



SMC1.3 / SMC2.4

Safety Motion Monitors for Incremental Encoders / Sensors

Product features:

- Monitoring of ramp, underspeed, overspeed, standstill and direction of rotation
- Wire monitoring of the sensor signals
- Up to SIL3/PLe with two independent non certified sensors (Version **SMC2.4**)
- Up to SIL3/PLe with one equally certified sensor (Version **SMC1.3**)
- Safety Functions equivalent to EN 61800-5-2 (SS1, SS2, SOS, SLS, SDI, SSM, SLI, SBC, STO, SMS)
- Inputs:
 - 2 incremental inputs (HTL differential/ HTL single ended/ RS422) (Version **SMC2.4**)
 - 1 incremental input (HTL differential/ RS422) (Version **SMC1.3**)
 - 8 control inputs (HTL, PNP)
- Outputs (safe):
 - 2 connected relay outputs, 2 closers (5 ... 250 VAC/ VDC)
 - 1 analogue output (4 ... 20 mA)
 - 4 x 2 control outputs (HTL, Push-Pull)
- Signal splitter (safe): 1 programmable splitter output (HTL/ RS422)
- Mounting to 35 mm top hat rail (according to EN 60715)
- USB interface for simple parametrization by the OSxx operator surface
- Optional available display unit SMCB.1

Available Models:

- **SMC2.4**: 2 inputs for non-certified incremental encoders
- **SMC1.3**: 1 input for a SIL3/PLe incremental encoder

Version:	Description:
R60047 01a_oi/sn/01/18	First edition pre series
R60047 01b_oi/sn/af/05/18	First edition series
R60047 01c_oi/sn/af/06/18	Revised version
R60047 01d_oi/af/cn/07/18	Next revised version
R60047 05/2019	Order code
R60047 02a_02/2020	New Parameter
R60047 3_12/2020	OSxx
R60047 2b 07/2021 kae	Revised version
R60047 2c 02/2022 kae	Revision in chapter 11.2 → PRG Error

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German is the original version.

Important note about this document:

In addition to this manual, you can find the parameter description in the separate description **SMC1.3/SMC2.4_pd_e (document no. R67052)**. It contains a detailed description and a list of all parameters for setup and operation.



Further important manuals:

- OSxx Operating Manual
- OSxx User Installation Manual
- SMCB.1 Operating Manual (optionally)

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1 Safety Instructions and Responsibility

1.1 General Safety Instructions

This operation manual is a significant component of the unit and includes important rules and hints about the installation, function and usage. Non-observance can result in damage and/or impairment of the functions to the unit or the machine or even in injury to persons using the equipment!

Please read the following instructions carefully before operating the device and observe all safety and warning instructions! Keep the manual for later use.

A pertinent qualification of the respective staff is a fundamental requirement in order to use these manuals. The unit must be installed, configured, commissioned and serviced by a qualified electrician.

Liability exclusion: The manufacturer is not liable for personal injury and/or damage to property and for consequential damage, due to incorrect handling, installation, operation and maintaining.

Further claims, due to errors in the operation manual as well as misinterpretations are excluded from liability.

In addition, the manufacturer reserves the right to modify the hardware, software or operation manual at any time and without prior notice. Therefore, there might be minor differences between the unit and the descriptions in operation manual.

The raiser respectively positioner is exclusively responsible for the safety of the system and equipment where the unit will be integrated.

During installation, operation or maintenance all general and also all country- and application-specific safety rules and standards must be observed.

If the device is used in processes, where a failure or faulty operation could damage the system or injure persons, appropriate precautions to avoid such consequences must be taken.

1.2 Use according to the intended purpose

The unit is intended exclusively for use in industrial machines, constructions and systems.

Non-conforming usage does not correspond to the provisions and lies within the sole responsibility of the user. The manufacturer is not liable for damages which are arisen through unsuitable and improper use. Please note that device may only be installed in proper form and used in a technically perfect condition in accordance to the technical Specifications. The device is not suitable for operation in explosion-proof areas or areas which are excluded by the EN 61010-1 standard.

1.3 Installation

The device is only allowed to be installed and operated within the permissible temperature range. Please ensure adequate ventilation and avoid all direct contact between the device and hot or aggressive gases and liquids.

Before installation or maintenance, the unit must be disconnected from all voltage-sources. Further it must be ensured that no danger can arise by touching the disconnected voltage-sources.

Devices which are supplied by AC-voltages, must be connected exclusively by switches, respectively circuit-breakers with the low voltage network. The switch or circuit-breaker must be placed as near as possible to the device and further indicated as separator.

Incoming as well as outgoing wires and wires for extra low voltages (ELV) must be separated from dangerous electrical cables (SELV circuits) by using double resp. increased isolation.

All selected wires and isolations must be conforming to the provided voltage- and temperature-ranges. Further all country- and application-specific standards, which are relevant for structure, form and quality of the wires, must be ensured. Indications about the permissible wire cross-sections for wiring are described in the technical specifications.

Before first Start-up it must be ensured that all connections and wires are firmly seated and secured in the screw terminals. All (inclusively unused) terminals must be fastened by turning the relevant screws clockwise up to the stop.

Overvoltage at the connections must be limited to values in accordance with the overvoltage category II.

1.4 EMC Guidelines

All Safety-M compact devices are designed to provide high protection against electromagnetic interference. Nevertheless, you must minimize the influence of electromagnetic noise to the device and all connected cables.

Therefore, the following measures are mandatory for a successful installation and operation:

- **Use shielded cables for all signal and control input and output lines.**
- **Cables for digital controls (digital I/O, relay outputs) must not exceed a length of 30 m and are allowed for in building operation only**
- Use shield connection clamps to connect the cable shields properly to earth
- The wiring of the common ground lines must be star-shaped and common ground must be connected to earth at only one single point
- The device should be mounted in a metal enclosure with sufficient distance to sources of electromagnetic noise.
- Run signal and control cables apart from power lines and other cables emitting electromagnetic noise.

Please also refer to Kübler manual “General Rules for Cabling, Grounding, Cabinet Assembly”. You can download that manual by the link <https://www.kuebler.com/emc> → “[General **EMC** Rules for Wiring, Screening and Earthing]”.

1.5 Cleaning, Maintenance and Service Notes

To clean the front of the unit please use only a slightly damp (not wet!), soft cloth. For the rear no cleaning is necessary. For an unscheduled, individual cleaning of the rear the maintenance staff or assembler is self-responsible.

During normal operation no maintenance is necessary. In case of unexpected problems, failures or malfunctions the device must be shipped for back to the manufacturer for checking, adjustment, or reparation. Unauthorized opening and repairing can have negative effects or failures to the protection-measures of the unit.

The service interval of the SMCX device is 1 year, in case of continuous operation the SMCX unit must be switched on and off for at least 1 time a year.

2 Introduction

This series of speed monitors is suitable for safety-related monitoring tasks, e.g. over-speed, under-speed, standstill and direction of rotation. This SIL3/PLe certified generation of devices was developed to achieve functional safety by supporting a wide range of sensors and encoders in different combinations.

Due to parallel encoder inputs these devices are perfectly suitable for the retrofitting of existing plants and machines which are using “non-safe” sensors. This offers a great opportunity to save costs for expensive and certified sensors. Also, the costs for new installations and adjustments can be reduced significantly by using the existing components and wiring.

Typical examples are centrifuges, cranes, wind power or hauling plants.

Special features:

- Additionally, suitable for use with setup operations, e. g. for manual settings in plants with open protection doors and reduced speed
- All models are safety-related and dually certified according to EN 61508, EN 62061 / SIL3 and EN ISO 13849-1 Cat. 3 / PLe, even when using “non-safety-related” standard sensors or encoders
- Generally, the use of 2 sensors / encoders is required because only then SIL3 / PLe can be achieved. When using a single SIL2/PLd certified Incremental encoder, only a maximum of SIL2/PLd can be reached.
- Wide input frequency range and fast response time
- Very versatile range of possible monitoring functions
- It is recommended to setup the SMCX unit via the front USB port by using a PC and the OSxx operator software.
- The final “Safety Integrity Level (SIL)” or “Performace Level (PL)” results from the selected configuration and from external components connected to the unit.
- The additional display and operating unit SMCB.1 (optional accessory, not included in the delivery) is used to display the encoder frequencies in converted operator units and further for visual monitoring of the SMCX unit.

3 Available Models

Order code	8 . SMC1 . 3 SA . 442	
a Encoder interface 3 = 1 x screw terminal HTL differential, RS422	b Internal signal splitting S = with	c Analog output A = 4 ... 20 mA

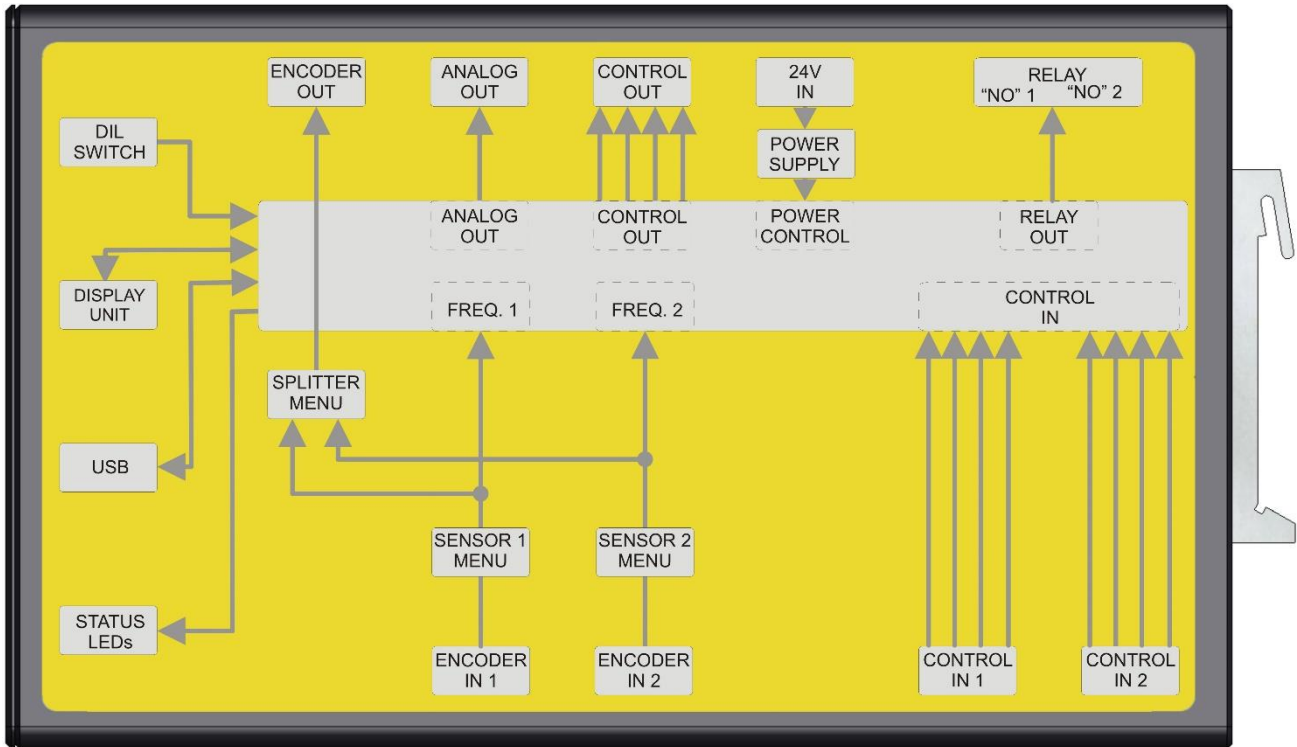
Order code	8 . SMC2 . 4 SA . 442	
a Encoder interface 4 = 2 x screw terminals HTL differential, HTL, RS422	b Internal signal splitting S = with	c Analog output A = 4 ... 20 mA



SMC2.4 is the execution for two independent encoders
SMC1.3 is the execution for a certified SIL2 / PLd encoder

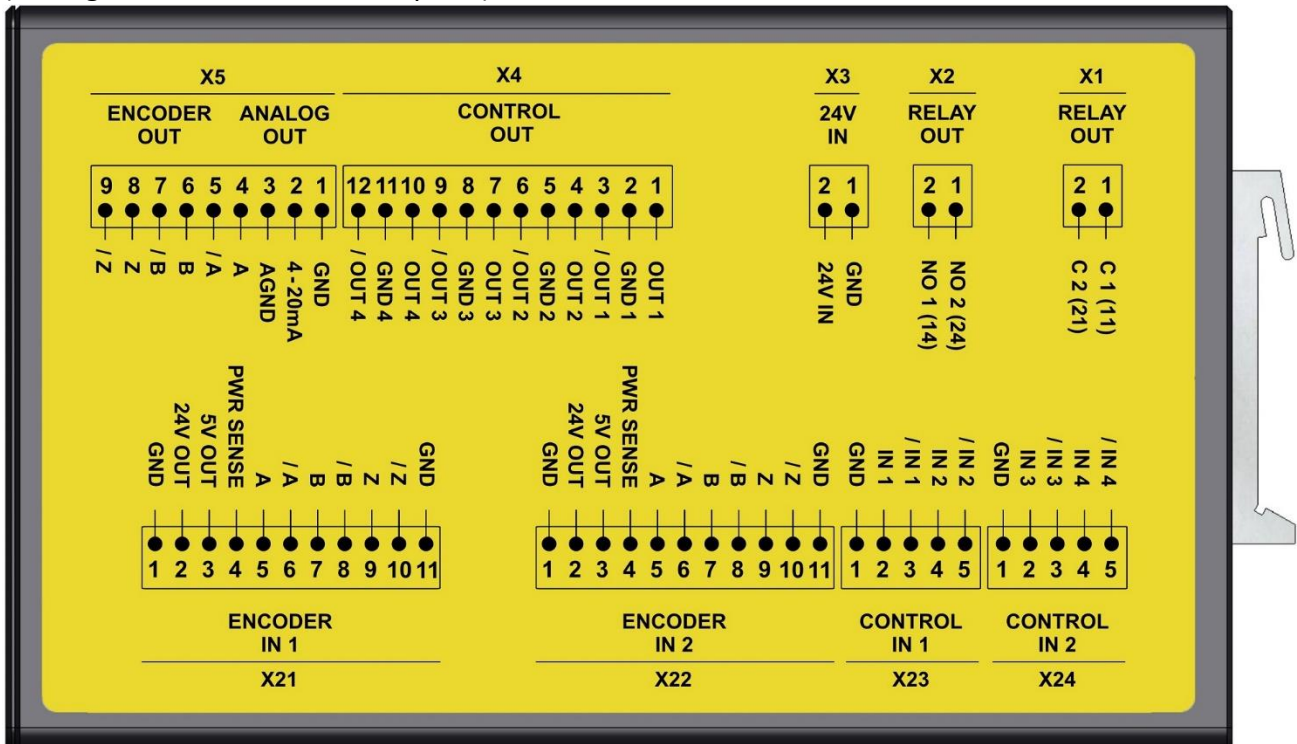
4 Block Diagrams and Connections

4.1 SMC2.4 Block Diagram

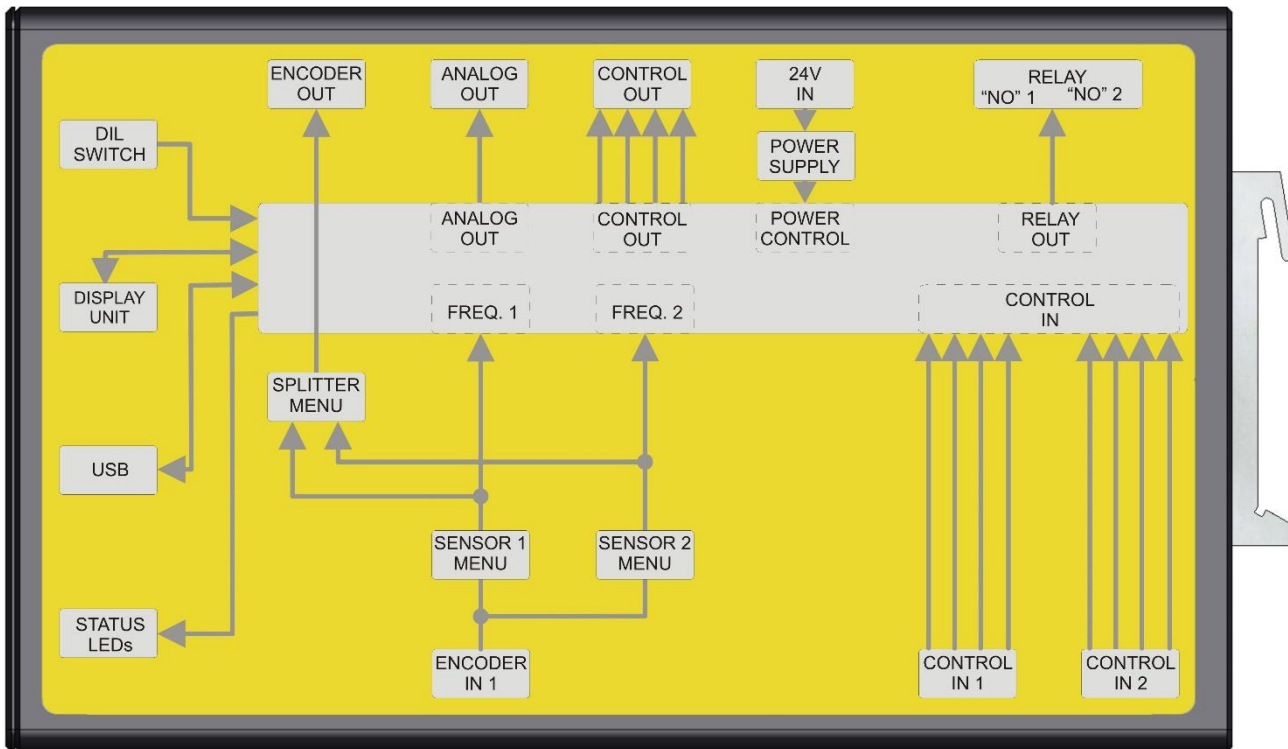


4.2 SMC2.4 Connections

(The figure shows the available ports)

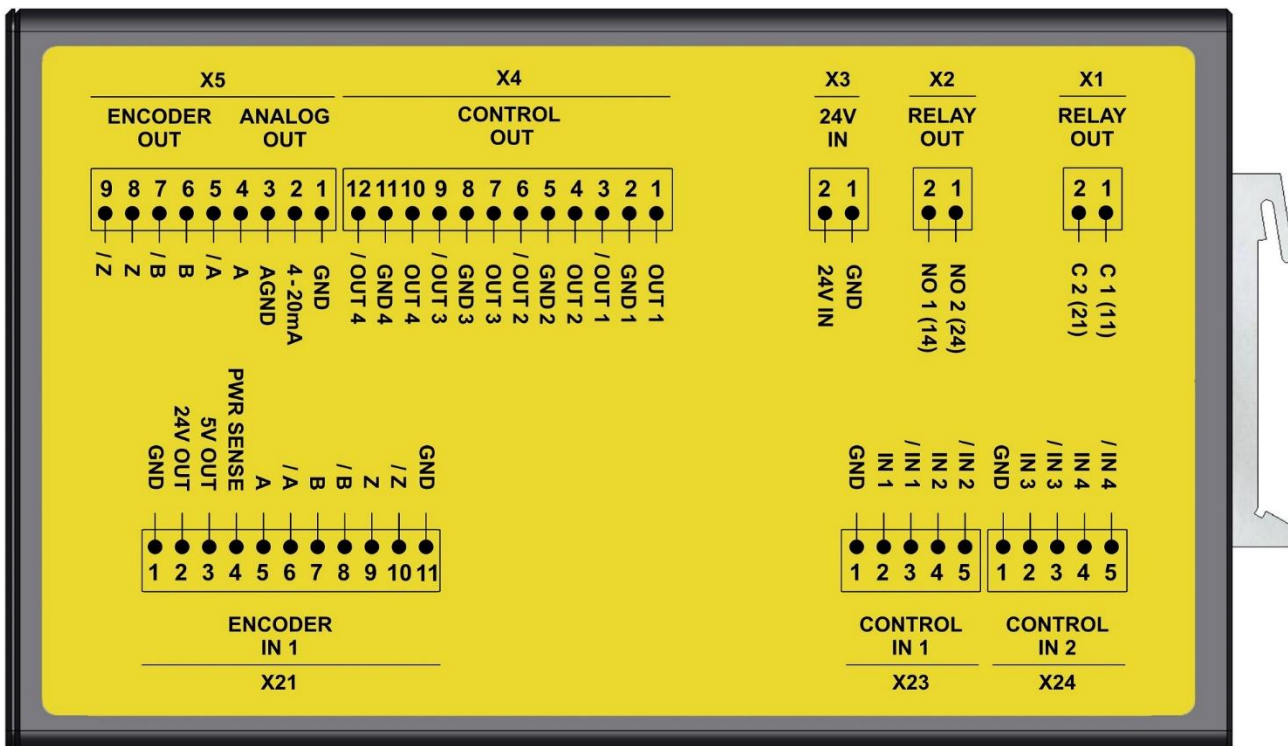


4.3 SMC1.3 Block Diagram



4.4 SMC1.3 Connections

(The figure shows the available ports)



5 Description of Connections

This chapter describes only the electrical connections and their general function.

Name	Description see chapter
X1 RELAY OUT	0 5.8 Relais
X2 RELAY OUT	0 Relais outputs
X3 24V IN	5.1 Power supply
X4 CONTROL OUT	5.7 Control output
X5 ANALOG OUT	5.6 Analog output 4 to 20 mA
X5 ENCODER OUT	5.5 Encoder output
X11	5.10 SMCB.1 Operator Interface
X12	5.11 USB Interface for the OSxx Operator Surface
X21 ENCODER IN 1	5.3 Encoder inputs
X22 ENCODER IN 2	5.3 Encoder inputs
X23 CONTROL IN 1	5.4 Control inputs
X24 CONTROL IN 2	5.4 Control inputs
S1	5.9 DIL switch
ERROR – ON	5.12 LEDs / Status Indication



The connection to the outputs is only safe when the follower unit is able to detect the fault status of each output and when the outputs are configured accordingly.



In order to prevent simultaneous damages and disturbance of the cables by external influences, the encoder resp. sensor lines must be kept physically apart from each other.

5.1 Power Supply

If the unit is connected to a DC power supply network which also supplies further devices or systems, it must be ensured that no voltages ≥ 60 V can occur at the terminals [X3:1] und [X3:2].

If this cannot be ensured, the unit must be supplied by a separate DC power pack, which must not be connected to further devices or systems.

The requirements for both kinds of power supplies are:

- Nominal voltage ranges from 18 ... 30 VDC
- Ripple $< 10\%$ @ 24 V and maximum load
- External fuse (3.15 A, medium time lag) required

A separate power pack must cover the following requirements:

- The consumption of the unit is approx. 45 W (at permissible load and without short-circuit)

The 18 ... 30 VDC power supply must be connected via the pluggable 2-position screw terminal strip [X3 | 24V IN]. The power supply input is protected by an internal reverse polarity protection.



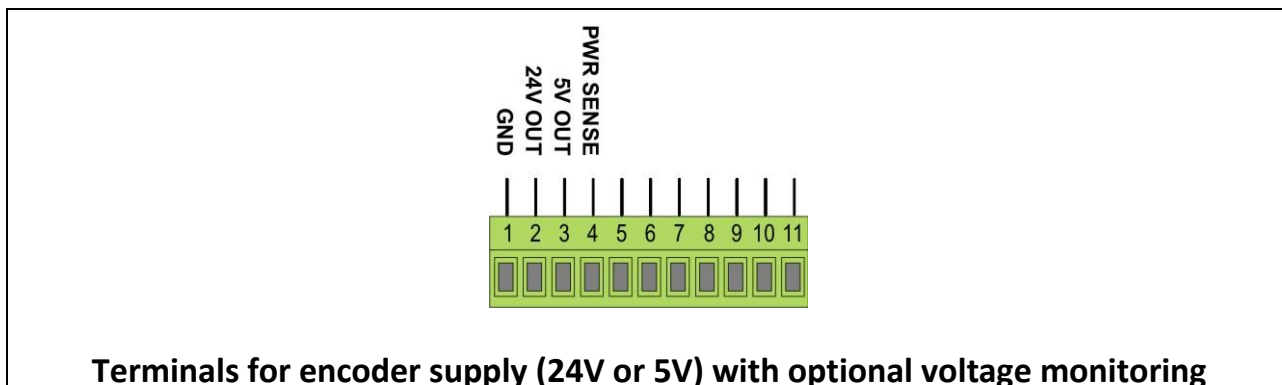
Pluggable 2-position terminal [X3]



- **The DC input must be protected by an external fuse (type and value see above or technical specifications).**
- **The SMCX unit has no internal galvanic isolation, thus all GNDs are interconnected. Please avoid any GND loops to the power supply input [X3].**
- **Even with use of a SIL3 certified power supply (UFAIL < 60 V), an external fuse must be installed.**

5.2 Encoder Supply

The unit offers an auxiliary voltage output for separate supply of the encoders or sensors in use. The encoder supply must be taken directly from the safety monitor, or via relay contact when using an indirect power supply.



The maximum load of the encoder supply is 200 mA per channel (Sensor 1 and Sensor 2). An encoder supply is available for each sensor channel (24V out or 5V out). The voltage of the 24V Out encoder supply is approx. 2 V below the supply voltage of the device supplied to [X3] (18... 30 VDC). Via the connection PWR sense, the voltage of the encoder supply can be monitored (optional).

When powering up the encoder supply, the maximum input current of the safety unit could be exceeded, depending on the encoders in use. In this case, the encoder supply would not be enabled, and an error appears.

