	Steps/1000mm	64	Steps/1000mm
Offset:	0	Steps	0	Steps
	General parameters correctly configured			
	Parameter Sensor 1 correct			
	Parameter Sensor 2 correct			

12.3.9 Performance of the ystem test / FIT (fault injection test)

For the FIT the manufacturer must prepare a complete list of the functions to be tested. This list includes the defined safety functions as well as the fault test for checking the right response of the SRP/CS to this fault.

Example test list:

No	Setup	Test	Result
1 Test SLS for max. speed in setup operation			
	Activate setup operation Travel with maximally allowed speed	- Diagnose of the actual speed versus the SLS limit - Manipulation of the setup speed beyond the permitted reduced speed	
2 Test SSX for Stop-category 2			
	Travel with max. speed Actuate the emergency stop	- Diagnose of the SSX-ramp against the actual deceleration ramp - Setting an impermissible weak deceleration - Moving the axis after standstill is reached by manipulating the drive	
3 Test of the dual-channel door monitoring			
	Select operating mode for setup operation	Diagnose of inactive monitoring with door closed (using diagnostics function FUP) Diagnose of active monitoring with door open (using diagnostics function FUP) Disconnecting one channel and opening the door Generate cross-shorting between both inputs	

13 Appendix

Appendix A – Classification of switch types

General note:

The individual switches of the following input elements can be assigned to the digital inputs DI1 to DI8 as desired.

Enable switch (Confirm Button)

Switch type	Comment	Classification PL acc. to EN ISO 13849-1	Classification SIL acc. to IEC 61508
1 normally closed	Confirm button standard	PL d	SIL 2
1 normally open	Confirm button standard	PL d	SIL 2
2 normally closed	Confirm button higher requirements	PL e	SIL 3
2 normally closed time monitored	Confirm button monitored	PL e	SIL 3

Emergency stop

Switch type	Comment	Classification category	Classification SIL
1 normally closed	Emergency Stop standard	PL d[1)]	SIL 2
2 normally closed	Emergency stop higher requirements	PL e	SIL 3
2 normally closed time monitored	Emergency Stop monitored	PL e	SIL 3

1) Fault exclusion and boundary conditions acc. EN ISO 13849-2 must be observed!

Door Control (Door monitoring)

Switch type	Comment	Classification category	Classification SIL
2 normally closed	Door monitoring higher requirements	PL e	SIL 3
2 normally closed time monitored	Door monitoring monitored	PL e	SIL 3
1 normally open + 1 normally closed	Door monitoring higher requirements	PL e	SIL 3
1 normally open + 1 normally closed time monitored	Door monitoring monitored		SIL 3
2 normally open + 2 normally closed	Door monitoring higher requirements	PL e	SIL 3
2 normally open + 2 normally closed time monitored	Door monitoring monitored	PL e	SIL 3
3 normally closed	Door monitoring higher requirements	PL e	SIL 3
3 normally closed time monitored	Door monitoring monitored	PL e	SIL 3

Two-hand control

Switch type	Comment	Classification category	Classification SIL
2 two-way switch	Two-hand control higher requirements	Typ III C PL e	SIL3
2 normally open	Two-hand control monitored	Typ III A PL e	SIL1

NOTICE

With these in Port elements a fixed pulse assignment takes place, which cannot be influenced by the user!

Light curtain

Switch type	Comment	Classification category	Classification SIL
2 normally closed	Light curtain higher requirements	PL e	SIL 3
2 normally closed time monitored	Light curtain monitored	PL e	SIL 3
1 normally open + 1 normally closed	Light curtain higher requirements	PL e	SIL 3
1 normally open + 1 normally closed time monitored	Light curtain monitored	PL e	SIL 3

Mode selector switch

Switch type	Comment	Classification category	Classification SIL
2 positions	Mode selector switch monitored	PL e	SIL 3
3 positions	Mode selector switch monitored	PL e	SIL 3