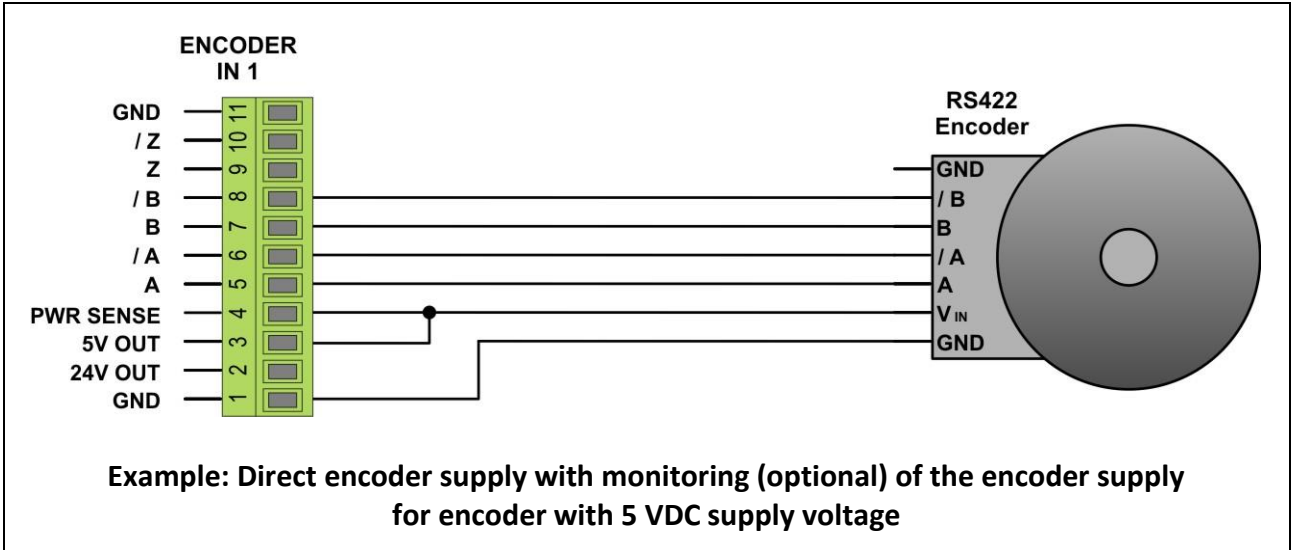
In case of such problems, or if another voltage level is required, the encoder supply can be switched on from an external voltage source via remote relay. In this case, it is mandatory to energize the relay from the internal encoder supply of the SMCX unit.



- **In case of a direct encoder supply it is mandatory to operate the encoders with the auxiliary voltage from the unit.**
- **Indirect encoder supply must in any case be carried out via relay, energized by the auxiliary voltage of the SMCX unit.**

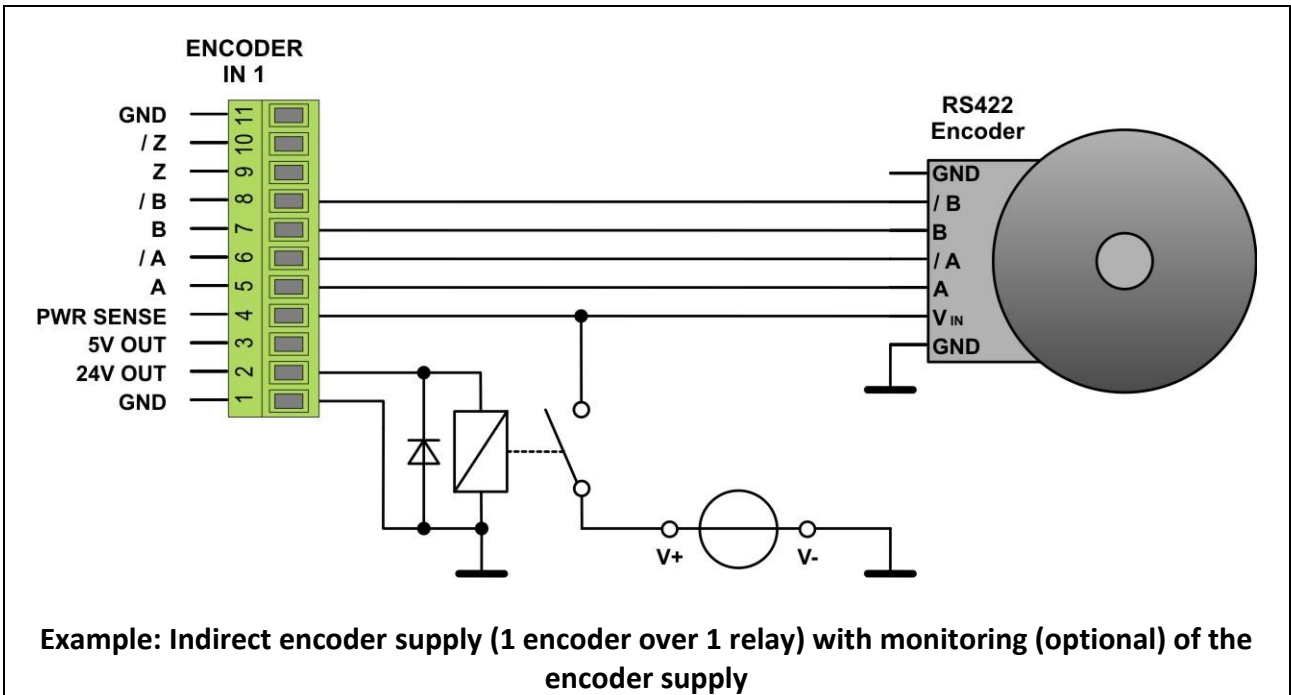
5.2.1 Direct Encoder Supply

With direct encoder supply, the encoder must be connected as shown in the figure below:



5.2.2 Indirect Encoder Supply

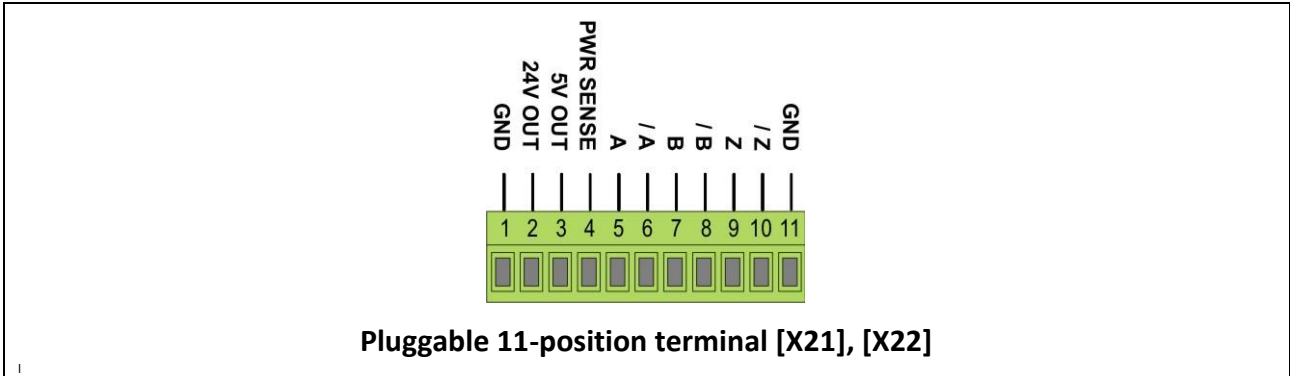
Indirect encoder supply must necessarily, and each separately, be switched on by use of a relay, energized with the auxiliary voltage of the unit. This is necessary, because no encoder signals must be applied to the safety monitor before the unit has successfully completed its initialization and self-test.



5.3 Encoder Inputs

The incremental encoder is connected by one or both of the pluggable 11-position terminal [X21 | ENCODER IN 1] and [X22 | ENCODER IN 2]. The zero pulses (Z or/Z) do not have to be connected.

Encoder signals can be connected in the format RS422, HTL differential (both with A, /A, B, /B and 90 ° phase offset) and HTL single ended (A, B 90 °) and only single lane HTL signals (A).



The characteristics of the encoder inputs must be set in the Sensor menu. No external networks may be connected to the encoder signals. The encoder supply must be connected via the respective terminal.



- For unbalanced single channel signals, the parameter “Edge 1” and “Edge 2” must be set to 1, so that a stable frequency can be detected.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.



- The use of single track HTL signals (HTL single ended) can reduce the Safety Integrity Level (SIL) or the Performance Level (PL). At SMC1.3, SIL2/PLd encoder in HTL single ended configuration is not allowed, as no sensor errors can be detected anymore.

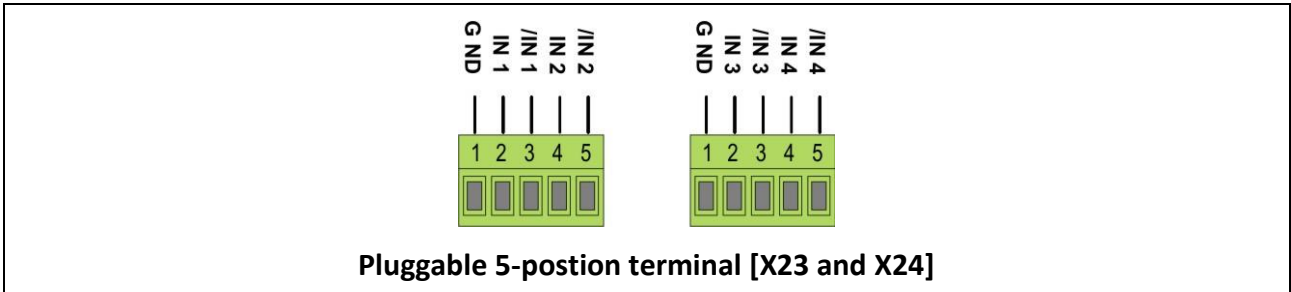


- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

5.4 Control inputs

Up to 8 input channels for control signals with HTL level and PNP switching characteristics are available on the terminal strips [X23 | CONTROL IN 1] and [X24 | CONTROL IN 2].

The configuration of the inputs has an effect on the Safety Integrity Level (SIL) or the Performance Level (PL). Attention, not all inputs have the same configuration option.



5.4.1 Control outputs CONTROL IN 1

The following functions and configuration options are available on the terminal strip [X23 | CONTROL IN 1]:

- **Two 2-pole inputs (IN1, /IN1 and IN2, /IN2)**

Signalpair 1	[X23: 2] IN1	Control signal 1, fault detection
	[X23: 3] /IN1	Homogeneous or inverse control signal 1, fault detection
Signalpair 2	[X23: 4] IN2	Control signal 2, fault detection
	[X23: 5] /IN2	Homogeneous or inverse control signal 2, fault detection

- **One 2-pole input (IN1, /IN1) and two 1-pole inputs (IN2 und /IN2)**

Signalpair 1	[X23: 2] IN1	Control signal 1, fault detection
	[X23: 3] /IN1	Homogeneous or inverse control signal 1, fault detection
Signal 2	[X23: 4] IN2	Control signal 2
Signal 3	[X23: 5] /IN2	Control signal 3

- **Four 1-pole inputs (IN1, /IN1, IN2 and /IN2)**

Signal 1	[X23: 2] IN1	Control signal 1
Signal 2	[X23: 3] /IN1	Control signal 2
Signal 3	[X23: 4] IN2	Control signal 3
Signal 4	[X23: 5] /IN2	Control signal 4

- **One 4-pole input (IN1, /IN1, IN2 and /IN2)**

Signal 1 - 4	[X23: 2-5]	Signals in gray (4 states with error detection) or binary format (16 states without error detection) for switching the switching points
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- **The use of 1-pole inputs reduces the Safety Integrity Level (SIL) or the Performance Level (PL).**
- **The use of 16 switching points reduces the Safety Integrity Level (SIL) or the Performance Level (PL).**

5.4.2 Control outputs CONTROL IN 2

The following functions and configuration options are available on the terminal strip [X24 | CONTROL IN 2]:

- **Two 2-pole inputs (IN3, /IN3 und IN4, /IN4)**

Signalpair 1	[X24: 2] IN3	Control signal 5, fault detection
	[X24: 3] /IN3	Homogeneous or inverse control signal 5, fault detection
Signalpair 2	[X24: 4] IN4	Control signal 6, fault detection
	[X24: 5] /IN4	Homogeneous or inverse control signal 6

- **One 2-pole input (IN3, /IN3) and ztwo 1-pole inputs (IN4 and /IN4)**

Signalpair 1	[X24: 2] IN3	Control signal 5, fault detection
	[X24: 3] /IN3	Homogeneous or inverse control signal 5
Signal 2	[X24: 4] IN4	Control signal 6
Signal 3	[X24: 5] /IN4	Control signal 7

- **Four 1-pole inputs (IN3, /IN3, IN4 and /IN4)**

Signal 1	[X24: 2] IN3	Control signal 5
Signal 2	[X24: 3] /IN3	Control signal 6
Signal 3	[X24: 4] IN4	Control signal 7
Signal 4	[X24: 5] /IN4	Control signal 8

- **One 4-pole input (IN3, /IN3, IN4 and /IN4)**

Signal 1 - 4	[X24: 2-5]	Signals in gray (4 states with error detection) or binary format (16 states without error detection) for switching the switching points
---------------------	------------	---



- **The use of 1-pole inputs reduces the Safety Integrity Level (SIL) or the Performance Level (PL).**
- **The use of 16 switching points reduces the Safety Integrity Level (SIL) or the Performance Level (PL).**

5.5 Encoder output

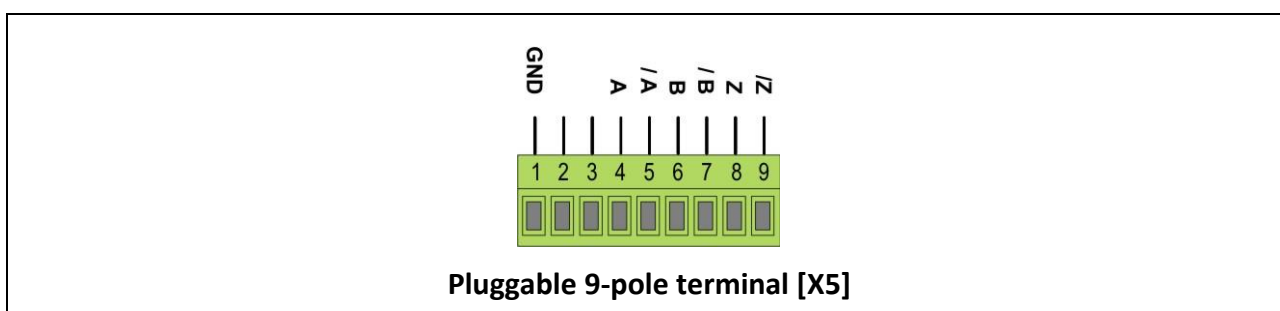
The unit provides a safety-related and programmable HTL / RS422-Splitter-Output.

The splitter output allows to return the input frequency of sensor 1 or sensor 2. The parameters in the Splitter menu allow the selection of the output level (5V = RS422 or 18-30V = HTL) as well as the selection of the frequency source (sensor 1 or sensor 2).

The signal delay between encoder input and splitter output is approx. 500 ns.

In case of error, no encoder signals are available at the splitter output (Tri-State, internal with 10 kOhm pull-down resistors).

The connection of the splitter output is only safe if the following device can detect the fault condition of the safety device.



The terminal [X5] is 9-pole:

[X5 ANALOG OUT]	Analog output	[X5:2-3]
[X5 ENCODER OUT]	HTL / RS422-output	[X5:4-9]



- If the parameter "Split Level" is set incorrectly, the device connected to the encoder output can be damaged.



- In case of error, all traces of the splitter output are switched to "low".



- The Safety Integrity Level (SIL) or the Performance Level (PL) is reduced if only the splitter output is connected. A parallel connection of splitter and relay output or switching output is necessary to reach SIL3 / PL_e.

5.6 Analog output 4 to 20 mA

A safety-related analogue output is available at terminal strip [x5 | ANALOGUE OUT]. The current output is freely scalable by setting parameters “Analog Start” and “Analog End”.

If the analogue output is not used, [X5:2] and [X5:3] must be bridged. An error is detected when the analogue output is open (e.g. wire breakage).

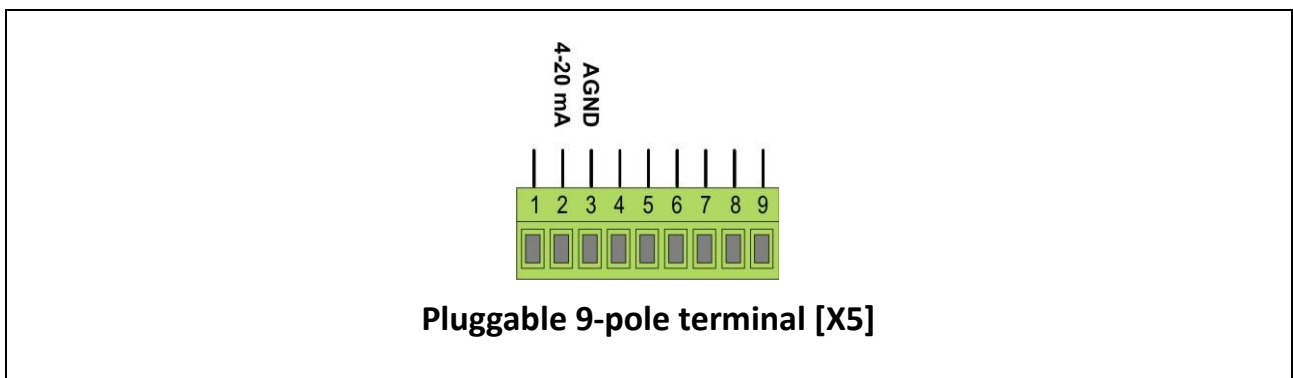
In the normal state, the output signal moves in the range between 4 and 20 mA.

In case of an error, the analogue output is controlled by 0 mA.

The connection of the analog output is only safe if the following device can detect the fault condition of the safety device.

The terminal [X5] provides 9 connections:

[X5 ANALOG OUT]	Analog out	[X5:2-3]
[X5 ENCODER OUT]	HTL / RS422-Output	[X5:4-9]



- If the analogue output is not used, [X5:2] and [X5:3] must be bridged.
- An error is detected when the analogue output is open (e.g. wire breakage).



- In case of an error, the analogue output is controlled by 0 mA.



- The Safety Integrity Level (SIL) or the Performance Level (PL) is reduced if only the analog output is connected. A parallel connection of splitter and relay output or switching output is necessary to reach SIL3/PLe.

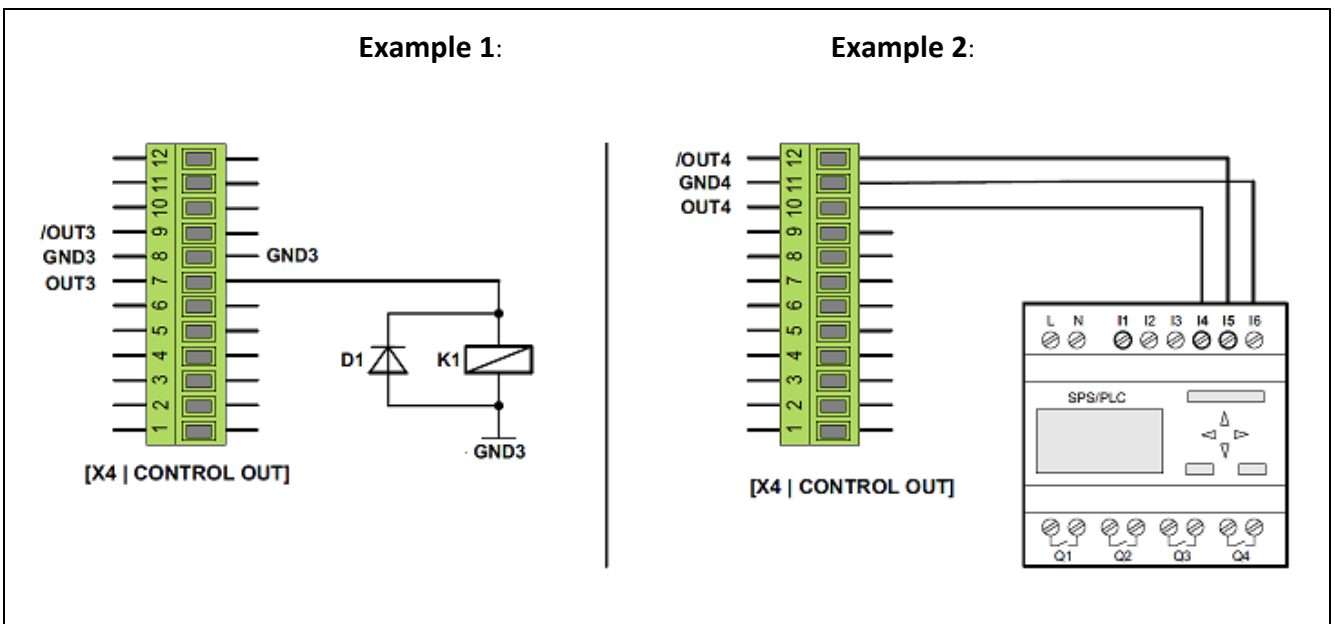
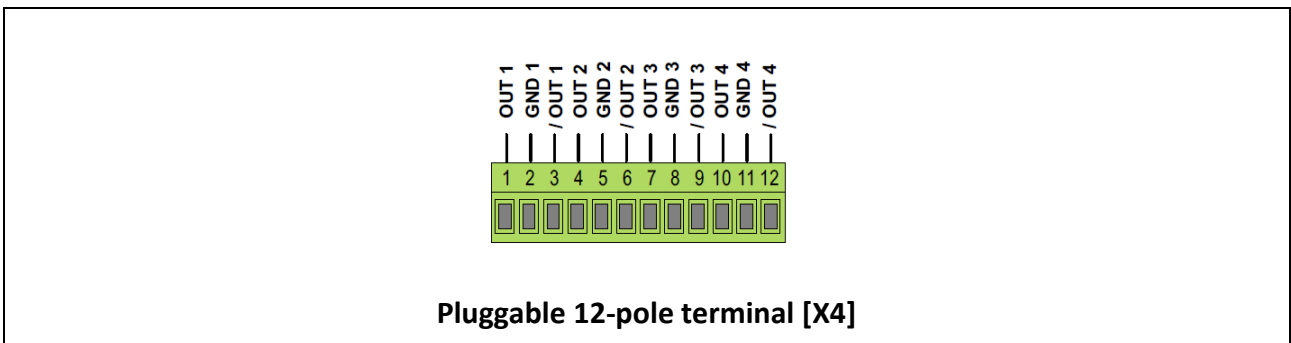
5.7 Control output

Four inverse/homogeneous HTL control outputs are available at the screw terminal [X4 | CONTROL OUT]. The switching points and switching conditions can be programmed by parameters.

In HIGH state, the output level is approximately 2 V lower than the supply voltage at terminal [X3 | 24V IN]. The outputs are short-circuit proof push-pull outputs. When switching inductive loads, additional external suppression measures are recommended.

Connections to the control output are only safe if the target device is able to detect the error state of the safety monitor.

The configuration of the control outputs will affect the Safety Integrity Level (SIL/PL).

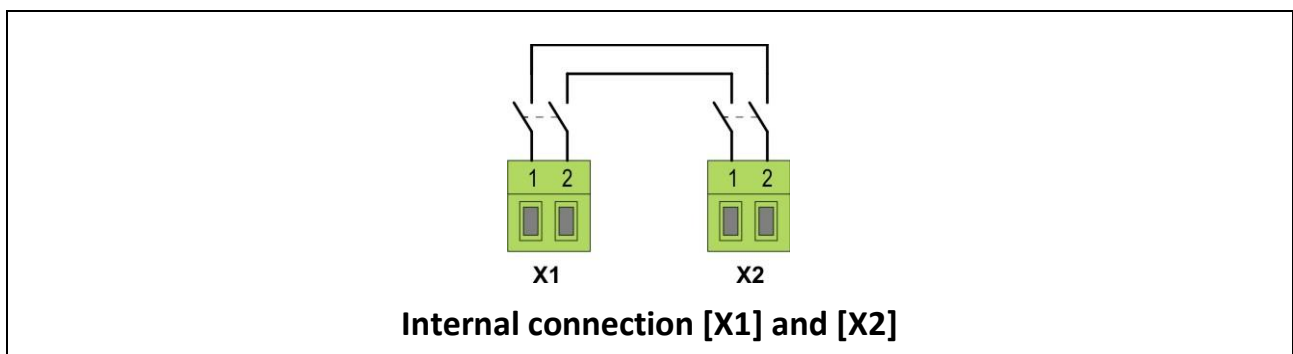
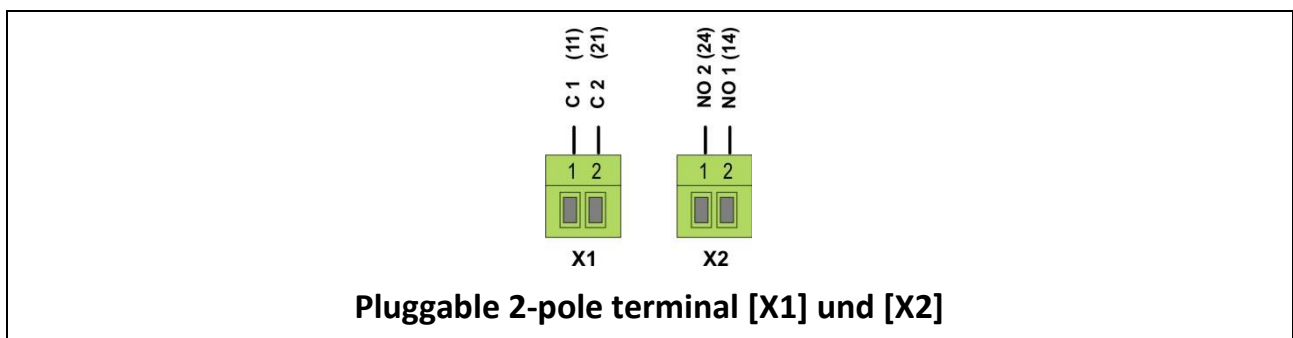


- In case of an error, all control outputs control a low level (no more inverted).

5.8 Relais outputs

The device has two connected-safety-oriented relay outputs. Each relay output consists of two consecutive contacts (NO). These series contacts are available at [X1 | RELAY OUT] and [X2 | RELAY OUT].

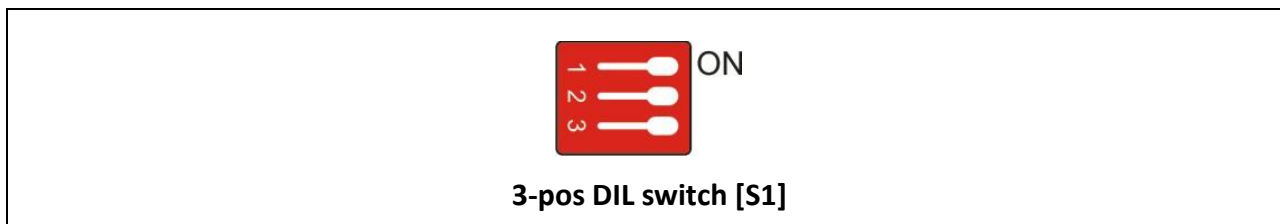
- The contacts are only closed during normal and disturbance-free operation. They will open to a safety state in case of errors or when the programmed switching condition occurs.
- In the de-energized state of the unit the contacts are also open.
- Switching points and switching conditions can be set by the corresponding parameters.
- An internal, forcibly guided opener of the relay is used to monitor the relay status by the unit itself.
- In case of an error the contact will change to the open and safe switching state.



- **The operator is responsible to ensure a safe state of all relevant parts and components of the equipment, whenever the relay contact is open.**
- **The target unit must be able to evaluate edges, in order to determine dynamical conditions of the relay output, too.**
- **With frequencies close to the switching point, relay bouncing may occur in consequence of variation of the frequency measurement. To prevent this, a hysteresis should be set.**
- **If also short overshoots of the switching point should be detected, a lock function should be set to the output.**

5.9 DIL switch

A 3-position DIL switch [S1] is located at the front of the unit (only accessible when no display and programming unit SMCB.1 is connected).



The DIL switch is used to set the operation state of the monitor:

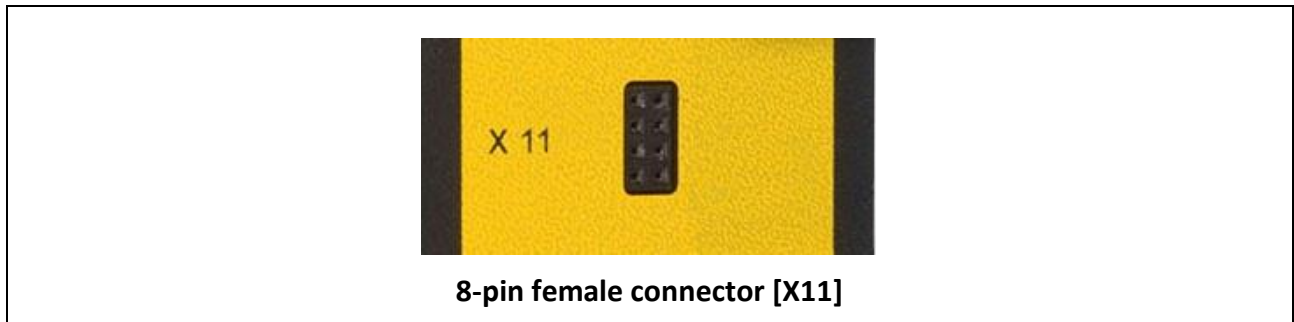
DIL1	DIL2	DIL3	Status	Info
ON	ON	ON	Normal Operation	Device in normal operation. Yellow LED off (lights up permanently at error state). Ready for operation approx. 10 s after power up
ON	---	OFF	Programming / Test - Mode	Device in programming or test mode, e.g. Start-up. Yellow led blinks slowly (lights up permanently at error state)
---	OFF	---	Self Test Message	For internal testing After power-up the device sends a log of the self tests. Yellow led blinks slowly (lights up permanently at error state). Ready for operation approx. 15 s after power up
OFF	---	---	Factory Settings	After power-up the Unit is reset to factory Setting. All parameters are overwritten with default values. Yellow led blinks slowly (lights up permanently at error state).



- **The Programming Mode (DIL switch) is used for Start-up and testing**
- **All DIL switch sliders must be set to „ON“ after Start-up and testing**
- **After Start-up the DIL switch sliders should be protected against manipulation (e. g. by covering with the adhesive tape)**
- **Normal operation is only permitted when the yellow LED is permanently off**
- **The safety function of the unit cannot be guaranteed before the commissioning has been completed.**

5.10 SMCB.1 Operator Interface

On the front site the unit provides a serial interface for communication with SMCB.1 operator units (optional accessory), allowing display and parameter setting.



The SMCB.1 unit and the safety monitor are connected by plugging the SMCB.1 directly onto the female 8-pin connector [X11] at the front.

This operator unit is intended for display of the encoder signals (in user units) and for visual monitoring of the SMCx unit.

With the SMCB.1 no parameters can be changed in the SMC2.4/SMC1.3.
The user interface OSxx is required for Start-up and commissioning.



The female connector [X11] is reserved for exclusive use with a SMCB.1 unit.

5.11 USB Interface for the OSxx Operator Surface

For communication between the unit and a PC or a superordinate controller, a virtual COM port is accessible at the USB connector. A standard USB-cable with a Type B connector is used for connection. This USB cable is available as an option. The USB port serves for PC setup of the SMCx monitors.



A separate manual is available describing the installation procedure of the USB driver (see page 2).

5.12 LEDs / Status Indication

Two status LEDs are located on the front of the unit.

The green one is marked as [ON] and the yellow one as [ERROR].



The green status LED uses the following conditions:

Green LED	Status
OFF	Power off (no power supply voltage)
ON	Power on (power supply voltage ok)

The yellow status LED uses the following conditions:

Yellow LED	Status
OFF	Normal operation, self-test successfully completed, no error messages
ON	During the self-test or with error state
Flashes slowly	Factory Settings or Programming / Test - Mode

6 Operational Modes SCM2.4

The following operating modes (combinations of encoders) are suitable for mapping a two-channel system. The table shows only a portion of the connection options, different duplicate applications are not shown.

Sensor 1			Sensor 2		
Format	Required signals	Optional signals	Format	Required signals	Optional signals
RS422	A, /A, B, /B	Z, /Z	RS422	A, /A, B, /B	Z, /Z
			HTL differential	A, /A, B, /B	Z, /Z
			HTL A, B, 90°	A, B	Z
			HTL A	A	
HTL differential	A, /A, B, /B	Z, /Z	HTL differential	A, /A, B, /B	Z, /Z
			HTL A, B, 90°	A, B	Z
			HTL A	A	
HTL A, B, 90°	A, B	Z	HTL A, B, 90°	A, B	Z
			HTL A	A	
HTL A *	A		HTL A	A	

The Z or/Z track is not evaluated by the device.

Only the line breakage monitoring of the Z tracks is active.



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

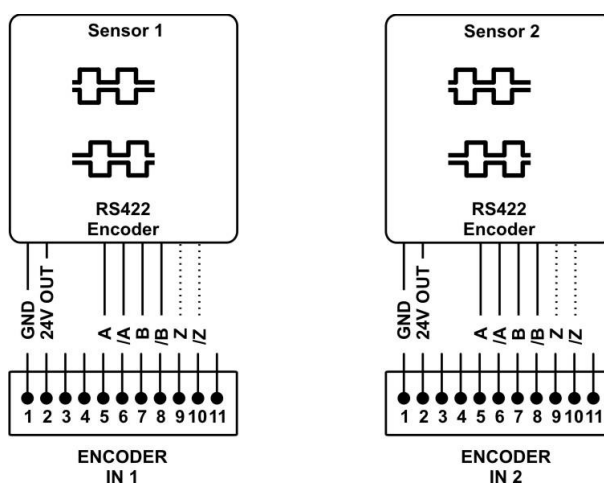


- For unbalanced single channel signals, the parameter A-Edge 2/1 must be set to 1, so that a stable frequency can be detected.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

6.1 Combination: RS422 + RS422

Device	SMC2.4		
„Op-Mode 1“:	0		
Sensor 1:	[X21 ENCODER IN 1]:	RS422 Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	0		
Sensor 2:	[X22 ENCODER IN 2]:	RS422 Encoder	A, /A, B, /B, (Z,/Z)
Safety Level	Speed	→ SIL3 / PL _e achievable (see below)	
	Direction	→ SIL3 / PL _e achievable (see below)	
	Standstill	→ SIL3 / PL _e achievable (see below)	

The encoder supply of the encoders can also be done over 5 V



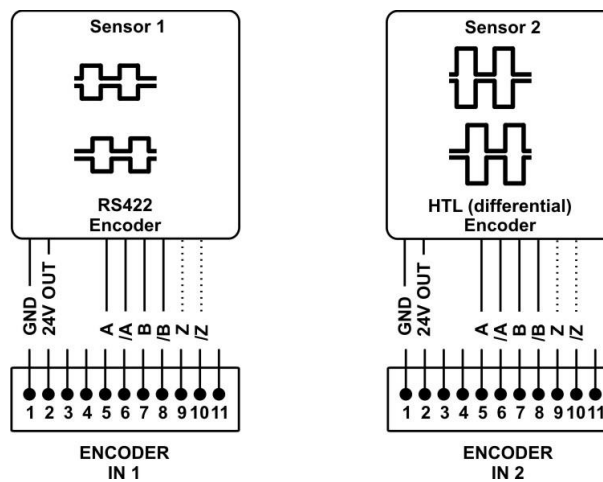
- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

6.2 Combination: RS422 + HTL (differential)

Device:	SMC2.4		
„Op-Mode 1“:	0		
Sensor 1:	[X21 ENCODER IN 1]:	RS422 Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	1		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (differential) Encoder	A, /A, B, /B, (Z,/Z)
Safety Level:	Speed	→ SIL3 / PL _e achievable (see below)	
	Direction	→ SIL3 / PL _e achievable (see below)	
	Standstill	→ SIL3 / PL _e achievable (see below))	

The combination HTL (differential) + RS422 is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.

The encoder supply of the encoder 1 can also be done over 5 V

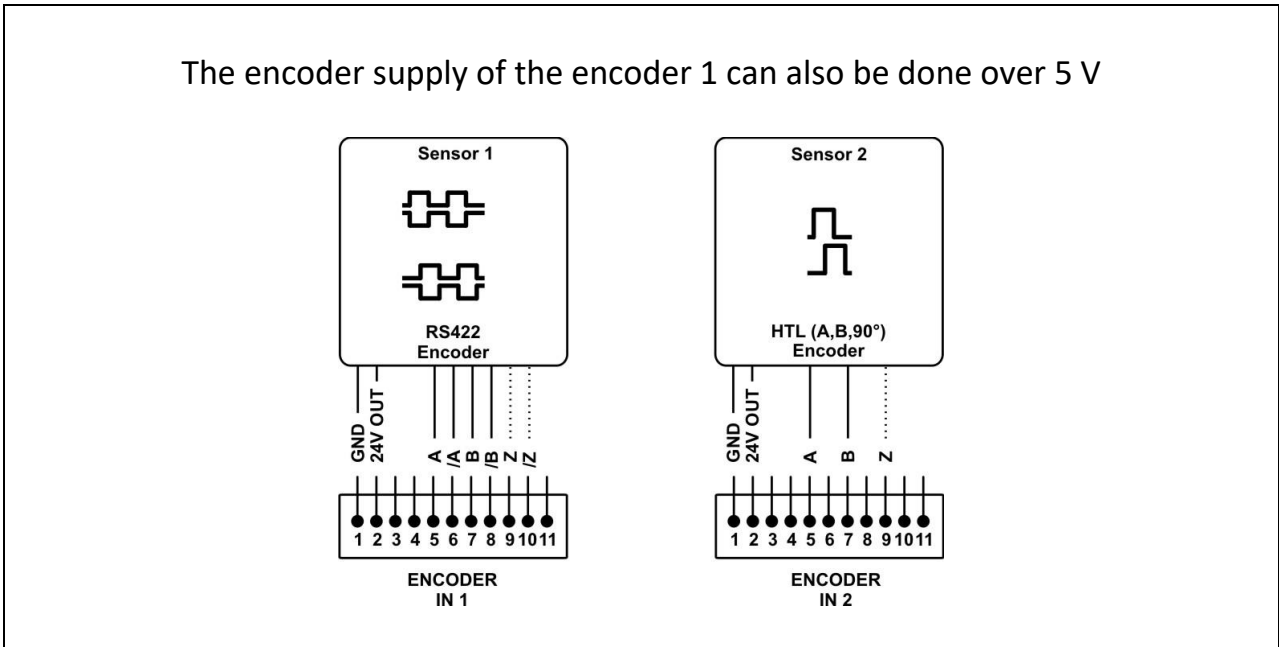


- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

6.3 Combination: RS422 + HTL (A, B, 90°)

Device:	SMC2.4		
„Op-Mode 1“:	0		
Sensor 1:	[X21 ENCODER IN 1]:	RS422 Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	2		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A,B,90°) Encoder	A, B, (Z)
Safety Level:	Speed	→ SIL3 / PLe achievable (see below)	
	Direction	→ SIL3 / PLe achievable (see below)	
	Standstill	→ SIL3 / PLe achievable (see below)	

The combination HTL (A; B; 90°) + RS422 is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.

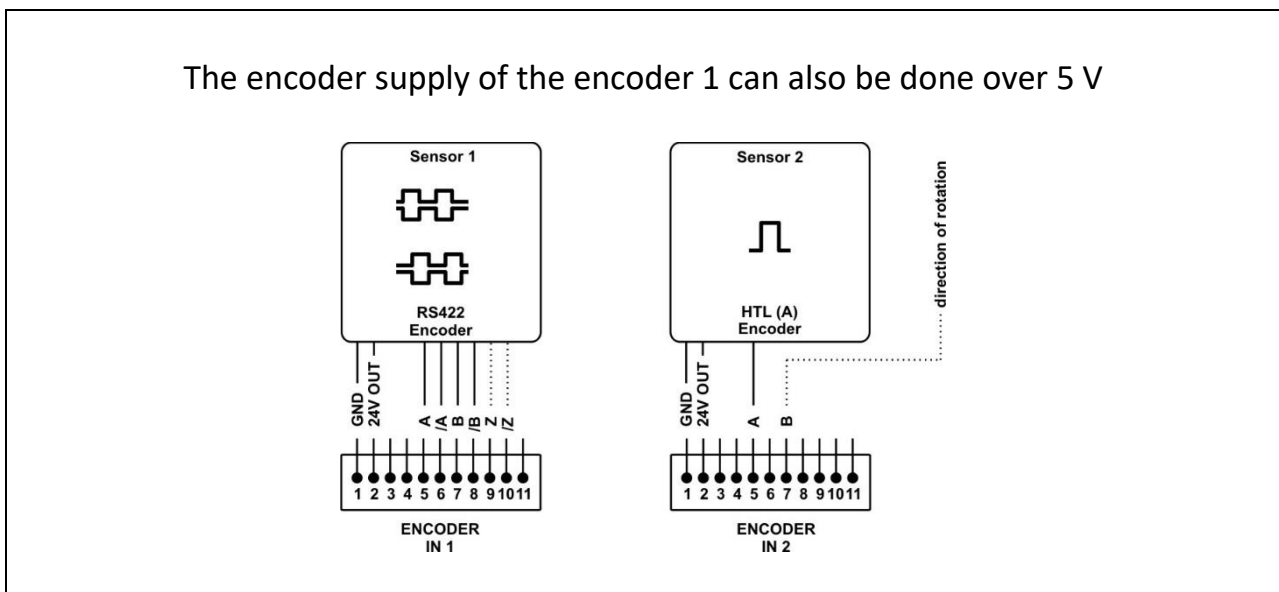


- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

6.4 Combination: RS422 + HTL (A)

Device:	SMC2.4		
„Op-Mode 1“:	0		
Sensor 1:	[X21 ENCODER IN 1]:	RS422 Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	3		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A) Encoder	A
Safety Level:	Speed	→ SIL3 / PLe achievable (see below) *	
	Direction	→ SIL3 / PLe achievable (see below) *	
	Standstill	→ SIL3 / PLe achievable (see below) *	

The combination HTL (A) + RS422 is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.



- For unbalanced single channel signals, the parameter “Edge 1” and “Edge 2” must be set to 1, so that a stable frequency can be detected.

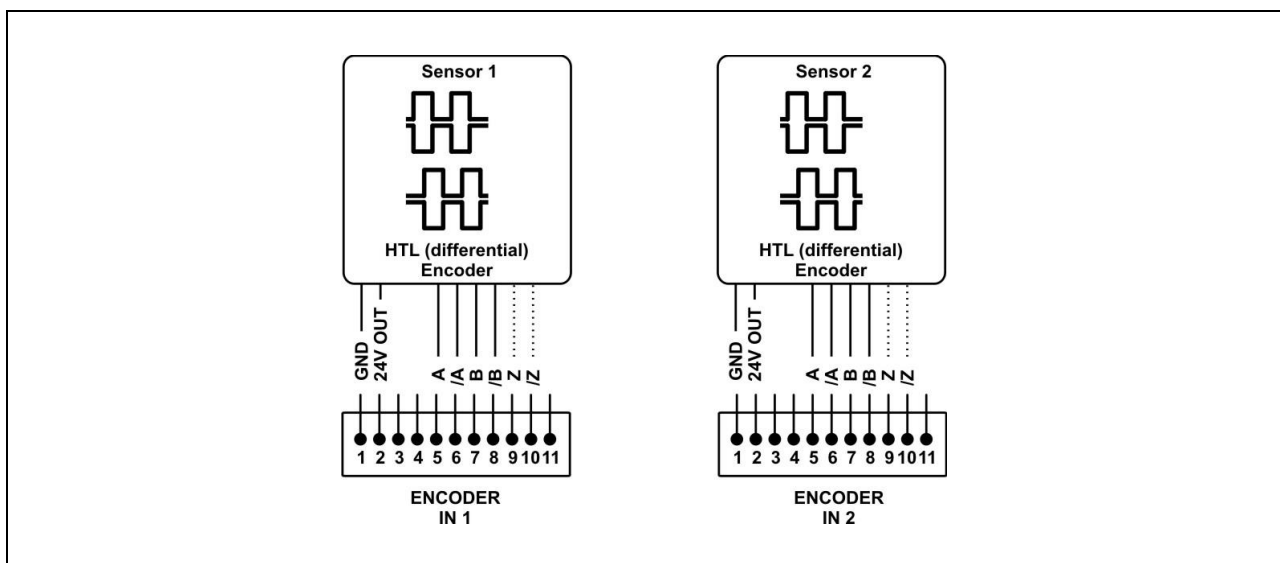


*)

- To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

6.5 Combination: HTL (differential) + HTL (differential)

Device:	SMC2.4		
„Op-Mode 1“:	1		
Sensor 1:	[X21 ENCODER IN 1]:	HTL (differential) Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	1		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (differential) Encoder	A, /A, B, /B, (Z,/Z)
Safety Level:	Speed	→ SIL3 / PLe achievable (see below)	
	Direction	→ SIL3 / PLe achievable (see below)	
	Standstill	→ SIL3 / PLe achievable (see below)	

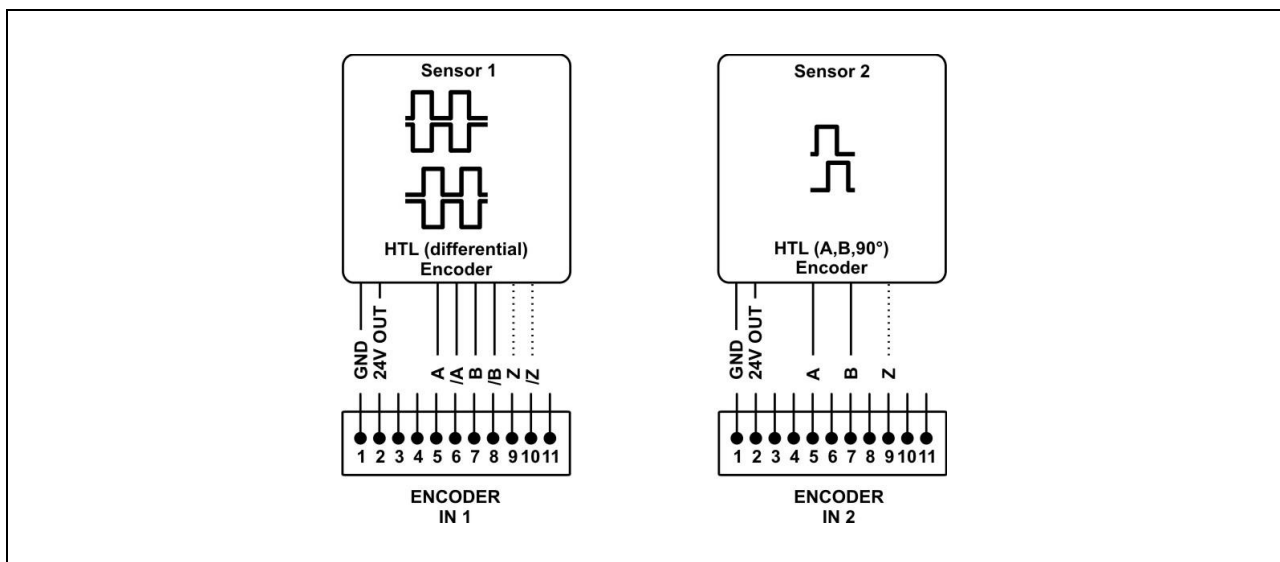


- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

6.6 Combination: HTL (differential) + HTL (A, B, 90°)

Device:	SMC2.4		
„Op-Mode 1“:	1		
Sensor 1:	[X21 ENCODER IN 1]:	HTL (differential) Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	2		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A,B,90°) Encoder	A, B, (Z)
Safety Level:	Speed	→ SIL3 / PLe achievable (see below)	
	Direction	→ SIL3 / PLe achievable (see below)	
	Standstill	→ SIL3 / PLe achievable (see below)	

The combination HTL (A, B, 90°) + HTL (differential) is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.

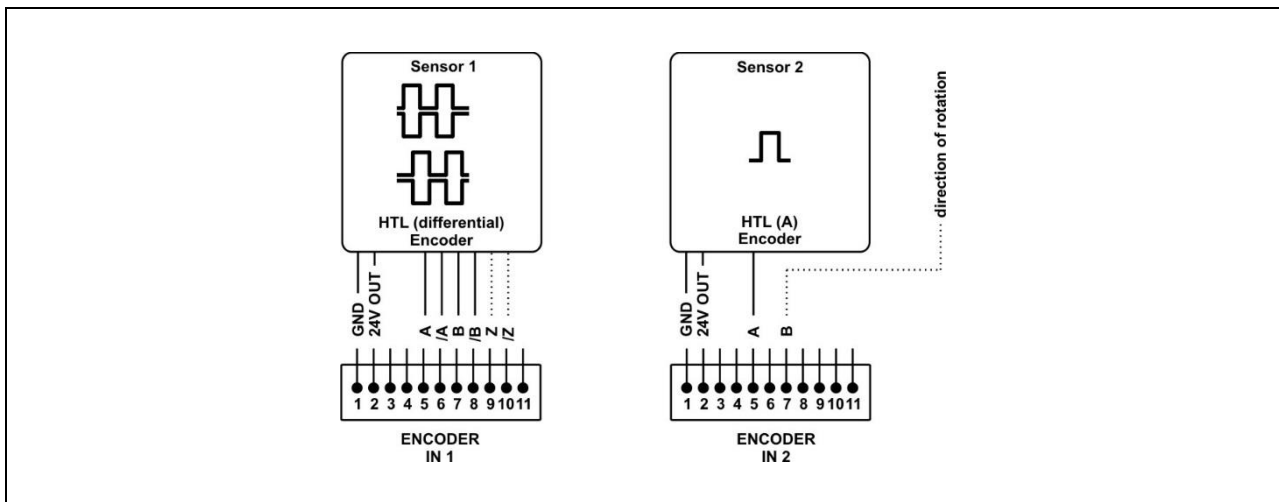


- **The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.**

6.7 Combination: HTL (differential) + HTL (A)

Device:	SMC2.4		
„Op-Mode 1“:	1		
Sensor 1:	[X21 ENCODER IN 1]:	HTL (differential) Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	3		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A) Encoder	A
Safety Level:	Speed	→ SIL3 / PLe achievable (see below) *	
	Direction	→ SIL3 / PLe achievable (see below) *	
	Standstill	→ SIL3 / PLe achievable (see below) *	

The combination HTL (A) + HTL (differential) is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.



- For unbalanced single channel signals, the parameter “Edge 1” and “Edge 2” must be set to 1, so that a stable frequency can be detected.

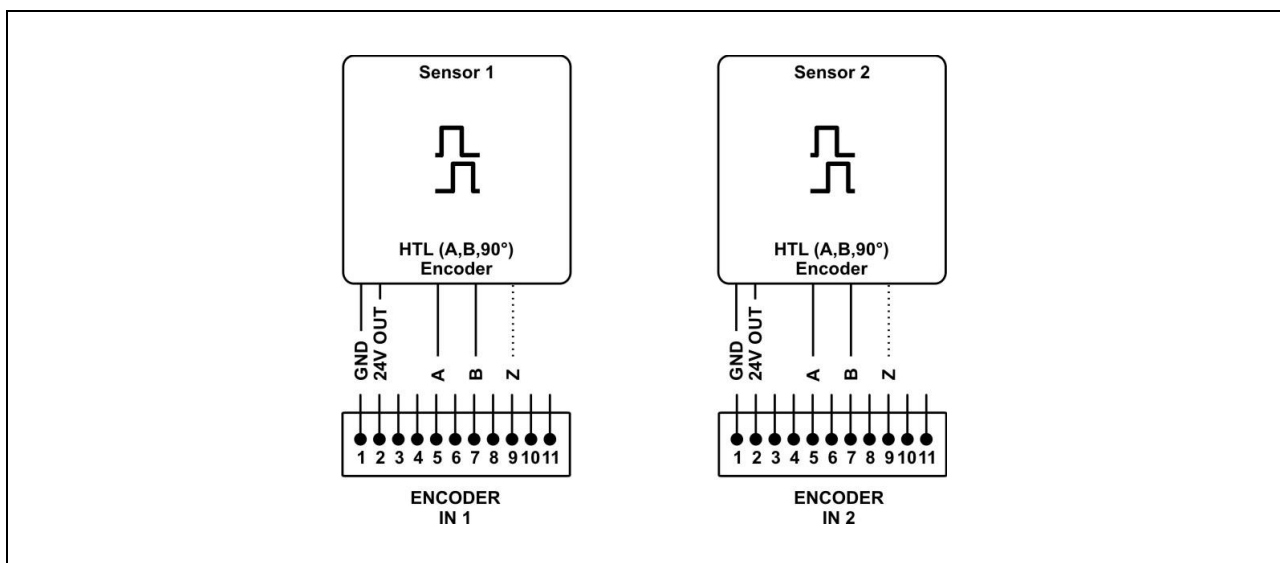


*)

- To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

6.8 Combination: HTL (A, B, 90°) + HTL (A, B, 90°)

Device:	SMC2.4		
„Op-Mode 1“:	2		
Sensor 1:	[X21 ENCODER IN 1]:	HTL (A,B,90°) Encoder	A, B, (Z)
„Op-Mode 2“:	2		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A,B,90°) Encoder	A, B, (Z)
Safety Level:	Speed	→ SIL3 / PLe achievable (see below)	
	Direction	→ SIL3 / PLe achievable (see below)	
	Standstill	→ SIL3 / PLe achievable (see below)	

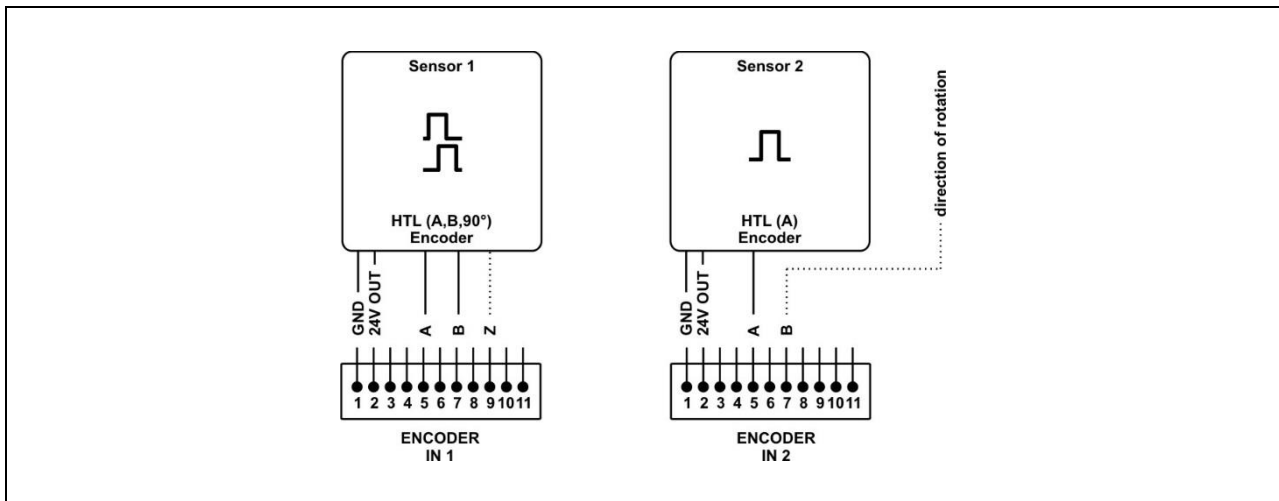


- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.