SAFETY NOTE

When changing the status of the switch the SafePLC2 program to be created must ensure that the outports of the module are deactivated (Note: Standard 60204-Part1-Paragraph 9.2.3

Sensor

Switch type	Comment	Classification category	Classification SIL
1 normally closed	Sensor input standard	PL d	SIL 2
1 normally open	Sensor input standard	PL d	SIL 2
2 normally closed	Sensor input higher requirements	PL e	SIL 3
2 normally closed time monitored	Sensor input monitored	PL e	SIL 3
1 normally open + 1 normally closed	Sensor input higher requirements	PL e	SIL 3
1 normally open + 1 normally closed time monitored	Sensor input monitored	PL e	SIL 3

Start / Reset element

Switch type	Comment	Classification category	Classification SIL
1 normally open	Alarm reset standard (evaluation of edge)	--	--
1 normally open	Logic reset standard	PL d	SIL 2
1 normally open	Start monitoring standard (optional function)	--	--

NOTICE The alarm reset input can be operated with 24V continuous voltage and is edge triggered

Appendix B – EC declaration

EG-Konformitätserklärung für Sicherheitsbauteile im Sinne der EG-Maschinenrichtlinie 2006/42/EG (Anhang IV)

EC declaration of conformity for safety components according the EU Machinery Directive 2006/42/EG (Appendix IV)

Firma *Manufacturer*	**BBH Products GmbH**
Anschrift *Address*	**Böttgerstrasse 40** **92637 Weiden** **Deutschland**
Produkt	**SMXGen2 – Series** **Frei programmierbare Sicherheitssteuerung zur sicheren Überwachung von Antriebssystemen, geeignet für SIL 3 IEC 61508:2010, bzw. PL e nach EN ISO 13849-1:2015.**
Product	***SMXGen2 – Series*** ***Free programmable safe plc for monitoring of drives, appropriated for SIL 3 IEC 61508:2010,*** ***resp. PL e according EN ISO 13849-1:2015***
Produktname *Product name*	**SMX10/2/x, SMX10 HI/x, SMX10A/2/x, SMX10R/2/x** **SMX11/2/x, SMX11HI/x, SMX11-2/2/x,** **SMX12/2/x, SMX12A/2/x, SMX12-2/2/x, SMX12-2A/2/x,** **SMX31/2, SMX31R/2, SMX31R-4/2**
FW-Version	SMX1x: 05-00-00-01 (PS), 05-00-00-17 (PS), 05-00-04-19 (PS), 05-01-00-01 (FSoE) SMX3x: 03-00-00-01
HW-Version	11-11-07, 11-11-07, 11-11-04-07, 03-11-11-07, 11-11-07, 11-11-07, 11-11-04-07, 11-11-04-07, 11-11-04-07, 11-11-04-04-04-07, 11-11-04-04-04-07, 10-11, 03-03-10-11, 03-10-11,

Produktname *Product name*	**SMX100-1/2/x, SMX100-2/2/x, SMX100-4/2/x, SMX111/2/D, SMX111-2/2/D, SMX112/2/D, SMX112A/2/D, SMX112-2/2/D, SMX112-2A/2/D, SMX121/2, SMX121-2/2, SMX122/2, SMX122A/2, SMX122-2/2, SMX122-2A/2, SMX131/2, SMX131R/2, SMX131R-4/2, SMX132-0/2/D, SMX132-0R/2/D, SMX132-1/2/D, SMX132-1R/2/D**

FW-Version	SMX100-x:	04-00-00-01
	SMX11x:	04-00-00-01
	SMX12x:	04-00-00-01
	SMX131x:	04-00-00-01
	SMX132x:	01-00-00-01