6.9 Combination: HTL (A, B, 90°) + HTL (A)

Device:	SMC2.4		
„Op-Mode 1“:	2		
Sensor 1:	[X21 ENCODER IN 1]:	HTL (A,B,90°) Encoder	A, B, (Z)
„Op-Mode 2“:	3		
Sensor 2:	[X22 ENCODER IN 2]:	HTL (A) Encoder	A
Safety Level:	Speed	→ SIL3 / PL _e achievable (see below) *	
	Direction	→ SIL3 / PL _e achievable (see below) *	
	Standstill	→ SIL3 / PL _e achievable (see below) *	

The combination HTL (A) + HTL (A, B, 90°) is also possible, the sensors, the encoder supplies and the settings have to be adjusted accordingly.



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.



- For unbalanced single channel signals, the parameter “Edge 1” and “Edge 2” must be set to 1, so that a stable frequency can be detected.

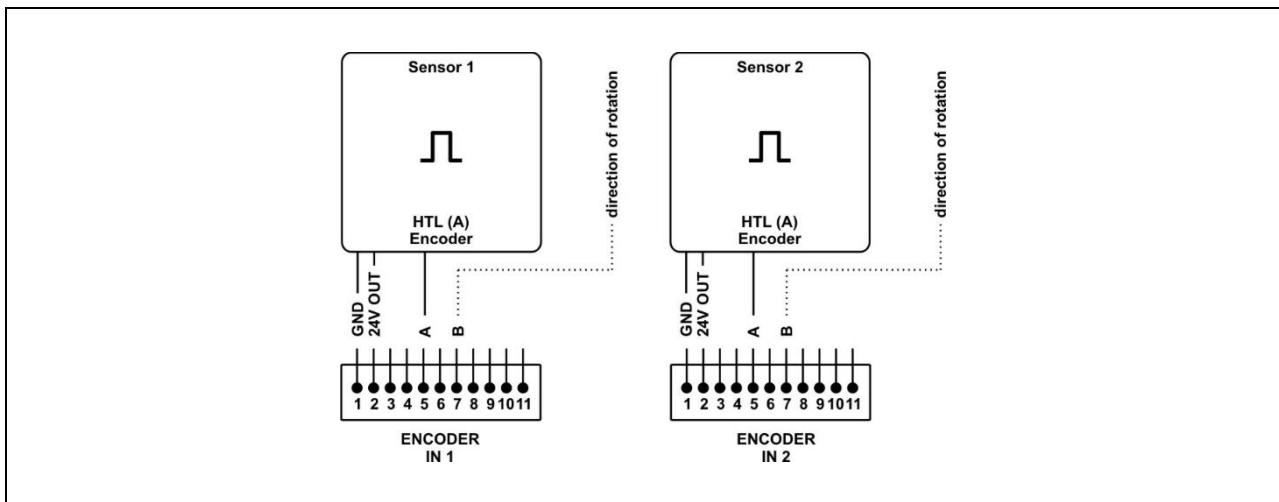


*)

- To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

6.10 Combination: HTL (A) + HTL (A)

Device:	SMC2.4
„Op-Mode 1“:	3
Sensor 1:	[X21 ENCODER IN 1]: HTL (A) Encoder A
„Op-Mode 2“:	3
Sensor 2:	[X22 ENCODER IN 2]: HTL (A) Encoder A
Safety Level:	Speed → SIL3 / PLe achievable (see below) * Direction → SIL3 / PLe achievable (see below) * Standstill → SIL3 / PLe achievable (see below) *



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.



- For unbalanced single channel signals, the parameter “Edge 1” and “Edge 2” must be set to 1, so that a stable frequency can be detected.



*)

- To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.
- With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

7 Operation modes SMC1.3

The following operating modes are suitable for mapping a system with a SIL2/PLd certified sensor. The encoder tracks in the SMC1.3 are internal bridged (two-channel structure).

The following operation modes are possible:

Sensor 1 – SIL2 / PLd z certified –			Sensor 2 – internal bridged –		
Format	Required signals	Optional signals	Format	Required signals	Optional signals
RS422	A, /A, B, /B	Z, /Z	RS422	internal bridged	internal bridged
HTL differential	A, /A, B, /B	Z, /Z	HTL differential	internal bridged	internal bridged

The Z or/Z track is not evaluated by the device.

Only the line breakage monitoring of the Z tracks is active.

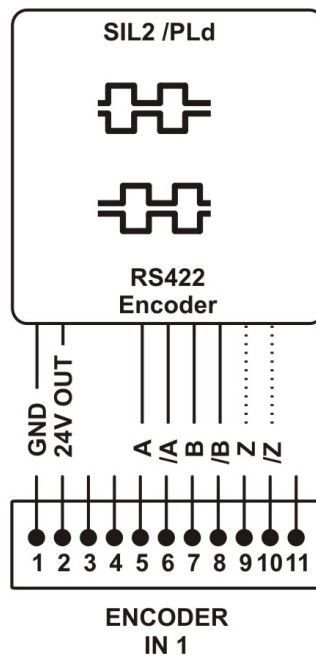


- **The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.**
- **At the SMC1.3, SIL2 / PLd can be reached.**

7.1 Combination: RS422 SIL2 / PLd Encoder

Device:	SMC1.3		
„Op-Mode 1“:	0		
Sensor 1:	[X21 ENCODER IN 1]:	SIL2 / PLd RS422 Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	0		
Sensor 2:	[X22 ENCODER IN 2]:	unbenutzt	(intern gebrückt)
Safety Level:	Speed	→ SIL2 / PLd achievable (see below)	
	Direction	→ SIL2 / PLd achievable (see below)	
	Standstill	→ SIL2 / PLd achievable (see below)	

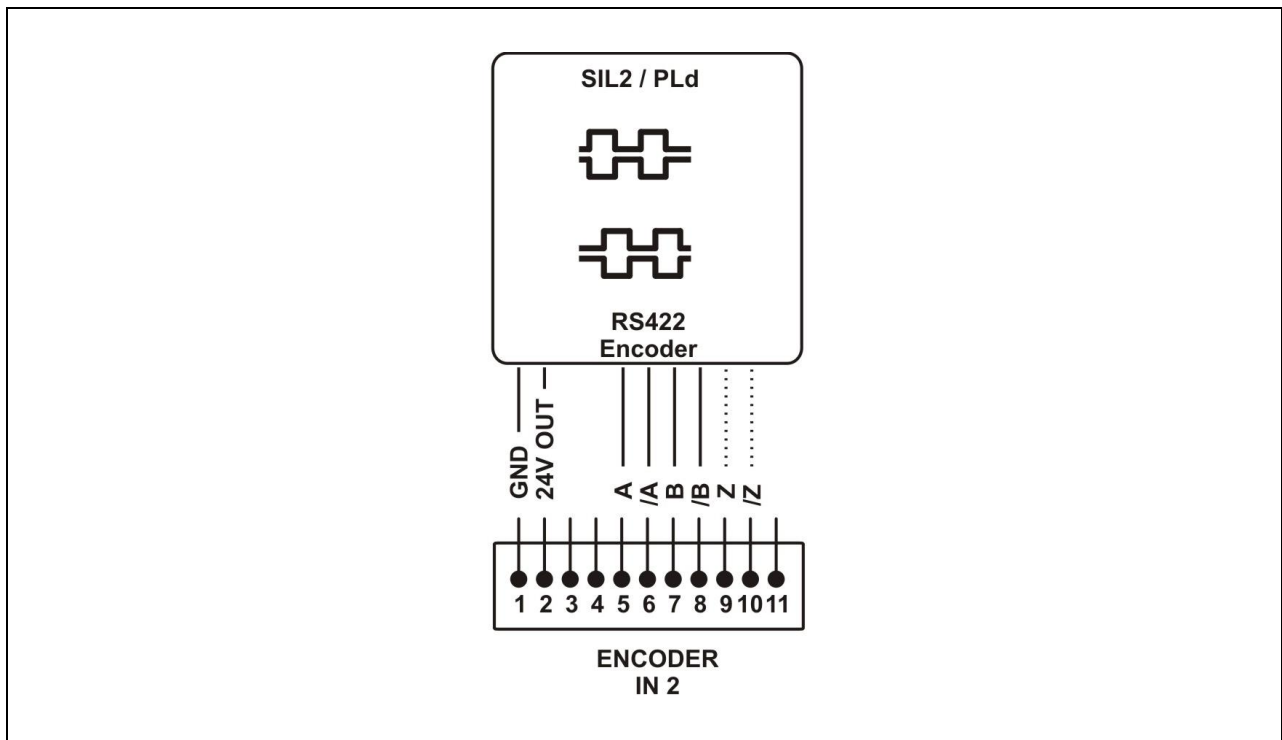
The encoder supply of the encoder can also be done over 5 V



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.
- At the SMC1.3, SIL2 / PLd can be reached.

7.2 Combination: HTL (differential) SIL2 / PLd Encoder

Device:	SMC1.3		
„Op-Mode 1“:	1		
Sensor 1:	[X21 ENCODER IN 1]:	SIL2 / PLd HTL Encoder	A, /A, B, /B, (Z,/Z)
„Op-Mode 2“:	1		
Sensor 2:	[X22 ENCODER IN 2]:	unbenutzt	(intern gebrückt)
Safety Level:	Speed	→ SIL2 / PLd achievable (see below)	
	Direction	→ SIL2 / PLd achievable (see below)	
	Standstill	→ SIL2 / PLd achievable (see below)	



- The final Safety Integrity Level (SIL) and Performance Level (PL) depends on the selected configuration and on external components connected to the unit.
- At the SMC1.3, SIL2 / PLd can be reached.

8 Commissioning

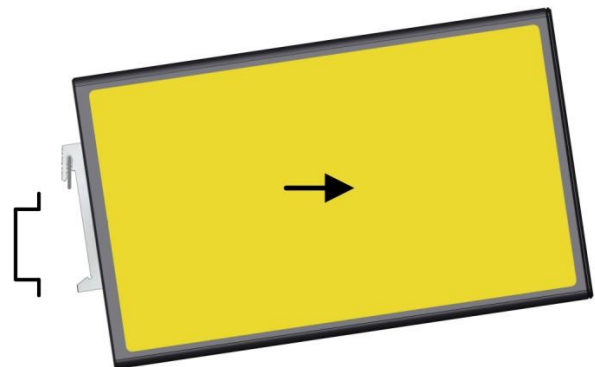
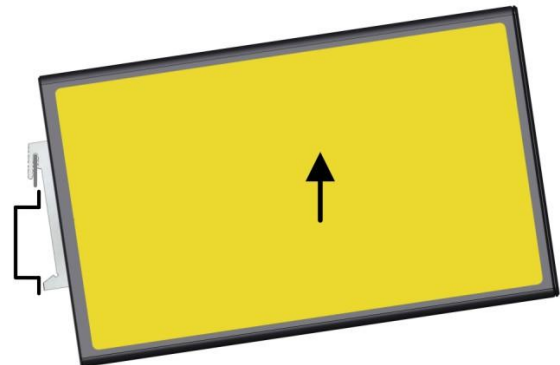
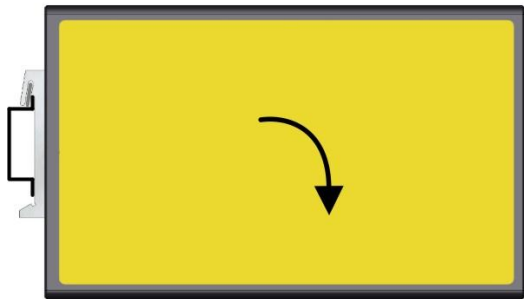
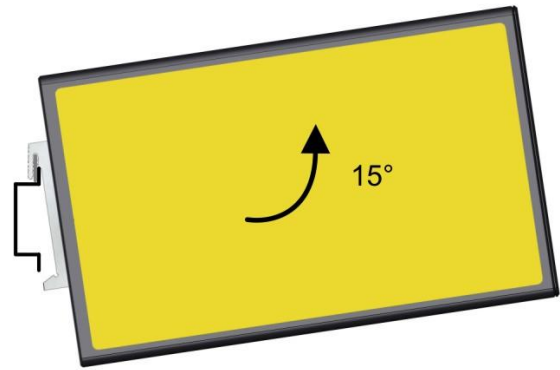
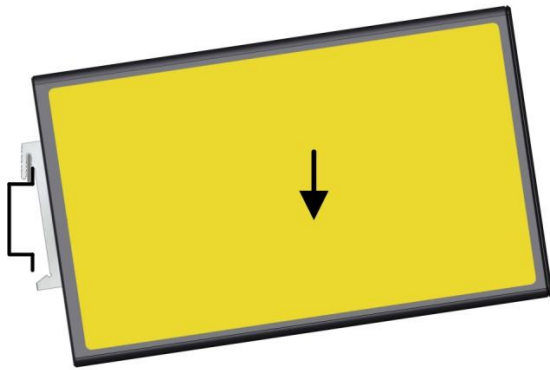
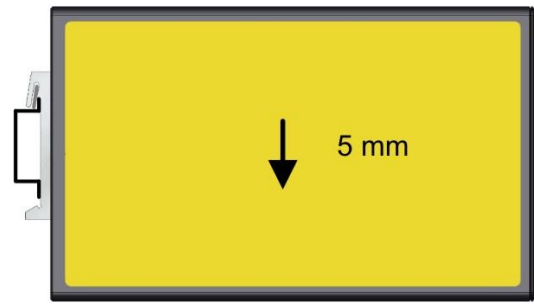
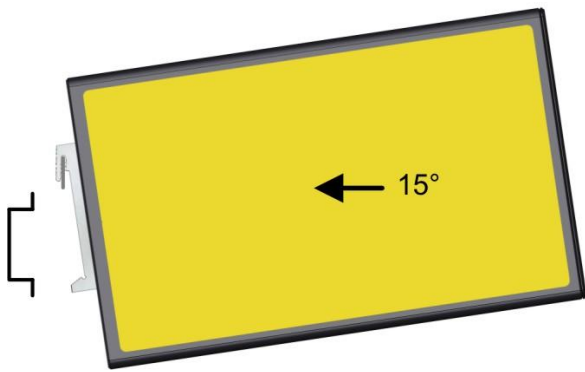
8.1 Cabinet installation

1. The unit must be in a mechanically and technically perfect condition.
2. The unit must be snapped onto a 35 mm DIN rail (according to EN 60715) by using the clip at the rear.
3. It must be ensured that the permissible environmental conditions of the specification are met accordingly.
4. All wirings must be executed in accordance with the general provisions for wiring (see <https://www.kuebler.com/emc>).
5. To choose and to connect the power supply unit, please refer to the chapter “Power Supply”.
6. To choose and to connect the encoders, please refer to the chapter “Encoder Supply” and “Encoder Inputs”.
7. When control inputs, digital inputs or external relays are used, please note that the configuration will take part in the final Safety Integrity Level (SIL).
8. Analog output, digital outputs as well as the splitter output are only safe, if the follower unit is capable to detect and evaluate the error states of the monitor.
9. The relay contacts at terminal [X1] and [X2] must be integrated into the safety circuit.



- **In order to prevent simultaneous damages to the cables by external influences, the encoder lines or sensor lines must be kept physically separate from one another.**
 - **Installation, commissioning, and maintenance must only be performed by qualified personnel.**
 - **In order to prevent manipulations, the machine as well as the equipment must be protected from unauthorized access.**
 - **The machine must be securely mounted and be ready to operate.**
 - **The safety function of the unit cannot be guaranteed before the commissioning resp. parametrization procedure has been fully completed.**
 - **Before commissioning and parametrization, the risk situation of the system must be analyzed, and all precautions must be taken accordingly.**
- These are fundamental measures to protect persons and machinery.**

8.2 Mounting / Dismounting



8.3 Preparations for Setup and Testing

In order to put the SMCX monitor into operation or to change settings and Parameters, the following measures must be taken:

- Connect the unit to a power supply source
- Set the DIL switch sliders 1, 2 ON and 3 to OFF (Programming and Testing Mode)
- Install the OSxx operating software properly on a PC and start the program
- Connect the unit to the OSxx operator surface via the USB port

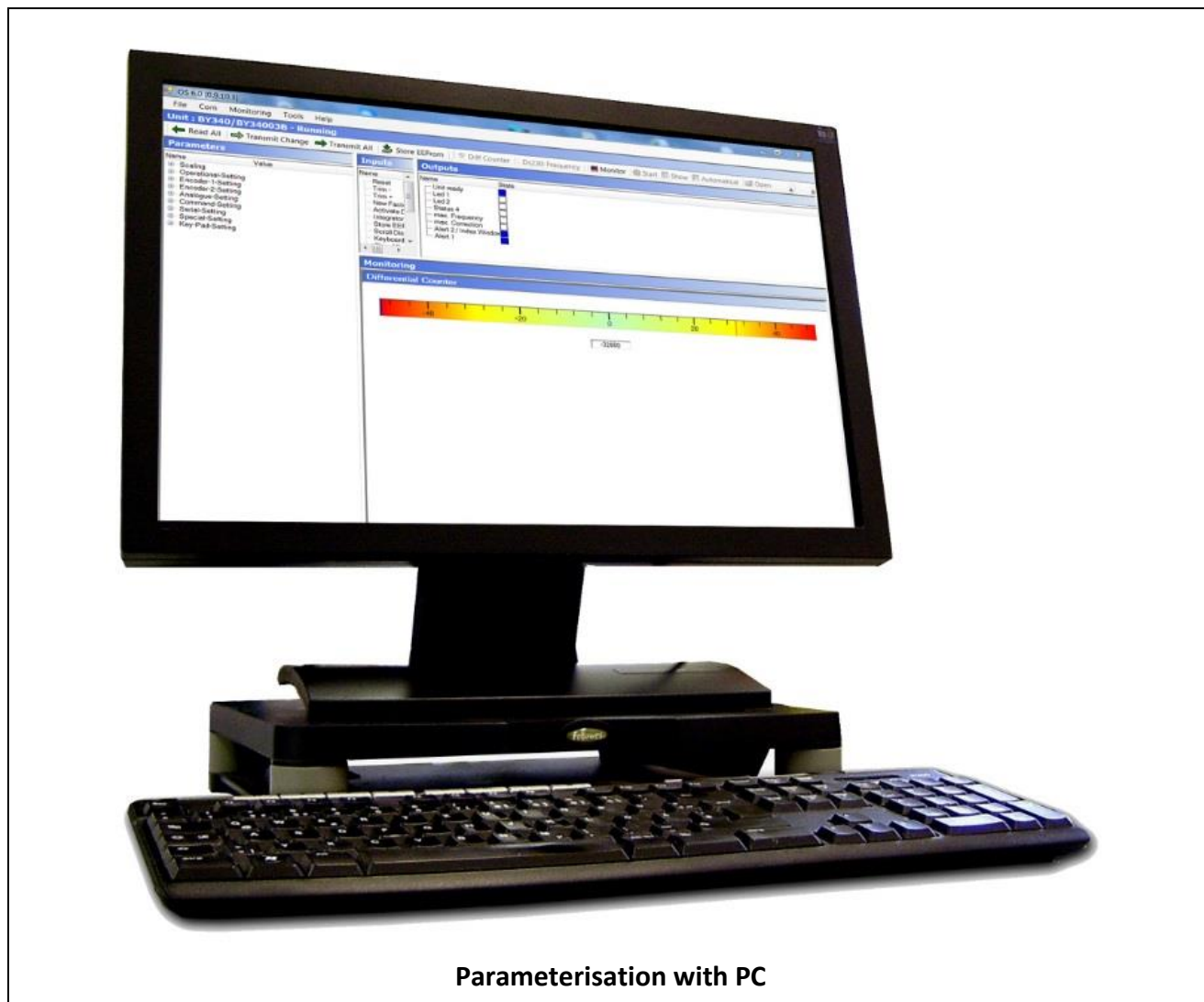
The parameterization and testing can be performed with the help of the OSxx. Parameters can be changed on-the-fly and their behaviour can be verified immediately after changing. The Programming and Test-Mode contains the complete functionality of the Normal or Safety Mode, so that all tests in the Programming and Test-Mode are also valid in the Safety Mode.

The parameters “Set Frequency X”, “Action Output”, “Action Polarity” and the related commands “Set Frequency” and “Freeze Frequency” are an exception, they are intended only for the Test Mode.

During the test the switching of the DIL-switch is not necessary to activate the parameter changes.

8.4 Parameter Setting by PC

For parameterization of the safety monitor by PC, the operator software OSxx is used. This software is included in delivery on CD and is also available for download from <https://www.kuebler.com/software>. After successful installation of the operator software and the USB driver (see page 2) the PC can be connected to the safety monitor via USB cable.



All functions of the operator software OSxx are described in a separate manual (see page 2).

8.5 Visualization by the SMCB.1 Operator Unit

Visualization as well as configuration of the safety device also can be done with use of the Display- and Programming Module Type SMCB.1. This optional operator unit is primarily used for visualization and diagnosis without PC, it can't be used for parameter setting. The module can be simply plugging onto the front of the SMCX unit.



All functions of the SMCB.1 display module are described in a separate manual.

9 Setup

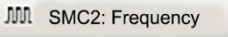
In order to ensure proper functionality, the parameters must be set appropriate values. This section describes the most important parameters, which have to be set or checked in either case.

9.1 Operational Mode Settings

The Parameters "Op-Mode 1" and Op-Mode 2 "are determined by the used encoder. Notes on the encoder connection and the resulting "OP Modes" for Sensor 1 and sensor 2 can be read in the chapter Operating Modes SMC2.4 or SMC1.3.

No.	Parameter	Remark
017	„Op-Mode 1“	See chapter “Operating modes SMC2.4” or “Operating modes SMC1.3”.
029	„Op-Mode 2“	See chapter “Operating modes SMC2.4” or “Operating modes SMC1.3”. At SMC1.3 "Op-Mode 2" must be set equal to "Op-Mode 1"!

9.2 Direction Settings

In order to define the directions, the machine must move resp. turn in its working direction. As a first step,  must be selected from the button bar of the operator screen.

The corresponding frequencies of Sensor 1 and Sensor 2 will then be indicated in the Monitor field. In case of negative frequency values, the direction must be changed by using the associated “Direction” register in the parameter field of the corresponding sensor menu.

No.	Parameter	Remark
019	„Direction 1“	Select direction of rotation
031	„Direction 2“	Select direction of rotation At SMC1.3 " Direction 2" must be set equal to " Direction 1"!

Parameters	
Name	Value
[-] Main Menu	
[-] Sensor 1 Menu	
Op-Mode 1	0
Edge 1	0
Direction 1	1
Multiplier 1	1
Divisor 1	1
Position Drift 1	0
Sense Value 1	0,00
Sense Tol.1	0,00
Phase Error 1	10
Set Frequency 1	0,00
Error Mask 1	7
Dir.Changes 1	0
[-] Sensor 2 Menu	
Op-Mode 2	0
Edge 2	0
Direction 2	1
Multiplier 2	1
Divisor 2	1
Position Drift 2	0
Sense Value 2	0,00
Sense Tol.2	0,00
Phase Error 2	10
Set Frequency 2	0,00
Error Mask 2	7
Dir.Changes 2	0

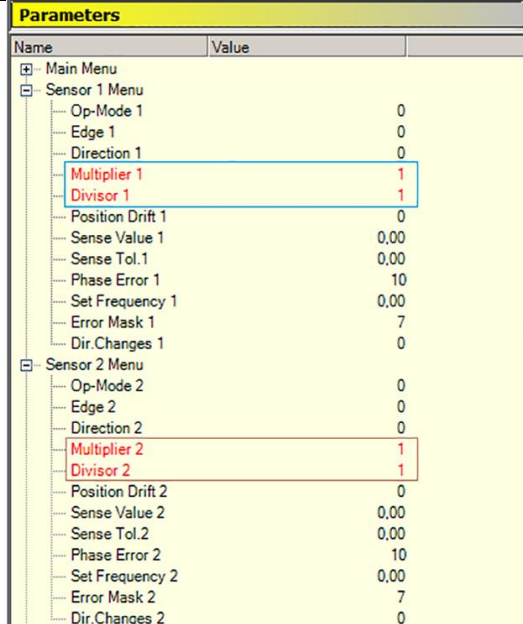
Inputs			
Name	Serial	Extern	Bus
.../IN 4		<input type="checkbox"/>	
.../IN 4		<input type="checkbox"/>	
.../IN 3		<input type="checkbox"/>	
.../IN 3		<input type="checkbox"/>	
.../IN 2		<input type="checkbox"/>	
.../IN 2		<input type="checkbox"/>	
.../IN 1		<input type="checkbox"/>	
.../IN 1		<input type="checkbox"/>	

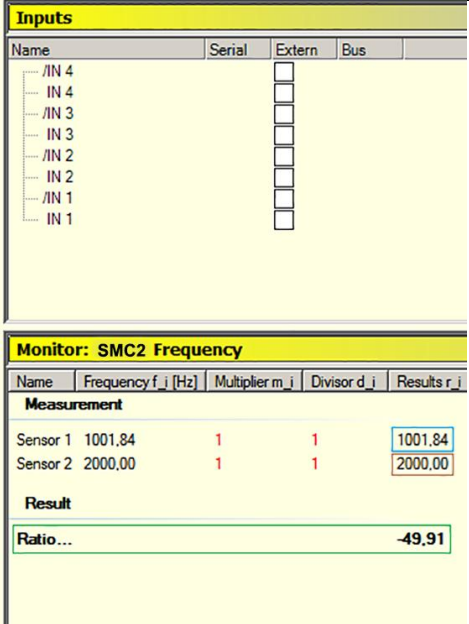
Monitor: SMC2 Frequency				
Name	Frequency f _i [Hz]	Multiplier m _i	Divisor d _i	Results r _i
Measurement				
Sensor 1	1002,88	1	1	1002,88
Sensor 2	2000,00	1	1	2000,00
Result				
Ratio...				-49,86

9.3 Frequency Ratio Settings

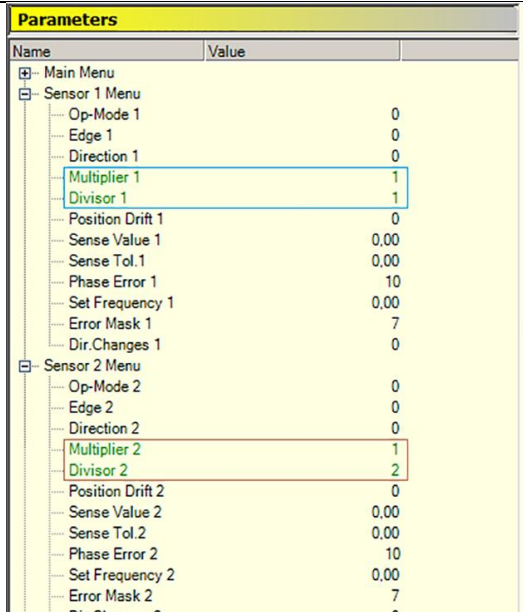
When using two sensors with different number of impulses, or in case of mechanical gear transmission ratio between both encoders, the higher one of the two frequencies must be adjusted to the lower one by corresponding setting of the scaling factors. Accurately calculated values are better than experimental results.

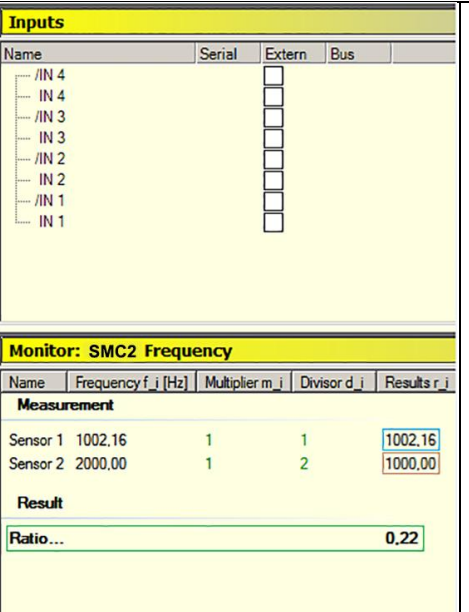
No.	Parameter	Remark
020	„Multiplier 1“	Proportional factor for sensor 1 For SMC1.3, this parameter must be set to value 1!
021	„Divisor 1“	Reciprocal factor for Sensor 1 For SMC1.3, this parameter must be set to value 1!
032	„Multiplier 2“	Proportional factor for sensor 2 For SMC1.3, this parameter must be set to the value 1!
033	„Divisor 2“	Reciprocal factor for Sensor 2 For SMC1.3, this parameter must be set to value 1!





In this example, the frequency 2 is greater than frequency 1 by a factor of 2. For adjustment, parameter "Divisor 2" can be set to 2.



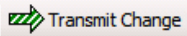
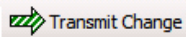


By this scaling procedure of frequency 2, internally both calculated frequencies are approximately equal and the calculated frequency ratio is close to 0.

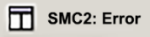
9.4 Clear Errors

After parameters „Op-Mode 1“ and „Op-Mode 1“ have been set correctly, the machine will move in working direction, with positive frequency indication of both, Sensor 1 and Sensor 2. Due to the frequency ratio setting, both frequencies are equal now since the higher frequency has been scaled down to the lower frequency. With the parameter “Error Simulation” the runtime test and initialization test can be set in the state field to green (green = no error, red = error). The following sequence must be followed.

At this time, the indication boxes “Runtime Test” and “Initialization Test” in the **State** field can be set to green (green = no error, red = error). For this purpose, the following sequence of operations must be observed:

- Set “Error Stimulation” to 2 and press 
- Set “Error Stimulation” back to 1 and press again 

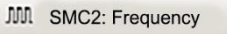
Now, all State boxes, except the DIL switch States (S1.X) should light green.

If a runtime error is triggered again, please press  of the button bar to find out more details about this error.

More information about errors see chapters “Runtime Test” and “Initialization Test”.

Error	Remark
Digital Input Error	If a Digital Input Error appears again after deleting without changing the input signal, check the setting of parameter “Input-Mode” and the signal status (High/Low) at the input. If a Digital Input Error appears, when changing the input signal, check the setting of parameter „GPI Err Time“.
Sense Error	A Sense Error appears when the monitored voltage at the PWR sense input differs from the programmed values. If the fault persists, the actual current voltage should be measured directly at the input and the programmed tolerance range may be increased.
Encoder Line Error	An Encoder Line Error appears when an error is detected in differential HTL or RS422 input signals, but the parameters Error Mask 1 and 2 must be set to match. If the error persists, the signals should be checked for switching, short-circuiting or demolition.
Frequency Error	If a Frequency Error appears at normal rotation speed, check the rotation direction and the ratio of the two encoders (see chapter “Direction Settings” and “Frequency Ratio Setting”). If the Frequency Error still appears, the rotations speeds are too different for a temporary or longer period of time. In case of temporary deviations, change the parameter settings of “Sampling Time” and “Filter” for smoothing the frequency or set the parameter “Div.Filter” to a higher value. In case of continual deviations, the permissible deviation can be increased by the parameter “Div %-Value”. In case of deviations in the low-frequency range, adjust the parameters „Div. f-Value“ and „Div. Switch“%-f“.
Position Error	If a Position error appears at normal rotation speed, check the rotation direction and the ratio of the encoders (see chapter Direction Settings and Frequency Ratio Setting). If the Position Error still appears, the encoder positions diverge. In this case, check the maximum permissible deviation of the encoder positions and adjust the parameter „Div. Inc-Value“. Do not use the Position comparison, when the encoders slip or no comparison is possible.

9.5 Sampling Time and Filter

All **State** boxes (except DIL switch States S1.X) light green at this time. Now please select  in the button bar. We must determine the operating range of the unit, comprising the frequency range from the lowest switching point to the highest switching point:

1. Find out, which of the sensor frequencies shows the highest instability and fluctuation.
2. Move through the frequency range and find out the point of maximum fluctuating. In general, this will be around the lowest switching point (underspeed or frequency band).
3. The frequency can be smoothed by use of parameter “Sampling Time” and parameter “Filter”. Higher settings result in smoother running but increase the response time and the fault detection time.
4. A combination of Sampling Time and Filter achieve the best result for smoothing the complete frequency range of input frequencies. Frequencies out of the Sampling Time, regarding to lower frequency range, are smoothed by the parameter Filter.
5. Only exceptionally you should set the Sampling Time to smoothen frequencies below the lower switch point setting (under speed or frequency band).
6. The Sampling Time and the Filter setting may also affect the signal variation on the analog output.
7. The settings can be verified at the **“Monitor SMC2.4 Frequency”**.

No.	Parameter	Remark
000	“Sampling Time”	Control of frequency fluctuation
013	„Filter“	Control of frequency fluctuation

9.6 Wait Time

The Wait Time parameter defines the frequency below which all frequencies will be taken as zero. Setting of e.g. 1.0 second will result in zeroizing all frequencies lower than 1 Hz. In this context it must be clarified whether the application requires a standstill- or drift-monitoring or not.

1. Where the application does not require any standstill or direction or drift control, you are free to set Standstill Time with regard of the expected minimum frequency and the required response time only.
2. Where the application uses standstill control, please observe also possible jitter during standstill and adjust Wait Time correspondingly.
3. Where the application uses forward/reverse direction control, also possible jitter should be considered while the system holds in closed loop position control.

No.	Parameter	Remark
001	“Wait Time”	Adjust the zero balancing window

9.7 F1-F2 Selection

This parameter is used to determine the base frequency. When the original frequency of sensor 1 is higher than the original frequency of sensor 2, the parameter F1-F2-Selection is set to 0, otherwise to 1. The higher frequency is used to set the switching points, because it is more stable.

No.	Parameter	Remark
002	„F1-F2 Selection“	When Frequenz 1 > Frequenz 2, parameter is set = 0 (F1 selected). When Frequenz 2 < Frequenz 1, parameter is set = 1 (F2 selected).

9.8 Divergence Parameters

The parameter “Div.Mode” defines the type of comparison: Frequency Comparison or Position Comparison. The setting of this parameter affects only the error detection. If the frequency ratio cannot be adjusted accurately, do not use the Position Comparison caused by cumulative position increments. If the encoders slip, Frequency Comparison has to be preferred.

At SMC1.3 the position comparison can generally be used, since only one encoder is connected here.

No.	Parameter	Remarks
003	„Div. Mode“	Type of comparison of encoder inputs
004	„Div. Switch %-f“	Frequency threshold
005	„Div. %-Value“	Percentage of frequency deviation above the Div.Switch %.
006	„Div. f-Value“	Absolute frequency deviation (Hz) below the Div. Switch %-f threshold
007	„Div. Calculation“	0
008	„Div. Filter“	Filter (OFF = 0, MEDIUM = 5, HIGH = 10)
009	Div. Filter Time	Max. filter time for “Div. Filter”
010	„Div. Inc-Value“	Max. incremental deviation



Divergence parameters are relevant even for the SMC1.3 devices, since also with only one SIL2 encoder frequency or position is splitted into two channels, where asynchronism during changes of the frequency may cause frequency divergence. Using SMC1.3 position deviation has to be preferred.

9.8.1 Frequency comparison:

These parameters defines the maximum permissible frequency deviation between sensor 1 and sensor 2, based on percentaged values of Div Calculation. Parameter Div. Switch %-f defines the frequency threshold below which deviations are taken as absolute values, and above which deviations are taken as percentage. When the absolute difference of frequencies exceeds the setting of Div. f-Value below the threshold setting, a frequency error will be triggered. When the percentaged difference exceeds the setting of Div. %-Value above the threshold setting, also a frequency error will be triggered. Parameter Div. Filter provides an option for suppression of short-duration errors.

1. The facility of setting a frequency threshold provides suppression of possible frequency errors caused by jerking in the startup phase.
2. The threshold setting must be below the lower switchpoint setting (underspeed or frequency band).
3. It is an individual issue of the actual application to fix the deviation values under normal operating speed and under startup conditions that should trigger a frequency error signal.
4. Where no standstill nor drift nor direction control is needed, the frequency threshold can also serve as trigger threshold for error activation, by increasing the setting of Div. f-Value correspondingly (see 3.)
5. Where the application uses standstill control, possible jitter during closed-loop standstill should be observed to adjust Div. f-Value correspondingly.
6. Where forward/reverse direction control is used, please also observe possible jitter during standstill for best setting of Div. f-Value.

9.8.2 Sensor Position Comparison:

This parameter defines the maximum permissible position deviations between sensor 1 and sensor 2. Parameter DIV. Inc Value defines the position threshold. If deviation exceeds this threshold a frequency error will be triggered. This position threshold is implemented independent of the direction of rotation. If parameter DIV.Inc Value is set to zero, no error message will be applied.

9.9 Power-up Delay

After initialization, Power-up Delay defines a retardation time before the unit takes the normal control state.

1. During this delay time, the unit will not take care of any errors
2. The delay is important to allow the encoder signals to stabilize after power up.
3. In case of indirect encoder connection, the retardation must also include the switching time of the relays.
4. In case of different power-up times of the parts and components, adaption can be achieved by the retardation time settings.

No.	Parameter	Remarks
012	Power-up Delay	Delay time after power on

9.10 Encoder Splitter Output

The signal (A, /A, B, /B, Z, /Z) from sensor 1 or sensor 2 is emitted, regardless of the input configuration. With the parameter "Split. Level", the output voltage (5V or 24V) can be set. The parameter "Split. Selector" determines whether the signal from sensor 1 or sensor 2 is emitted. Signal and inverted signal are always available, even if the inverted signal is not connected at the input.

No.	Parameter	Remark
214	„Split. Level“	Setting the output voltage
215	„Split. Selector“	Sensor 1 is output = 0, sensor 2 is output = 1



- If the parameter "Split. Level " is set incorrectly, the following device connected to the encoder output can be damaged.

9.11 Analog Output

In case of an unused analog output the output terminals must be bridged. The parameters

“Analog Start” and “Analog End” are related to the frequency which is selected by the “F1-F2 Selection” register. The “Analog Gain” setting should be changed only in exceptional cases (e.g. for limitation of the upper current value). The “Analog Offset” parameter serves for fine adjustment.

1. Fluctuation of the analog output signal can be reduced by corresponding setting of Sampling Time and Filter.
2. With very small span (between “Analog Start” and “Analog End”) the analog output signal can become stepped due to the low frequency resolution.
3. “Analog Start” and “Analog End2 operate under control of F1-F2 Selection.

Nr.	Parameter	Remark
216	„Analog Start“	Input frequency to produce output of 4 mA
217	„Analog End“	Input frequency to produce output of 20 mA
218	„Analog Gain“	(change only in exceptional cases)
219	„Analog Offset“	Zero Point fine adjustment

9.12 Control Output Settings

The configuration of the control outputs will affect the Safety Integrity Level (SIL).

1. Switching points are affected by the F1-F2 Selection setting
2. Output fluttering caused by unstable frequencies must be eliminated by corresponding setting of a hysteresis.
3. No hysteresis setting is required with self-sustaining outputs.

No.	Parameter	Remark
041 – 060	Presel.OUT1.XX	Setting the switching points for OUT 1
061 – 080	Presel.OUT2.XX	Setting the switching points for OUT 2
081 – 100	Presel.OUT3.XX	Setting the switching points for OUT 3
101 - 120	Presel.OUT4.XX	Setting the switching points for OUT 4
141 - 185	Switching Menu	Definition der Schaltbedingungen für die Ausgänge

9.13 Relay Output Settings

The relay contacts must be embedded into the safety circuit.

1. Switching points are affected by the F1-F2 Selection setting
2. Output fluttering caused by unstable frequencies must be eliminated by corresponding setting of a hysteresis.
3. No hysteresis setting is required with self-sustaining outputs.
4. It is mandatory to assign the most important and essential of all safety functions to the relay output.

No.	Parameter	Remark
121- 140	Presel REL1.XX	Setting of the tripping points
141 - 185	Switching Menu	Definition of switching conditions for the relay

9.14 Control Input Settings

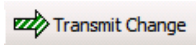
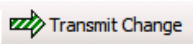
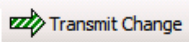
The configuration of the control inputs will affect the Safety Integrity Level (SIL).

1. With 2-pole control inputs please observe possible difference with regard of the transition times.
Parameter "GPI Err Time" defines the permissible delay time during illegal conditions.
2. With 1-pole clocked inputs the static triggering characteristics (low/high) should be adapted to the dedicated command according to safety requirements.

No.	Parameter	Remark
186 - 207	Control Menu	Configuration if the inputs

9.15 Producing an Error

After setting of all relevant parameters an error can be produced for testing purpose. This conduces to force all outputs of the device into the error state and to check function and behavior of the follower units.

- Set the device in error state:
Set parameter „Error Stimulation“ to 0 and activate 
- Delete/Reset Error state:
Set parameter „Error Stimulation“ to 2 and activate 
- Set the unit back to normal operation:
Set parameter „Error Stimulation“ to 1 again and activate 

While in Error State, the safety monitor acts as follows:

- The analog output signal is set to 0 mA
- The relay contact is open (both contacts)
- The control outputs are in LOW state
- The traces of the encoder splitter output are in LOW state.

It is important to check for proper detection of these error indications on site of the target units connected to the monitor.

10 Completion of the Setup Procedure

Finally, all application-specific parameters should once more be reviewed for correctness and plausibility. The safety-relevant relay output falls back to its open state when an error occurs or when the programmed switching condition occurs. Of course the contact is also open in powerless state of the unit. It is mandatory to check the safety behavior of the monitor and all connected follower units carefully.

The following items must be verified:



- **Plausibility of the encoder frequencies**
- **Sense of rotation and proper scaling of the encoder frequencies**
- **Plausibility of the frequencies themselves**
- **Correct settings of all necessary parameters**
- **Plausibility of the parameter settings**
- **Frequency and level of encoder splitter output**
- **Detecting the failure at the encoder splitter output**
- **Control of the analogue output in relation to the frequency range**
- **Detecting the failure at the analogue output**
- **Control of the digital outputs**
- **Detecting the failure at the digital outputs**
- **Control of the double relay output**
- **Detecting the failure at the double relay output**
- **Switching points with regard to correct comporment**
- **Response times and related parameter settings**
- **Control inputs regarding proper function and comporment**

It is on the responsibility of the operator to ensure that all relevant parts of the whole installation pass over to a safe state as soon as the relay contact of the safety monitor opens.


After commissioning (parameterization and testing), the Programming Mode of the unit must be left by setting slider 3 of the DIL switch back to its ON position. Please observe that for normal operation of the monitor always all 3 sliders of the DIL switch must be set to ON.



- **Programming Mode (DIL switch setting) must only be used for Start-up (parameterization and testing)**
- **Set all DIL switch positions to ON after Start-up**
- **Protect the DIL switch against later manipulation after conclusion of the Start-up procedure (e. g. by covering with the supplied adhesive tape)**
- **Normal operation is only permitted while the yellow LED is permanently OFF**

11 Error Detection

In order to ensure a maximum of operational safety and reliability, the Safety Monitors are equipped with several and profound monitoring-functions. This monitoring allows immediate recognition and messaging of possible failures and malfunctions.

	<p>In case of errors:</p> <ul style="list-style-type: none"> • The relay contact switches to its open (safety) condition (interruption of the safety circuit) • The analog output sets to 0 mA (which is out of the regular operating range of 4 ... 20 mA) • All control outputs are set to LOW. No more inversion between OUTx and /OUTx (Attention in case of homogenous configuration!) • Encoder splitter output does not provide any incremental signals (tri-state with pull-down termination)
---	--

The following types of error recognition are distinguished:

- Initialization Test Error
- Runtime Test Error

Both error types are described in detail on the following pages.

11.1 Error Representation

Error Representation	Reference																				
Front LED's	Yellow LED lights continuously																				
SMCB.1 Operator Unit	The bottom line displays the error when the SMCB.1 is not in the programming mode																				
Operator surface OSxx	<p>Initialization Test = red (State field) Runtime Test = red (State field)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #ffff00;"> <th colspan="2">States</th> </tr> <tr style="background-color: #d3d3d3;"> <th>Name</th> <th>State</th> </tr> </thead> <tbody> <tr> <td>Initialization Test</td> <td style="text-align: center;">■</td> </tr> <tr> <td>Runtime Test</td> <td style="text-align: center;">■</td> </tr> <tr> <td>Overtemperature Test</td> <td style="text-align: center;">■</td> </tr> <tr> <td>Short Circuit Test</td> <td style="text-align: center;">■</td> </tr> <tr> <td>External Watchdog</td> <td style="text-align: center;">■</td> </tr> <tr> <td>S1.1</td> <td style="text-align: center;">□</td> </tr> <tr> <td>S1.2</td> <td style="text-align: center;">□</td> </tr> <tr> <td>S1.3</td> <td style="text-align: center;">□</td> </tr> </tbody> </table>	States		Name	State	Initialization Test	■	Runtime Test	■	Overtemperature Test	■	Short Circuit Test	■	External Watchdog	■	S1.1	□	S1.2	□	S1.3	□
States																					
Name	State																				
Initialization Test	■																				
Runtime Test	■																				
Overtemperature Test	■																				
Short Circuit Test	■																				
External Watchdog	■																				
S1.1	□																				
S1.2	□																				
S1.3	□																				

11.2 Initialization Test

These self-monitoring tests are processed automatically when switching the unit on.

Error code SMCB.1	Error OSxx operator software	Instruction
H' 0000 0001	ADC Error	Internal error
H' 0000 0002	I2C Error	Internal error
H' 0000 0004	OTH Error	Check the SMCB.1 power supply or the encoder supply or internal error
H' 0000 0008	SCI Error	Internal error
H' 0000 0010	DIO Error	Check the digital outputs for short circuit resp. other errors or internal error
H' 0000 0020	GPI Error	Check the connections of the digital inputs and the input configuration or internal error
H' 0000 0040	CAP Error	Internal error
H' 0000 0080	SPI Error	Check the connections of the analog output or internal error
H' 0000 0100	QEP Error	Check the separation or disconnection of the encoder supply at Self-Test or internal error
H' 0000 0200	SCO Error	Check splitter output or internal error
H' 0000 0400	CPU Error	Internal error
H' 0000 0800	RAM Error	Internal error
H' 0000 1000	WDO Error	Internal error
H' 0000 2000	EDM Error	Error in EDM Selftest, ceck connected contactor or relay
H' 0000 4000	FLA Error	Internal error
H' 0000 8000	PRG Error	Adjust and save the parameter set or internal error
H' 0001 0000	POE Error	Saved error active, error must be erased before the device is re-connected.*



For all error messages, the following applies:

Switch the unit OFF and ON again.

If the error message continues, please contact the manufacturer of the unit.



If a POE error is triggered during the initialization phase, the activated Power-up error will also trigger a run time error, regardless the cause is still there. The deletion sequence can be found in the parameter description under the parameter "Power-up error".

11.3 Runtime Test

These internal monitoring procedures run automatically and continuously in the background:

Error code SMCB.1	Error Message on PC (Operator Software OSxx)	Instruction
H' 0000 0001	Sense Error 1	Incorrect voltage value at PWR sense input X21 [4] or internal error
H' 0000 0002	Sense Error 2	Incorrect voltage value at PWR sense input X22 [4] or internal error
H' 0000 0004	Encoder Supply Error	Short circuit resp. faulty circuit for encoder supply or SMCB.1 supply or internal error
H' 0000 0008	Position Error	Position error detected Parameter "Div. Mode" = 1, 2
H' 0000 0010	Encoder Line Error 1	Error in encoder tracks at X21 or internal error
H' 0000 0020	Encoder Line Error 2	Error in encoder tracks at X22 or internal error
H' 0000 0040	EDM Error	Error when controlling or rereading the external relay or internal error
H' 0000 0080	Sensor Overlap Error	Error in sensor cover
H' 0000 0100	Temperature Error	Impermissible high temperature
H' 0000 0200	Digital Output Error	Short circuit resp. faulty circuit at the control outputs or internal error
H' 0000 0400	Analog Error	Open analog output {
H' 0000 0800	Relais Output Error	Relay control error, contact readback error
H' 0000 1000	Direction Error	Too many change of direction, possibly a encoder track torn off
H' 0000 2000	Digital Input Error	Illegal transition state at the inputs
H' 0000 4000	Signal Error 1	n.a.
H' 0000 8000	Signal Error 2	n.a.
H' 0001 0000	Phase Error 1	Illegal signal change at Encoder 1
H' 0002 0000	Phase Error 2	Illegal signal change at Encoder 2
H' 0004 0000	Frequency Error	Frequency error $F1 \neq F2$ Parameter Div. Mode = 0, 2
H' 0008 0000	Drift Error 1	Drift error at Encoder 1
H' 0010 0000	Drift Error 2	Drift error at Encoder 2
H' 0020 0000	Internal Error (ESM)	Internal error
H' 0040 0000	Undervoltage Error	Under Voltage detected
H' 0080 0000	Wrong Parameter Error Simulation	Parameter "Error simulation" $\neq 1$ for DIL-switch setting "Normal operation"
H' 0100 0000	Internal Error (REG)	Internal Error
H' 0200 0000	Internal Error (CYC)	Internal Error
H' 0400 0000	Internal Error (CLK)	Internal error
H' 0800 0000	Wrong Parameter Setting	Frequency too high for parameter setting "Sampling Time" (overflow) or ramp time set too high

Continuation „Runtime Test“:

Error code SMCB.1	Error Message on PC (Operator Software OSxx)	Instruction
H' 1000 0000	Internal Error (ADC)	Internal error
H' 2000 0000	Internal Error (I2C)	Internal error
H' 4000 0000	Initialization Test Error	An initialization test error has been detected (see chapter "Initialization Test")



**With all error messages, the following applies:
Switch the unit OFF and ON again. If the error message continues,
please contact the manufacturer of the unit.**



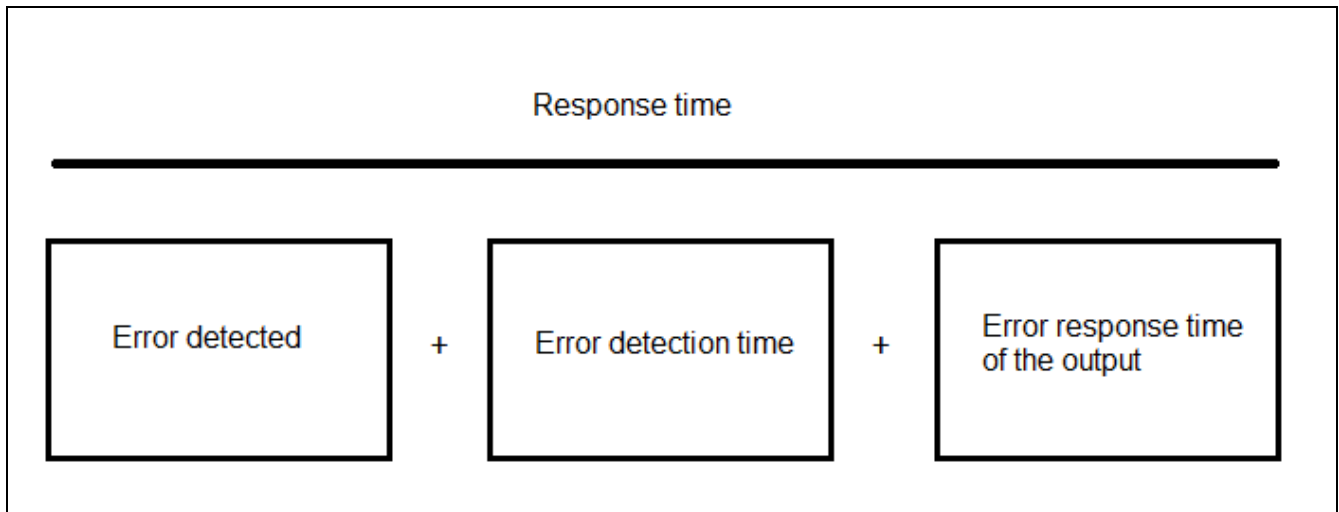
**If a Poe error is triggered during the initialization phase, the activated
Power-up error will also trigger a run time error, regardless the cause
is still there. The deletion sequence can be found in the parameter
description under the parameter "Power-up error".**

11.4 Error Clearing

Error states can generally be cleared by switching power off and on again (after the cause of the error has been removed). During commissioning only, errors can also be cleared as described under chapter "Setup / Clearing Errors". If a Poe error is triggered during the initialization phase, the activated run time error is also raised, regardless the cause is still there. The deletion sequence can be found in the parameter description under the parameter "Power-up Error"

11.5 Error Detection Time

Basically, it is not possible to specify an accurate error detection time, since times depend on many factors and error reasons. The time period until a frequency error is detected is another such as for example an analogue error. For simplification, it can be assumed that the errors are detected after 85 ms plus the tripping time. As an exception of this, detection of frequency errors could also take longer, since these times are related to the input frequency and to parameter settings. Typical respond times for various outputs and for frequency errors can be found in chapter “Response time”.