HW-Version	11-11-07, 11-10-10-11-07, 11-10-10-10-10-11-07, 11-11-07, 11-11-04-07, 11-11-04-07, 11-11-04-07, 11-11-04-04-04-07, 11-11-04-04-04-07, 11, 11-04, 11-04, 11-04, 11-04-04-04, 11-04-04-04, 10-11, 03-03-10-11, 03-10-11, 11-11-07, 03-11-11-07, 11-10-11-07, 03-11-10-11-07

Das Produkt wurde entwickelt, konstruiert und gefertigt in Übereinstimmung der o.g. Richtlinie.
The product was developed, designed and manufactured in accordance to the directive as named above

Folgende Normen wurden angewendet:
Following standards were applied:

Norm / *Standard*	Titel / *Title*	Ausgabe / *Edition*
EN 61800-5-2	Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl Teil 5-2: Anforderungen an die Sicherheit – Funktionale Sicherheit *Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional*	2007
EN ISO 13849-1	Sicherheit von Maschinen - Sicherheitsbezogene Teile von Steuerungen - Teil 1: Allgemeine Gestaltungsleitsätze *Safety of machinery – Safety-related parts of control systems - Part 1: General principles for design*	2015
EN 62061	Sicherheit von Maschinen - Funktionale Sicherheit sicherheitsbezogener elektrischer, elektronischer und programmierbarer elektronischer Steuerungssysteme *Safety of machinery - Functional safety of safety-related electrical, electronic, programmable electronic control systems*	2005 + AC:2010 + A1:2013 + A2:2015
EN 50178	Ausrüstung von Starkstromanlagen mit elektronischen Betriebsmittel *Equipment of power installations with electronic equipment*	1997
EN 60204-1	Sicherheit von Maschinen – Elektrische Ausrüstung von Maschinen - Teil 1: Allgemeine Anforderungen *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*	2018
EN ISO 13850	Sicherheit von Maschinen, NOT-Halt, Gestaltungsleitsätze *Safety of machinery, Emergency stop, principles for design*	2015
EN ISO 13851	Sicherheit von Maschinen - Zweihandschaltungen - Funktionelle Aspekte und Gestaltungsleitsätze *Safety of machinery - Two-hand control devices - Principles for design and selection*	2019
EN 61508	Teil 1-7: Funktionale Sicherheit sicherheitsbezogener elektrischer/elektronischer/programmierbarer elektronischer Systeme *Part 1-7: Functional safety of electrical/electronic/programmable electronic safety-related systems*	2010

Bemerkungen/*Notes*:
Die Produkte entsprechen den Anforderungen der Niederspannungs-Richtlinie 2014/35/EU und der EMV-Richtlinie 2014/30/EU.
The products are in accordance to the Low Voltage Directive 2014/35/EC and EMC Directive 2014/30/EC.

Folgende Prüfstelle hat eine Baumusterprüfung des Produkts im Zusammenhang mit der EMV Richtlinie ausgeführt:
The below listed test house has executed a type certification in relation to the Low Voltage and EMC Directive:
EMC: TEMPTON Service Plus GmbH, Thurn- und Taxis-Str. 18, D-9011 Nürnberg
Reg.-Nr.: DGA-PL-231/9-04 Doc. Nr. 10-143
Bzw. TÜV SÜD Senton, Äußere Frühlingsstraße 45, D-94315 Straubing
Reg.-Nr.: DGA-PL-171/94-03

LVD: TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, D-51105 Köln
Notified body number: NB 0035 Doc. Nr. 01/205/5128.01/15

Den im Produkthandbuch beschriebenen Sicherheits-, Installations- und Bedienungshinweisen muss Folge geleistet werden.
These products must be installed and operated with reference to the instructions in the Product Manual. All instructions, warnings and safety information of the Product Manual must be adhered to.

Für das Produkthandbuch zeichnet sich Dipl.-Ing. (FH) Gerhard Bauer verantwortlich.
For the Product Manual is responsible Dipl.-Ing. (FH) Gerhard Bauer.

Weiden, 19/05/2021

Gerhard Bauer, *Managing Director*