The error detection time depends (amongst others) on the following factors:

- Type of error
- Parameter settings
- External events and actions
- Internal events and actions
- Respond time of the output

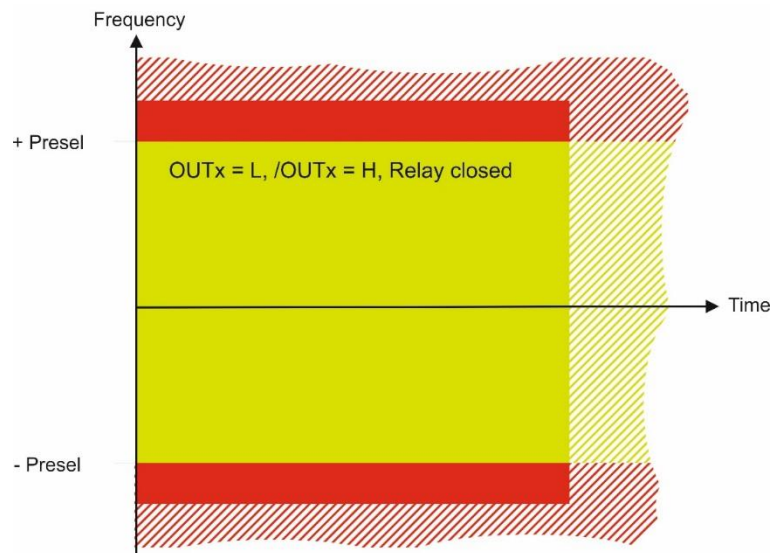
12 Monitoring Functions

The monitoring functions are used to set the properties of digital outputs and relay output.

12.1 Overspeed (Switch Mode = 0)

With parameter setting “Switch Mode” = 0, the frequency is monitored for overspeed. The function is always active and independent of the direction of rotation. The switching point for overspeed is always at Frequency = Presel (no matter if with or without hysteresis).

Relevant Parameters	Remark
Switch Mode XXXX	= 0
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	hysteresis
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

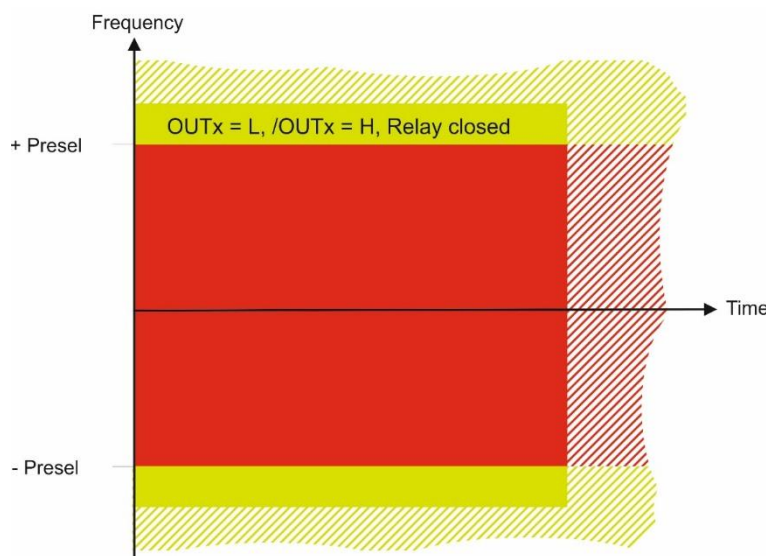
Example:

With Presel = 1000.0 Hz and Hysteresis = 10 %, frequencies $|f| \geq 1000$ Hz are detected as overspeed. The overspeed output will be cleared with frequencies $|f| < 900$ Hz.

12.2 Underspeed (Switch Mode = 1)

With parameter setting “Switch Mode” = 1, the frequency is monitored for underspeed. The function is always active and independent of the direction of rotation. The switching point for underspeed is always at Frequency = Presel (no matter if with or without hysteresis).

Relevant Parameters	Remark
Switch Mode XXXX	= 1
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	hysteresis
Startup Mode	type of start-up-delay
Startup Output	assignment of the outputs for start-up delay
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	When lock function is active only
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

Example:

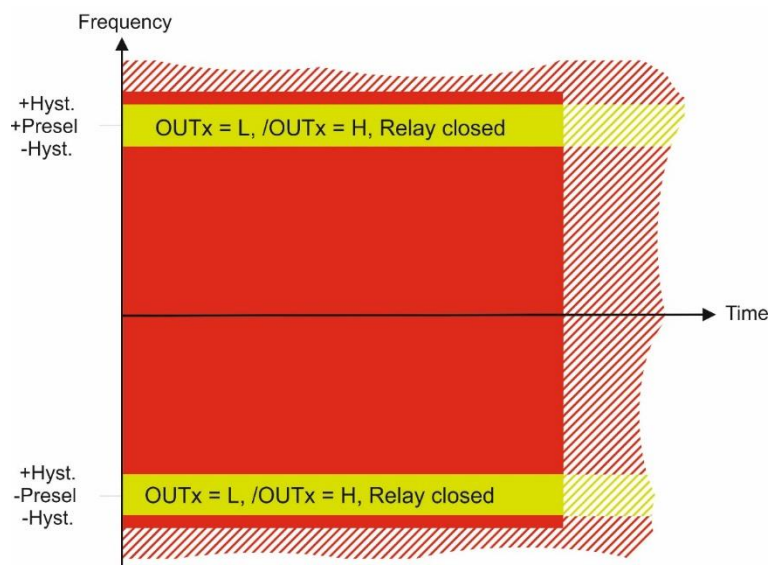
With Presel = 1000.0 Hz and Hysteresis = 10 %, frequencies $|f| < 1000$ Hz are detected as underspeed. The underspeed output will be cleared with frequencies $|f| > 1100$ Hz.

12.3 Frequency Band (Switch Mode = 2)

With parameter setting “Switch Mode” = 2, the frequency is monitored within a frequency band.

The function is always active and independent of the direction of rotation. The switching points of the band are located at Presel +/- Hysteresis.

Relevant Parameters	Remark
Switch Mode XXXX	= 2
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	+/- range (center)
Startup Mode	type of start-up delay
Startup Output	output assignment for start-up delay
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	center
Delay XXXX	shutter release delay
Input Mode X	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	Max. permissible delay time during illegal conditions



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

Example:

With Presel = 1000.0 Hz and Hysteresis = 10 %, frequencies $|f| < 900$ Hz are detected as underspeed and frequencies $|f| > 1100$ Hz as overspeed.

12.4 Standstill (Switch Mode = 3)

With parameter setting “Switch Mode” = 3, the frequency is monitored for standstill. The function is always active. The output is set after detection of frequency 0 Hz and expiration of the standstill time. When a frequency different from zero is detected, the output will be reset. Parameter “Wait Time” determines the threshold under which a frequency is taken as zero.

Relevant Parameters	Remark
Switch Mode XXXX	= 3
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Standstill Time	standstill time in x seconds
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)

Relevant input functions	Remark
none	none

Example:

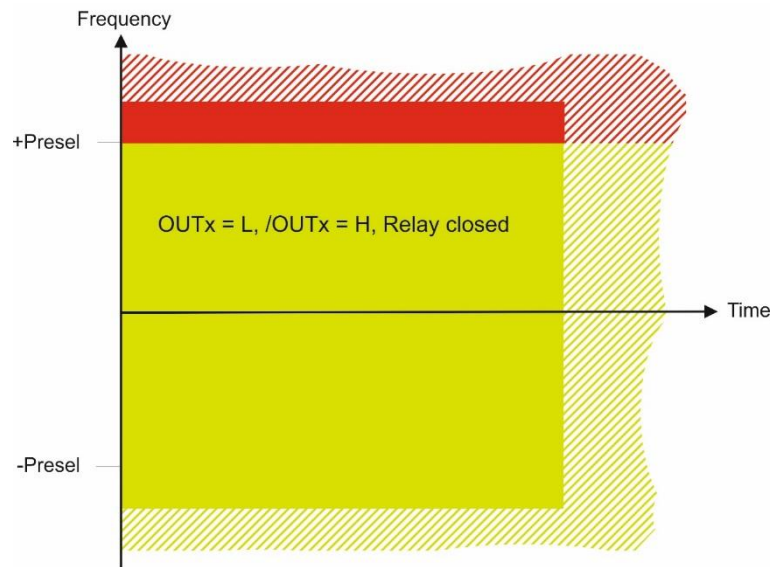
With a Wait Time setting of 0.01 seconds, all frequencies < 100 Hz will be taken as zero ($f = 0$).

The expiration of Standstill Time starts as soon both channels report 0 Hz. When this time has expired and both frequencies are still 0 Hz, the standstill output will be set. As soon one of the two frequencies becomes different from zero again, the standstill output will be reset.

12.5 Overspeed (Switch Mode = 4)

With parameter setting “Switch Mode” = 4, the frequency is monitored for overspeed. The function is always active and considers the direction of rotation. The switching point for overspeed is always at Frequency = Presel (no matter if with or without hysteresis). If hysteresis is used, only positive Presel. values are allowed.

Relevant Parameters	Remark
Switch Mode XXXX	= 4
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	hysteresis
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

Example:

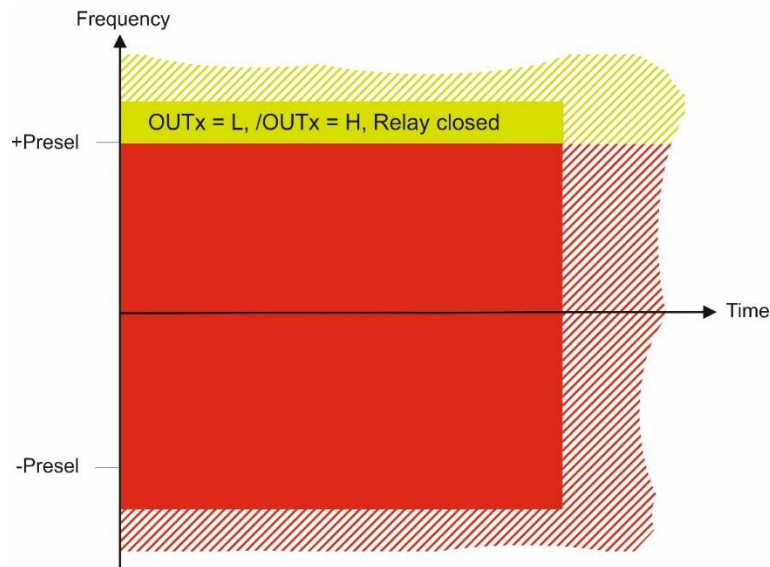
With Presel = 1000.0 Hz and Hysteresis = 10 %, Frequencies $f \geq 1000$ Hz are declared as overspeed.

The overspeed output will be cleared with frequencies $f < 900$ Hz.

12.6 Underspeed (Switch Mode = 5)

With parameter setting “Switch Mode” = 5, the frequency is monitored for underspeed. The function is always active and considers the direction of rotation. The switching point for underspeed is always at Frequency = Presel (no matter if with or without hysteresis). If hysteresis is used, only positive Presel. values are allowed.

Relevant Parameters	Remark
Switch Mode XXXX	= 5
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	hysteresis
Startup Mode	type of start-up delay
Startup Output	output assignment for start-up delay
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function“	function of the control input
IN Config“	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

Example:

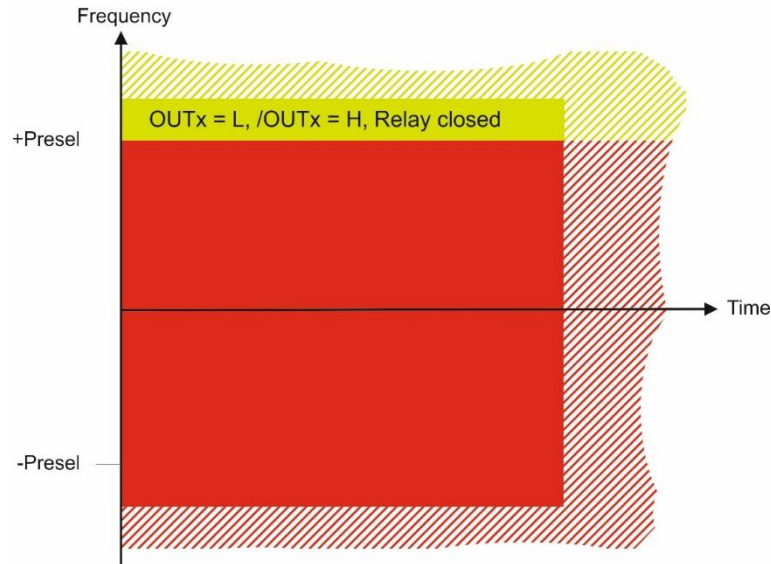
With Presel = 1000.0 Hz and Hysteresis = 10 %, frequencies $f < 1000$ Hz are declared as underspeed. The underspeed output will be cleared with frequencies $f > 1100$ Hz.

12.7 Frequency Band (Switch Mode = 6)

With parameter setting “Switch Mode” = 6, the frequency is monitored within a frequency band.

The function is always active. The switching positions inside the frequency band are at Presel +/- Hysteresis. Only positive Presel values are allowed.

Relevant Parameters	Remark
Switch Mode XXXX	= 6
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Hysteresis XXXX	+/--range from the center point (Presel. Value)
Startup Mode	type of start-up delay
Startup Output	output assignment for start-up delay
Lock Output	lock function
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	center
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	Max. permissible delay time during illegal conditions



Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	When lock function is active only
Switchover switching points, e.g. parameter „IN2 Function“ = 13	Only when switchover is active

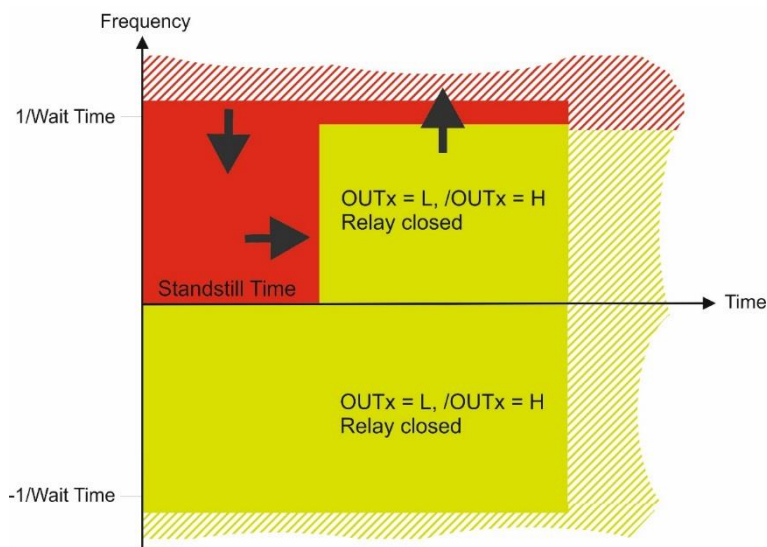
Example:

With Presel = 1000.0 Hz and Hysteresis = 10 %, frequencies $f < 900$ Hz are declared as underspeed and frequencies $f > 1100$ Hz as overspeed.

12.8 Frequency > 0 Hz (Switch Mode = 7)

With parameter setting “Switch Mode” = 7, the direction of the frequency is monitored. The function is always active. With positive frequencies ($f > 0$ Hz), the output is set to ON. The output will reset with negative frequencies ($f < 0$ Hz) or with standstill ($f = 0$ Hz) after expiration of the Standstill Time.

Relevant Parameters	Remark
Switch Mode XXXX	= 7
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Standstill Time	standstill time in seconds
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)



Relevant input functions	Remark
none	none

Example:

The transition from a negative to a positive frequency will cause an immediate change of the output state. Only in case of a transition from a positive frequency to zero, the output will not change before Standstill Time has elapsed.

12.9 Frequency < 0 Hz (Switch Mode = 8)

With parameter setting “Switch Mode” = 8, the direction of the frequency is monitored. The function is always active. With negative frequencies ($f < 0$ Hz), the output is set to ON. The output will reset with positive frequencies ($f > 0$ Hz) or with standstill ($f = 0$ Hz) after expiration of the Standstill Time.

Relevant Parameters	Remark
Switch Mode XXXX	= 8
Pulse Time XXXX	statically = 0 or pulse duration in x seconds
Standstill Time	standstill time in seconds
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)

Relevant input functions	Remark
none	none

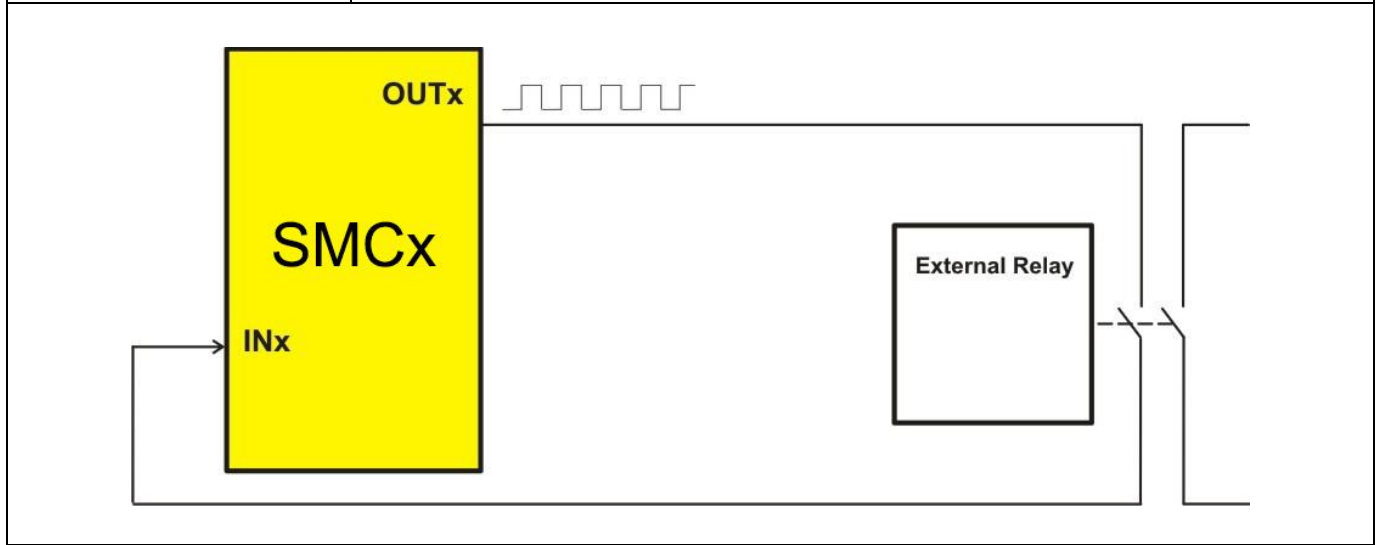
Example:

The transition from a positive to a negative frequency will cause an immediate change of the output state. Only in case of a transition from a negative frequency to zero, the output will not change before Standstill Time has elapsed.

12.10 Clock Generation for Pulsed Readback (Switch Mode = 9)

With parameter setting “Switch Mode” = 9, the output supplies a clock or an inverted clock with a specific frequency. The Output Mode of the output in use must be set to zero. Clock outputs provide different output frequencies. This function is used to monitor the readback contacts of an external relay (see EDM function).

Relevant Parameters	Remark
Switch Mode XXXX	= 9
Output Mode	= 0 for this output (inverse configuration)

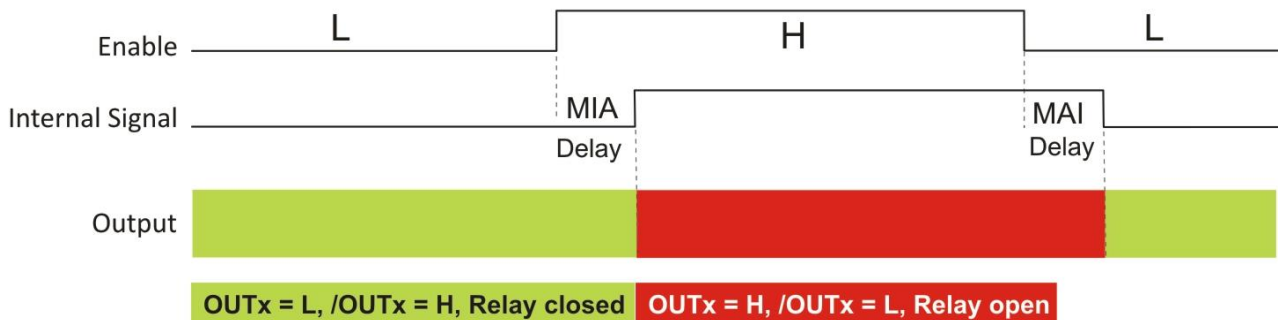


12.11 STO/SBC/SS1 by Input (Switch Mode = 10)

With parameter setting “Switch Mode” = 10, an STO, SBC or SS1 function is assigned to the output. The function requires an enable input signal which is assigned by the „Matrix“ parameter. Parameter “Lock Output” can be used to activate a lock function, which can be acknowledged by a further input. Acknowledgement is only possible with deactivated enable signal. There is no frequency or ramp monitoring.

Relevant Parameters	Remark
Switch Mode XXXX	= 10
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0
MAI-Delay XXXX	= 0
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)

STO/SBC Function: Without Selfhold Function and with static high Enable Input



Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

Important: A safety function will not be achieved before the SMC2.4 monitor has been combined with a corresponding actuator unit.

12.11.1 STO/SBC Produced by Situation (Switch Mode = 10)

If an STO should e.g. be triggered by overspeed, a second feedback output, configured as overspeed can be used as enable input (parameter „Matrix“). One of the two functions requires a lock function.

Relevant Parameters	Remark
Switch Mode XXXX	= 10
Matrix XXXX	feedback output
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config“	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)

Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.12 SS1 Produced by Input (Switch Mode = 10)

An SS1 function can be achieved when the STO function is provided with a MIA Delay. After this safe delay time an STO will be triggered. In this case a lock function must be activated. In case the Enable signal should be reset during the delay period, the output will not trigger. There is no frequency or ramp monitoring.

Relevant Parameters	Remark
Switch Mode XXXX	= 10
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	delay time
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config"	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)

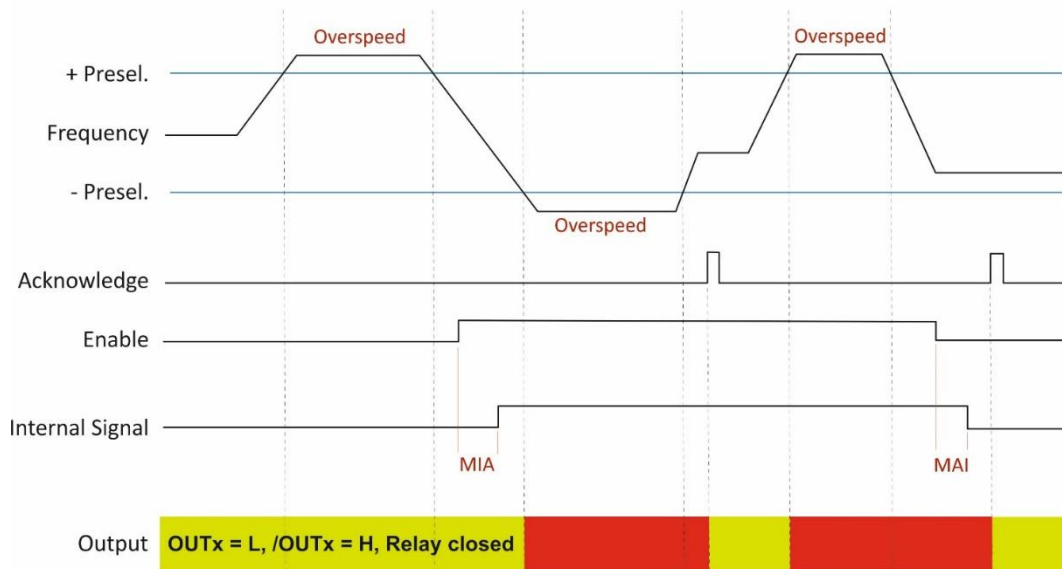
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.13 SLS Produced by Input (Switch Mode = 11)

With parameter setting “Switch Mode” = 11, an SLS function is assigned to the output. The function is triggered, independent of the direction of rotation, at overspeed. The function requires an enable input signal which must be assigned by parameter „Matrix □□□□“. A clear lock function can be attributed. The lock function can be acknowledged by a further input. Acknowledgement is only possible with frequencies below overspeed, or with the enable signal deactivated. No ramp monitoring is available.

Relevant Parameters	Remark
Switch Mode XXXX	= 11 (SLS = safe limited speed)
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	clear lock function, use only range of 0-31
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SLS Function: with static high Enable Input and activated Selfhold



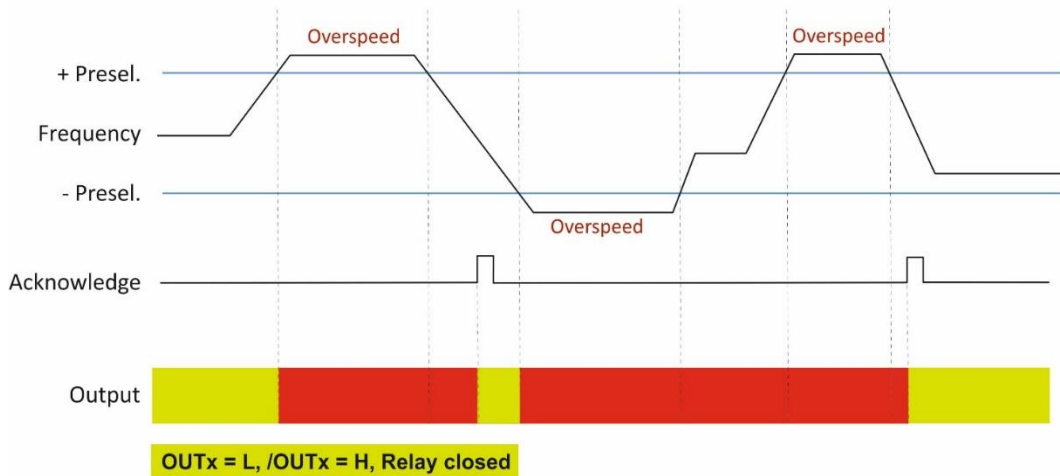
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.14 SMS (Switch Mode = 12)

With parameter setting “Switch Mode” = 12, an SMS function is assigned to the output. The function is triggered, independent of the direction of rotation, at overspeed. A lock function can be set separately. The lock function can be acknowledged by a further input. Acknowledgement is only possible with frequencies below overspeed. No ramp monitoring is available.

Relevant Parameters	Remark
Switch Mode XXXX	= 12 (SMS = Safe Maximum Speed)
Lock Output	clear lock function, use only range of 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Presel. XXXX. L/H	switching point
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SMS Function: without Enable Signal and activated Selfhold



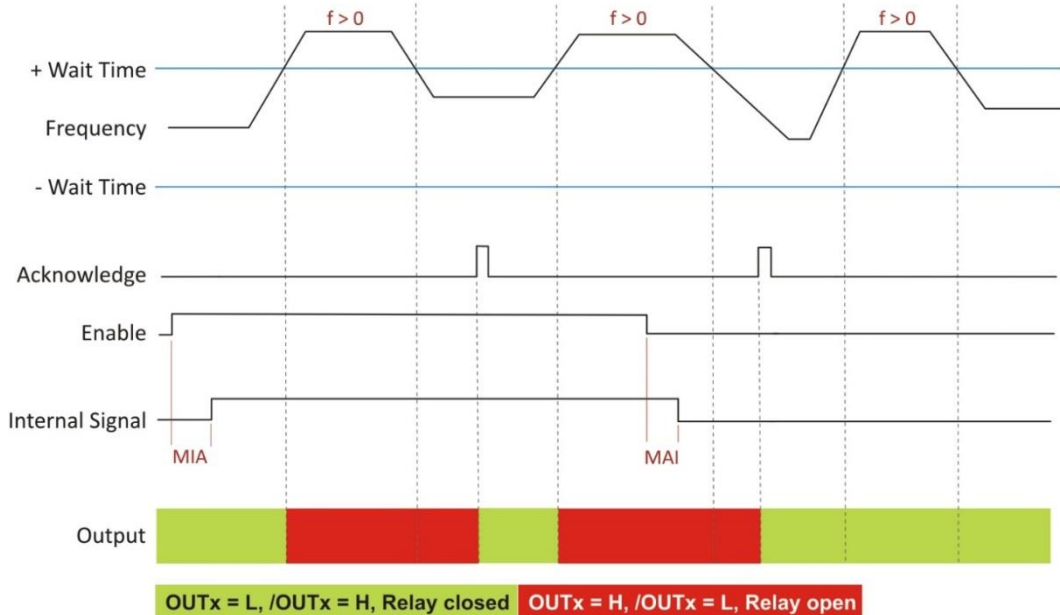
Relevant input functions	Remark
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active

12.15 SDI Produced by Input ($f > 0$ Hz), (Switch Mode = 13)

With parameter setting “Switch Mode” = 13, an SDI function is assigned to the output. The function is triggered with positive frequency. A clear lock function can be set separately. The lock function can be acknowledged by a further input. An Acknowledgement is only possible with frequencies lower than or equal to 0 Hz ($f \leq 0$ Hz) or with the Enable signal deactivated. The SDI function refers to evaluation of frequency, but not of the position.

Relevant Parameters	Remark
Switch Mode XXXX	= 13 (Safe Direction)
Wait Time	reset time
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	clear lock function, use only range of 0-31
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SDI Function: with static high Enable Input



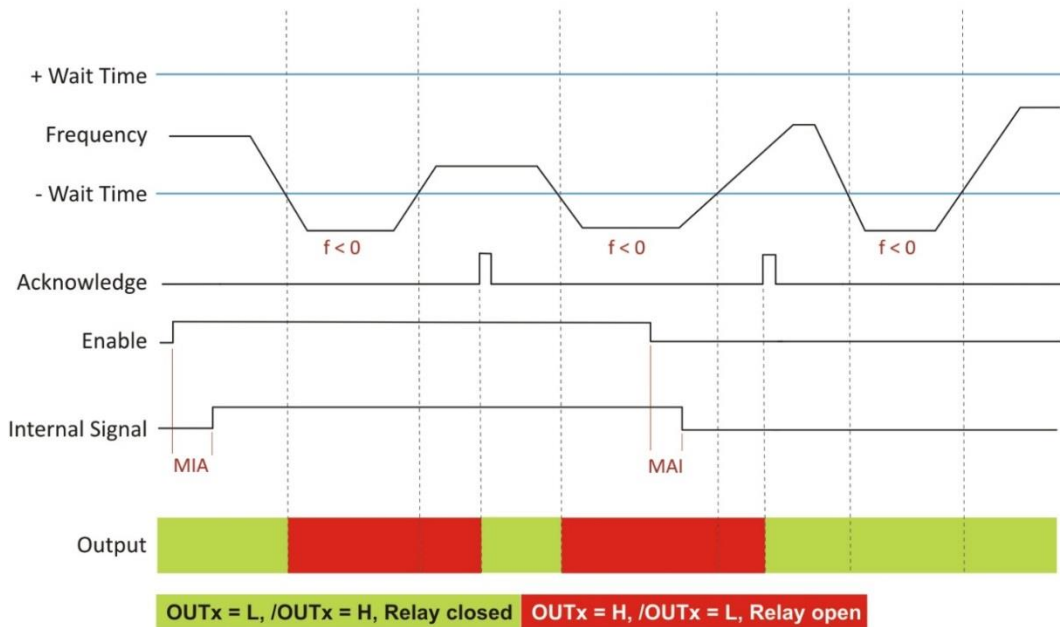
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN1 Function“ = 1 ... 6	Only when lock function is active

12.16 SDI Produced by Input ($f < 0$ Hz) (Switch Mode = 14)

With parameter setting “Switch Mode” = 14, an SDI function is assigned to the output. The function is triggered with negative frequency. A clear lock function can be attributed. The lock function can be acknowledged by a further input. An Acknowledgement is only possible with frequencies higher than or equal to 0 Hz ($f \geq 0$ Hz), or with the Enable signal deactivated. The SDI function refers to evaluation of frequency, but not of the position.

Relevant Parameters	Remark
Switch Mode XXXX	= 14 (Safe Direction)
Wait Time	reset time
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	clear lock function, use only range of 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SDI Function: with static high Enable Input



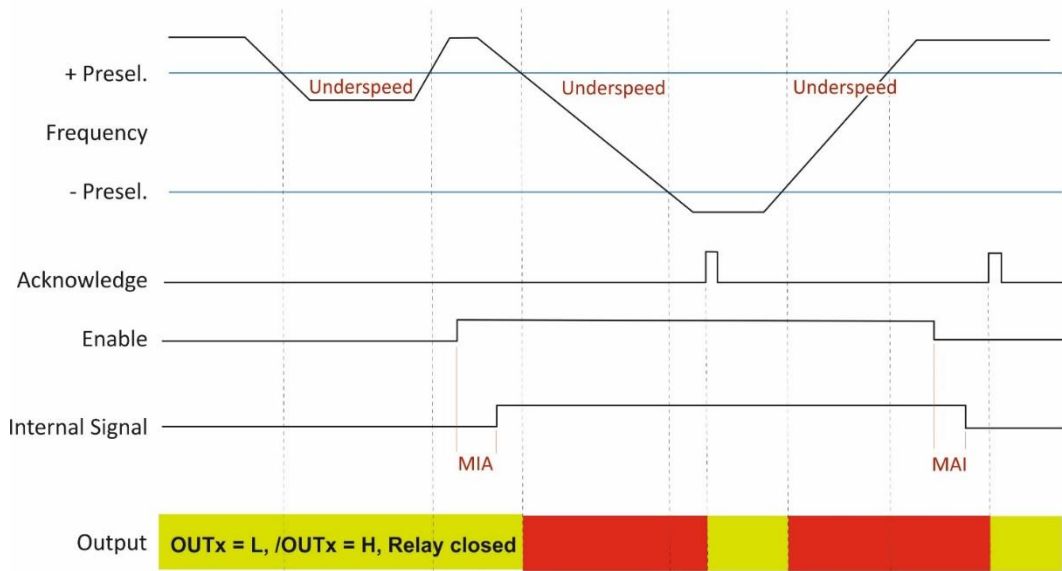
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.17 SSM via Input (Switch Mode = 15)

With parameter setting “Switch Mode” = 15, an SSM function is assigned to the output. The function is triggered by underspeed, independent of the direction of rotation. The function requires an enable input signal which must be assigned by parameter „Matrix“
 A lock function can be set separately, which can be acknowledged by a further input. Acknowledgement is only possible with frequencies higher than underspeed, or with the enable signal deactivated.

Relevant Parameters	Remark
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX. L/H	switching point
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN* Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SSM Function: with static high Enable Input and activated Selfhold



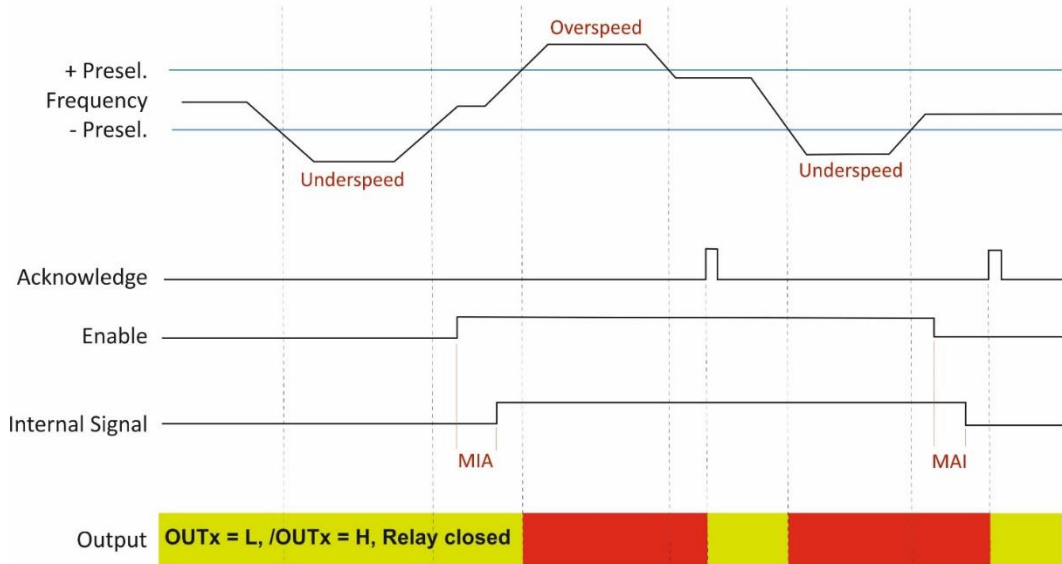
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.18 SSM via Input (Switch Mode = 16)

With parameter setting “Switch Mode” = 16, an SSM function is assigned to the output. The function is triggered when the frequency leaves the frequency band, independent of the direction of rotation. The function requires an enable input signal which must be assigned by parameter „Matrix“. A lock function can be set separately, which can be acknowledged by a further input. Acknowledgement is only possible with frequencies inside the frequency band, or with the enable signal deactivated.

Relevant Parameters	Remark
Switch Mode XXXX	= 16 (Safe Speed Monitor)
Hysteresis XXXX	+/- range (center)
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX. L/H	center
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SSM Function: with static high Enable Input and activated Selfhold



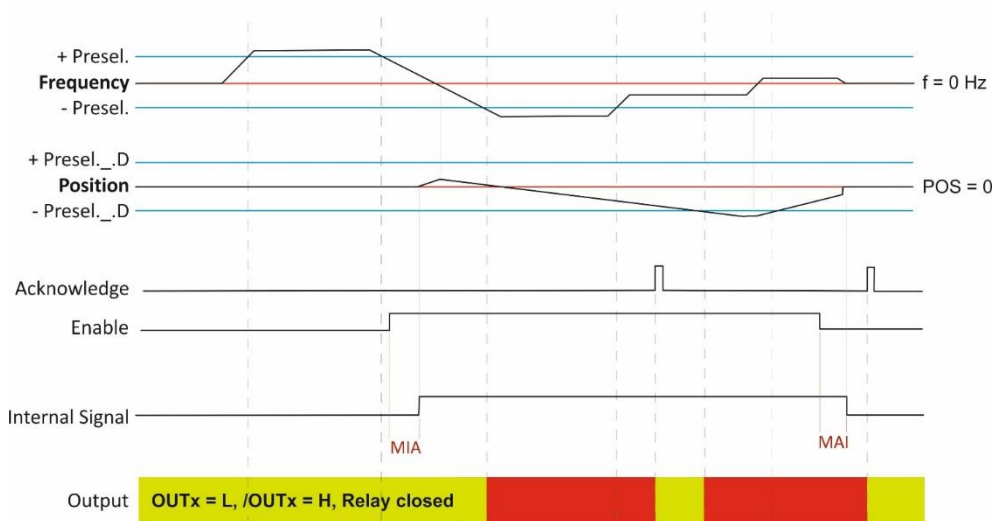
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.19 SOS/SLI/SS2 via Input (Switch Mode = 17)

With parameter setting “Switch Mode” = 17, an SOS/SLI/SS2 function is assigned to the output. This function will be triggered by overspeed or by position error, with no regard of the direction of rotation. An enable input signal is required, which can be assigned by the Matrix „Matrix“ parameter. A clear lock function can be attributed The lock function can be acknowledged by a further input. Acknowledgement is only possible with frequencies lower than overspeed, or with the enable signal deactivated. With the switchover the enable signal from inactive to active, the current position is adopted for error evaluation or cached. SLI and SOS are different with regard to the level of the switching points only. While SLI corresponds to a monitored Jog operation, SOS provides standstill monitoring. A position error can be acknowledged only by disabling the Enable signal. Any SOS function with MIA Delay unequal to zero will turn to an SS2 function.

Relevant Parameters	Remark
Switch Mode XXXX	= 17 (Safe Operating Stop)
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need, SS2)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX.D	switch point for cached position
Presel. XXXX. L/H	switching point for overspeed
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SOS Function: with static high Enable Input and activated Selfhold



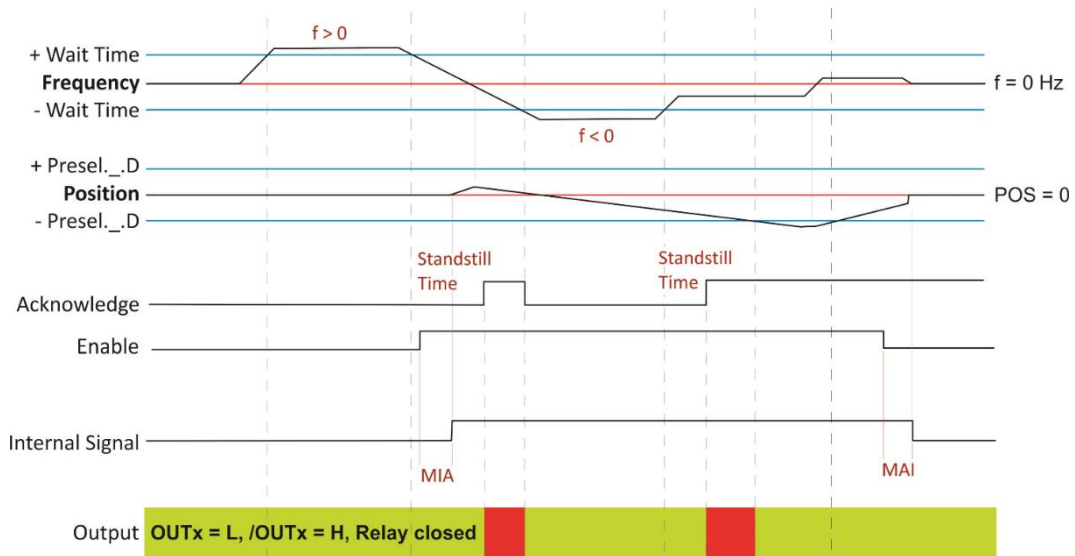
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.20 Standstill via Input (Switch Mode = 18)

With parameter setting “Switch Mode” = 18, a standstill function is assigned to the output. The function is triggered at standstill. The function requires an enable input signal which can be assigned by parameter „Matrix“. There is no lock function implemented. With the switchover the enable signal from inactive to active, the current position will be adopted for error evaluation or cached. The output is set after Standstill Time has elapsed. In case of a position error, or with a frequency unequal to zero, the output will reset. Position errors can be cleared only by deactivation of the Enable signal.

Relevant Parameters	Remark
Switch Mode XXXX	= 18
Wait Time	reset time
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX.D	switching point for cached position
Standstill Time	time (sec.)
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config“	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time“	max. permissible delay time during illegal conditions

Standstill Monitor: with static high Enable Input



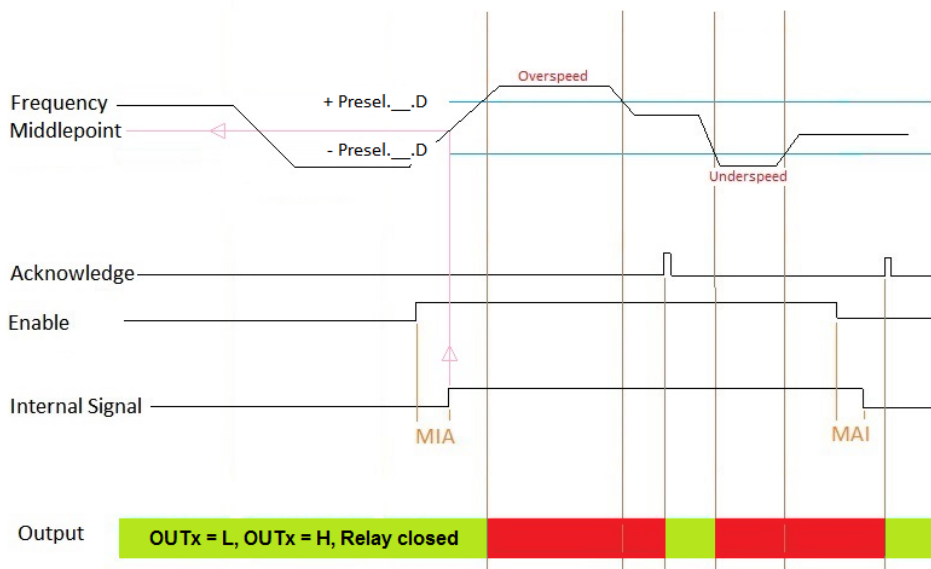
Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function

12.21 SMS (frequency band) via Input (Switch Mode = 19)

With parameter setting "Switch Mode" = 19, an SSM function is assigned to the output. The center point of the switching point corresponds to the current frequency during the transition from inactive to active enable flank and is cached in the device. The function dissolves regardless of the direction of rotation when leaving a frequency band. An enable input signal is required for the function, which is assigned by the parameter "Matrix". A lock function can be attributed. The lock output can be acknowledged by a further input. A receipt is only possible for frequencies within the frequency band or deactivated enable signal.

Relevant Parameters	Remark
Switch Mode XXXX	= 19 (Safe Speed Monitor)
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX.D	+/-range from the cached center point
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions

SSM Function: with static high Enable Input and activated Selfhold



Relevant input functions	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

12.22 No Standstill (Switch Mode = 20)

If the parameter „Switch Mode“ is set to 20, the functionality corresponds to the inverted Switch Mode = 3. The function is always active as in the Switch Mode = 3, but the output can only be set up statically.

With this function, the relay output is invertedly controlled to the Switch Mode=3, the relay is closed at standstill and opened for frequencies different to zero. The Standstill Time defines a delay before standstill is detected.

Relevant Parameters	Remark
Switch Mode XXXX	= 20
Pulse Time XXXX	Only statically = 0
Standstill Time	Standstill time in x seconds
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL)

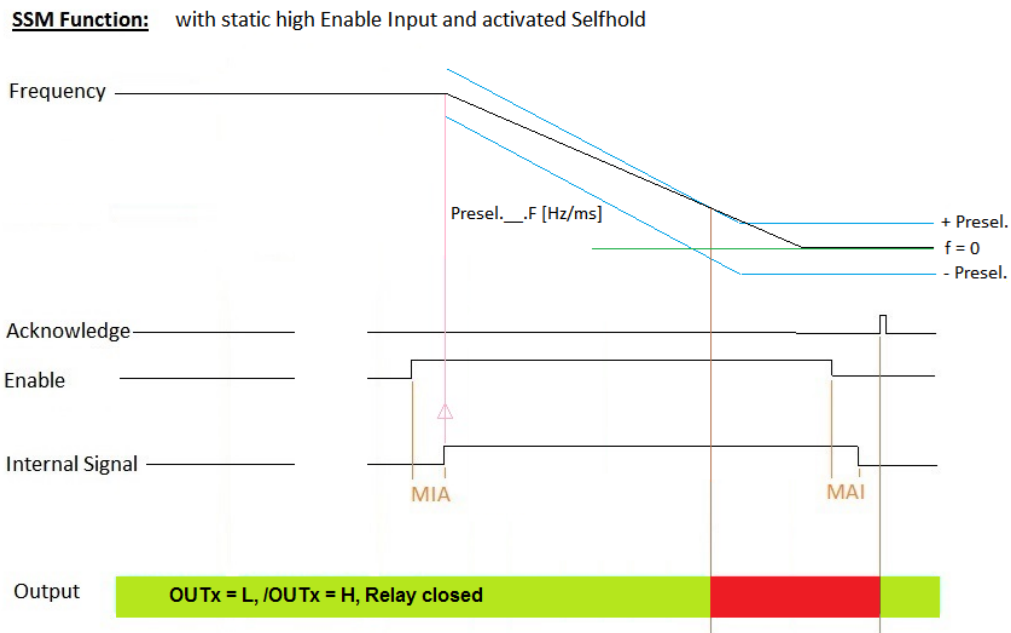
Relevant Input function	Remark
no	no

12.23 Ramp monitoring (Switch Mode = 21)

With parameter setting “Switch Mode” = 21, a ramp monitoring function is assigned to the output. The requirement for ramp monitoring is that the braking behavior follows a linear function of frequency and time. During the transition from inactive to active enable flank, the current frequency is cached in the device and the expected frequency can be determined by the pre-programmed ramp parameter "Presel. XXXX.F". If the current frequency deviates so that the precalculated window "Presel. XXXX. L/H" is left, the output is set. An enable input signal is required for the function, which is assigned by the parameter "Matrix". A lock function can be attributed. The lock function can be acknowledged by a further input. A confirmation is only possible if the enable signal is disabled.

Relevant Parameters	Remark
Switch Mode XXXX	= 21
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX. L/H	+/-range from the cached center point
Presel. XXXX.F	Entering the brake ramp
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input

IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time	max. permissible delay time during illegal conditions



Relevant Input function	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

The window is determined by the "Presel. XXXX.L/H" and is entered directly in 0.00 Hz values. An input of 100.00 Hz generates a window of +/-100.00 Hz by the calculated frequency. The parameter "Presel. XXXX.F" indicates the braking ramp.

If lock function has been activated, the Delay parameter must also be activated. It must be set at least to the smallest value of 2ms.

Example:

If a braking ramp is triggered from 0.01 Hz/ms at 1353 Hz, the time to 0 Hz is reached: $1353 \text{ Hz} / (0.01 \text{ Hz/ms}) = 135.3 \text{ s} = 2 \text{ min } 15,3 \text{ s}$.

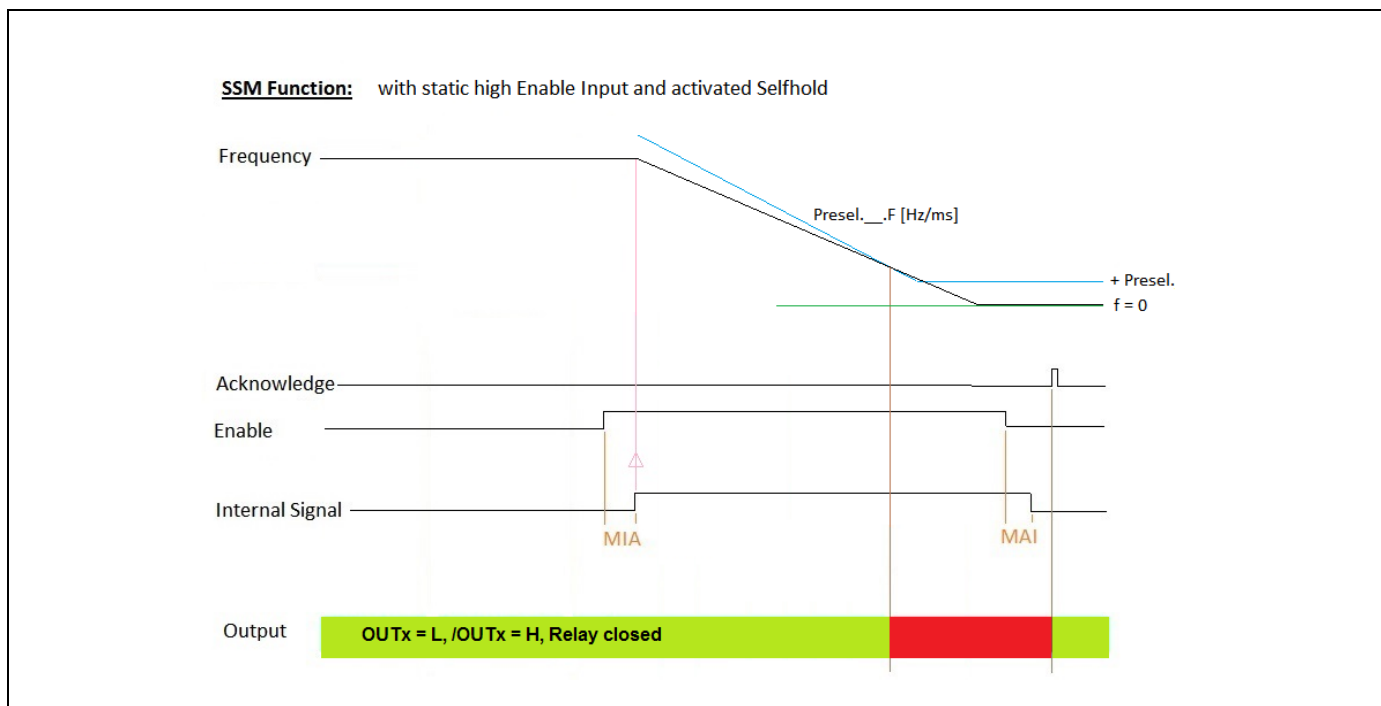
To determine the ramp, the drive should be braked at e.g. 1kHz and the time duration measured. The parameter value follows by calculation.

12.24 Ramp monitoring (Switch Mode = 22)

With parameter setting "Switch Mode" = 22, a ramp monitoring function is assigned to the output. The requirement for ramp monitoring is that the braking behavior follows a linear function of frequency and time. During the transition from inactive to active enable flank, the current frequency is cached in the device and the expected frequency can be determined by the pre-programmed ramp parameter "Presel. XXXX.F". In contrast to switch mode = 21, only one monitoring of the ramp is carried out. If the current frequency is greater, so that the precalculated window "Presel. XXXX.L/H" is left, the output is set. If the current frequency is smaller, so that the calculated window is left, the output is not set. An enable input signal is required for the function, which is assigned by the parameter "Matrix". A lock function can be attributed. The lock function can be acknowledged by a further input. A confirmation is only possible if the enable signal is disabled.

Relevant Parameters	Remark
Switch Mode XXXX	= 22
Matrix XXXX	use only inputs, but no feedback outputs
MIA-Delay XXXX	= 0 (can also be set according to need)
MAI-Delay XXXX	= 0 (can also be set according to need)
Lock Output	for lock function use only range 0-31
Output Mode	homogenous or inverse output configuration (affects the Safety Integrity Level SIL/PL)
Delay XXXX	shutter release delay
Presel. XXXX. L/H	+/-range from the cached center point
Presel. XXXX.F	Entering the brake ramp
Input Mode	configuration of the control inputs (affects the safety level SIL/PL)
IN Function	function of the control input
IN Config	switching behaviour (single-channel, two-channel, inverse, homogeneous, dynamic, static)
GPI Err Time"	max. permissible delay time during illegal conditions

Continuation „ramp monitoring (Switch Mode = 22)“:



Relevant Input function	Remark
Enable, e.g. Parameter „IN1 Function“ = 21	activates the function
Clear lock function, e.g. parameter „IN2 Function“ = 1 ... 6	Only when lock function is active

The window is determined by the "Presel. XXXX.L/H" and is entered directly in 0.00 Hz values. An input of 100.00 Hz generates a range of + 100.00 Hz by the calculated frequency. The parameter "Presel. XXXX.F" indicates the braking ramp.

If lock function has been activated, the Delay parameter must also be activated. It must be set at least to the smallest value of 2ms.

Example:

If a braking ramp is triggered from 0.01 Hz/ms at 1353 Hz, the time to 0 Hz is reached: $1353 \text{ Hz} / (0.01 \text{ Hz/ms}) = 135.3 \text{ s} = 2\text{min } 15,3\text{s}$.

To determine the ramp, the drive should be braked at e.g. 1kHz and the time duration measured. The parameter value follows by calculation.


13 Response times

13.1 Response Time of the Relay Output

Hardware delay of the relay itself: 25 ms (max.)

With normal monitoring of overspeed, underspeed or frequency band: (with frequency band please choose the lower frequency, since this produces more delay)	
2 x Sampling Time + 25 ms e.g. f = 10 kHz, Sampling Time = 1 ms	for frequencies > 1 / Sampling Time 10 kHz > 1 kHz -> delay = 27 ms
2 x 1/frequency + 25 ms e.g. f = 100 Hz, Sampling Time = 1 ms	for frequencies < 1 / Sampling Time 100 Hz < 1 kHz -> delay = 45 ms

With normal monitoring of standstill:	
2 x Wait Time + Standstill Time + 25 ms e.g. Standstill Time = 0 ms, Wait Time = 100 ms	for frequency = 0 delay = 225 ms




These response times are based on a step function.
For this time, the parameter “Filter” is not regarded. If Filter is activated, Sampling Time or 1/frequency has to be multiplied by the factor x 5. (5 = a final value about 100% is reached, 3= a final value about 95% is reached).
With a system error (critical internal error) the response time will be:
85 ms + 25 ms =110 ms.

13.2 Response Time of the Analog Output

Hardware delay of the analog output itself: 1 ms

With normal monitoring of overspeed, underspeed or frequency band: (with frequency band please choose the lower frequency, since this produces more delay)	
2 x Sampling Time + 1 ms e.g. f = 10 kHz, Sampling Time = 1 ms	for frequencies > 1 / Sampling Time 10 kHz > 1 kHz -> delay = 3 ms
2 x 1/frequency + 1 ms e.g. f = 100 Hz, Sampling Time = 1 ms	for frequencies < 1 / Sampling Time 100Hz < 1 kHz -> delay = 21 ms

With normal monitoring of standstill:	
2 x Wait Time + Standstill Time + 1 ms e.g. Standstill Time = 0, Wait Time = 100 m s	for frequency = 0 delay = 201 ms



These response times are based on a step function.
For this time, the parameter “Filter” is not regarded. If Filter is activated, Sampling Time or 1/frequency has to be multiplied by the factor x 5. (5 = a final value about 100% is reached, 3= a final value about 95% is reached).
With a system error (critical internal error) the response time will be:
85 ms + 1 ms =86 ms

13.3 Response Time of the Digital Outputs

Hardware delay of the digital output itself: 1 ms

With normal monitoring of overspeed, underspeed or frequency band:
 (with frequency band please choose the lower frequency, since this produces more delay)

2 x Sampling Time + 1 ms e.g. f = 10 kHz, Sampling Time = 1 ms	for frequencies > 1 / Sampling Time 10 kHz > 1 kHz -> delay = 3 ms
---	---

2 x 1/frequency + 1 ms e.g. f = 100 Hz, Sampling Time = 1 ms	for frequencies < 1 / Sampling Time 100Hz < 1 kHz -> delay = 21 ms
---	---

With normal monitoring of standstill:

2 x Wait Time + Standstill Time + 1 ms e.g. Standstill Time = 0, Wait Time = 100 ms	for frequency = 0 delay = 201 ms
--	-------------------------------------



These response times are based on a step function.
 For this time, the parameter "Filter" is not regarded. If Filter is abled, Sampling Time or 1/frequency has to multiplied by the factor x 5. (5 = a final value about 100% is reached, 3= a final value about 95% is reached).
 With a system error (critical internal error) the response time will be:
 85 ms + 1 ms =86 ms

13.4 Response Time of the Splitter Output:

Hardware delay of the splitter output itself: 1 ms



These response times are based on a step function.
 With a system error (critical internal error) the response time will be:
 85 ms + 1 ms = 86 ms

13.5 Response Time of the Frequency Error Evaluation

Response time with a sudden frequency drop:

Time calculations in the subsequent tables assume the following settings:

Sampling Time = 10 ms, Wait Time = 100 ms

- Use Sampling Time for the calculation when $f > 1/\text{Sampling Time}$
- Use reciprocal frequency $1/f$ when $f < 1/\text{Sampling Time}$



In addition to the delay times shown in the tables below, please add also the hardware delay time of the corresponding output (relay = 25 ms, analog output = 1 ms, digital output = 1 ms). The parameter Filter is excluded.

*) Calculated values for response times assume that "Sampling Time" would be greater than the reciprocal frequency $1/f$.

Div. Filter = 10	
With „Div. %-Value“ = 10:	11 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 210 ms*)
With „Div. %-Value“ = 20:	21 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 310 ms*)
With „Div. %-Value“ = 30:	31 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 410 ms*)
With „Div. %-Value“ = 40:	41 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 510 ms*)
Div. Filter = 5	
With „Div. %-Value“ = 10:	5 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 150 ms*)
With „Div. %-Value“ = 20:	10 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 200 ms*)
With „Div. %-Value“ = 30:	15 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 250 ms*)
With „Div. %-Value“ = 40:	21 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay = 310 ms*)
Div. Filter = 3	
With „Div. %-Value“ = 10:	1 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay 110 ms*)
With „Div. %-Value“ = 20:	2 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay 120 ms*)
With „Div. %-Value“ = 30:	3 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay 130 ms*)
With „Div. %-Value“ = 40:	5 x (Sampling Time or $(1/f)$) + 1x Wait Time -> delay 150 ms*)

Continuation “Response Time of the Frequency Error Evaluation”:

Filtering effect with a frequency drop of 10 %	
Div. Filter = 3 and Div. %-Value = 10:	tripping after 9 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)

Filtering effect with a frequency drop of 20 %	
Div. Filter = 3 and Div. %-Value = 20:	tripping after 13 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 10:	tripping after 4 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 20:	tripping after 20 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 20:	tripping after 20 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)

Filtering effect with a frequency drop of 30 %	
Div. Filter = 3 and Div. %-Value = 30:	tripping after 16 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 20:	tripping after 7 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 10:	tripping after 3 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 30:	tripping after 30 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 20:	tripping after 20 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 30:	tripping after 30 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 20:	tripping after 20 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)

Filtering effect at a frequency drop of 40 %	
Div. Filter = 3 and Div. %-Value = 40:	tripping after 18 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 30:	tripping after 9 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 20:	tripping after 5 x (Sampling Time or 1/f)
Div. Filter = 3 and Div. %-Value = 10:	tripping after 2 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 40:	tripping after 36 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 30:	tripping after 26 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 20:	tripping after 16 x (Sampling Time or 1/f)
Div. Filter = 5 and Div. %-Value = 10:	tripping after 6 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 40:	tripping after 40 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 30:	tripping after 30 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 20:	tripping after 20 x (Sampling Time or 1/f)
Div. Filter = 10 and Div. %-Value = 10:	tripping after 10 x (Sampling Time or 1/f)

14 Connection of the inputs

There are different ways to connect the inputs. The SMCx monitors offer HTL inputs with SIL3 capability, provided that their configuration is set to two-pole-inverse operation. The finally resulting Safety Integration Level (SIL) however also depends on the remote circuit and on the configuration.

Relevant Parameters	Remark
IN Config	Input characteristics (bipolar, unipolar, clocked)
Input Mode	Configuration of inputs (individual input, signal pair, mixed)
Switch Mode XXXX	=9, when an output is used for clock generation with clocked input
Output Mode	Clock output must be set to "inverse"
GPI Err Time	Max. permissible delay time during illegal conditions



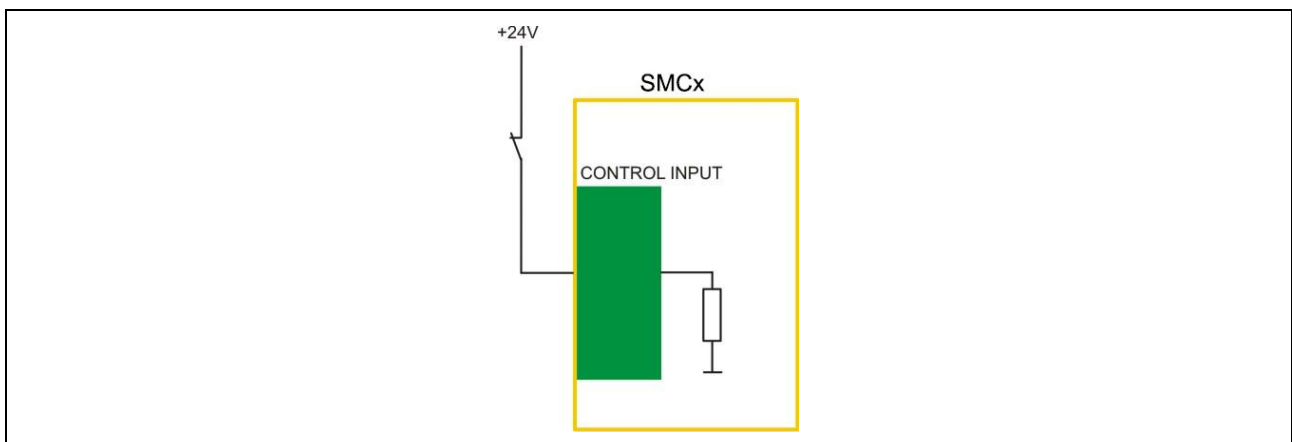
- Unipolar, un-clocked inputs provide SIL = 1 only
- Unipolar, clocked inputs can reach SIL = 1 - 2
- Bipolar, un-clocked inputs can reach SIL = 2 - 3

Where you utilize clocked inputs, for the clock generation you should use OUT1, OUT2 and OUT3 first, and lastly OUT4. The clock outputs are different regarding the output frequency, and OUT1 is able to emit the highest frequency.

Both output tracks can be used due to the 180° phase displacement (please observe parameter „Output Mode“)

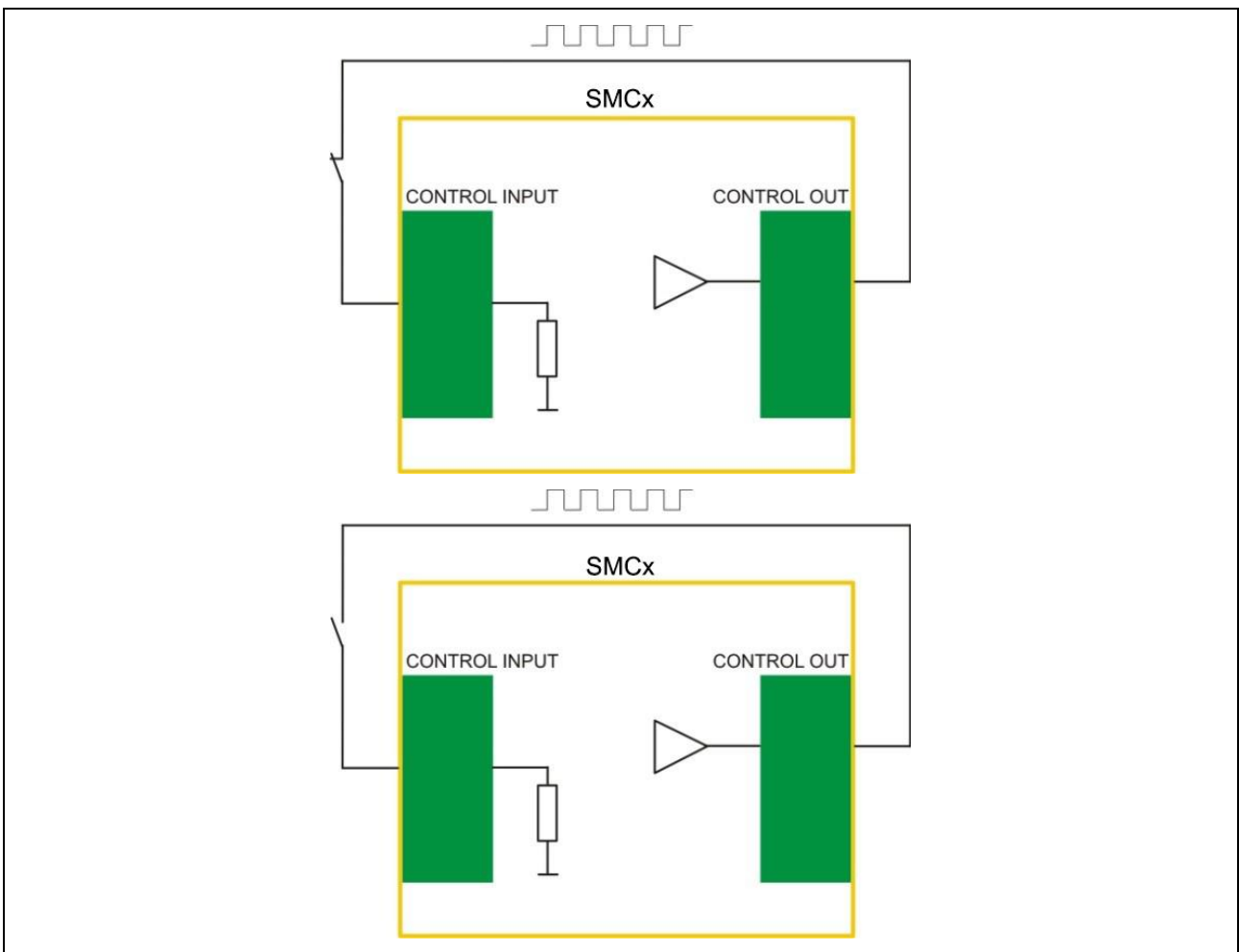
14.1 Connection: unipolar, un-clocked inputs

Unipolar, un-clocked inputs are connected as shown below. Alternatively, a change-over contact can be used, toggling between GND and +24 V. Unipolar, un-clocked inputs provide Safety Integrity Level (SIL) = 1. Parameter “*IN* Config” must be set to a value between 8 and 11. Parameter “Input Mode” must be set to 1 or 2. No errors can be detected; the response time is not affected.



14.2 Connection: unipolar, clocked inputs

Unipolar, clocked inputs are connected as shown below. This type of input reaches a Safety Integrity Level (SIL) = 1 - 2. Parameter “*IN* Config” must be set to a value between 20 and 35. Parameter “Input Mode” must be set to 1 or 2. For clock generation, one of the outputs must be available. In case of incorrect or missing clock signal, the tripping function (static high/low) must be chosen in a way that no safety risk can come up (line interruption and switching failure cannot be detected). In case of error, a Runtime Readback Digital Output Error will result and the response time will be approx. 20 ms.



Impacts to the final Safety Integrity Level (SIL):

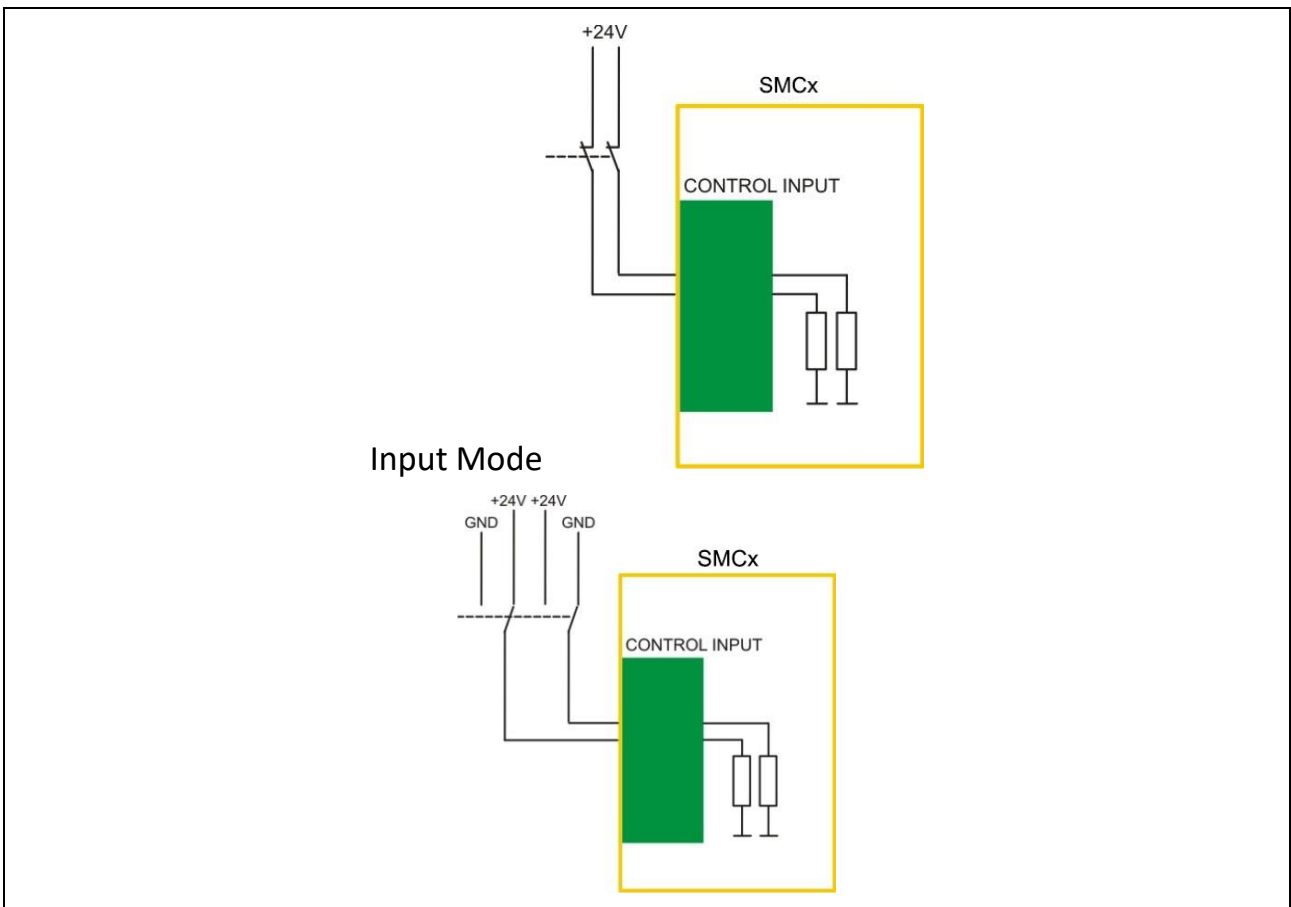


- Separate areas for cable leads of switch cables
- Forcibly guided and redundant series contacts
- Protected switch terminals to avoid short circuits and shunt faults
- MTTFd specification if the switch

14.3 Connection: bipolar, un-clocked inputs

Bipolar, un-clocked inputs can be connected as shown below. This type of input reaches a Safety Integrity Level (SIL) = 2 - 3. (homogenous = 2 - 3, inverse = 3). Parameter “*IN* Config” must be set to a value between 0 and 7. Parameter “Input Mode” must be set to 0 or 1.

In the case of an enable function, the input low should be active so that the function is always activated in the event of an error. When switching point switchover, for example, the smallest switching points should be selected for a low-active input at overspeed. The GPI err time parameter defines the maximum permissible delay time during the illegal conditons. (1 corresponds to approximately a duration of 1ms).



Impacts to the final Safety Integrity Level (SIL):

- Separate areas for cable leads of switch cables
- Forcibly guided and redundant series contacts
- Protected switch terminals to avoid short circuits and shunt faults
- MTTFd specification if the switch

14.4 Connection: switching point switchover

If a switching point switchover is to occur only between two different switching points, a shift command can be assigned to a control input. Therefore, the parameter "*IN* Function " must be set to 13 and both parameters "Input Mode" are not equal to 3. The input can be configured as any control input. (See Chapter 14.1-3).

The inputs at X23 or X24 can also be used for the switchover from more than 2 switching points. The corresponding parameter "Input Mode" for the respective input must be set to 3.

Gray Format with 4 switching points:

The parameter "Presel. XXXX.M" is used in the corresponding Presel. XXXX menu to define the function of the output. For example, the parameter "Presel. XXXX.M " is set to 1 if the switching points should be switched at the input X23 in gray format for this output. If the parameter is set to 3, the input X24 is used.

In gray format, only 4 states are valid for the 4 inputs, all others trigger a runtime GPI error. The "GPI Err time" parameter defines the maximum permissible delay time during the illegal intermediate state. (1 corresponds to approximately a duration of 1ms).

Binary format with 16 switching points:

The parameter "Presel. XXXX.M" is used in the corresponding Presel. XXXX menu to define the function of the output. For example, the parameter "Presel. XXXX.M" is set to 2 if the switching points should be switched at the input X23 in binary format for this output. If the parameter is set to 4, the input X24 is used.

In binary format, no error can be raised because all states are allowed. The switching function and the possible faults must be observed at the sequence of the switching points. In the case of overspeed and the risk of a possible demolition, the order can be chosen that the smaller switching point becomes relevant when demolished.

Combinations:

It is possible that one or more outputs can be switched to 4 switching points, while the others have fixed switching points. It is also possible to form two groups of outputs by using both inputs X23 and X24, switchover the switching points at different times which stimulate externally, or have 4 or 16 switching points.

15 Connection of the Outputs

There are different ways to connect the outputs. The SMCx monitors offers HTL outputs with SIL3 capability, provided that their configuration is set to two-pole-inverse operation. The finally resulting Safety Integration Level (SIL) also depends on the remote circuit and on the configuration.

Relevant Parameters	Remarks
Output Mode	Output configuration (homogenous / inverse)



- Unipolar outputs provide SIL = 1
- Bipolar homogenous outputs can reach SIL = 2 - 3
- Bipolar inverse outputs can reach SIL = 3



- In case of error, all switching outputs control a LOW level (no more inverting).

16 EDM Function

The EDM function (External Device Monitoring) provides special surveillance of faulty operation of remote relay or contactors by means of a separate feedback circuit. For feedback a clocked output signal is used, which is lead back to an input by a positively driven relay contact. This means that the SMCx monitor has to allocate one output to drive the relay coil, another output to generate the clock signal, and an input for reading back of the clock signal.

Parameter „*IN* Function“ appoints the output to be used for control of the relay.

Possible settings are from 17 – 20 and 22. Parameter „*IN* Config“ appoints the output to be used for clock generation.

The finally resulting Safety Integration Level (SIL) also depends on the remote circuit and on the configuration. In case of error, a Runtime External RB Error signal will be produced.

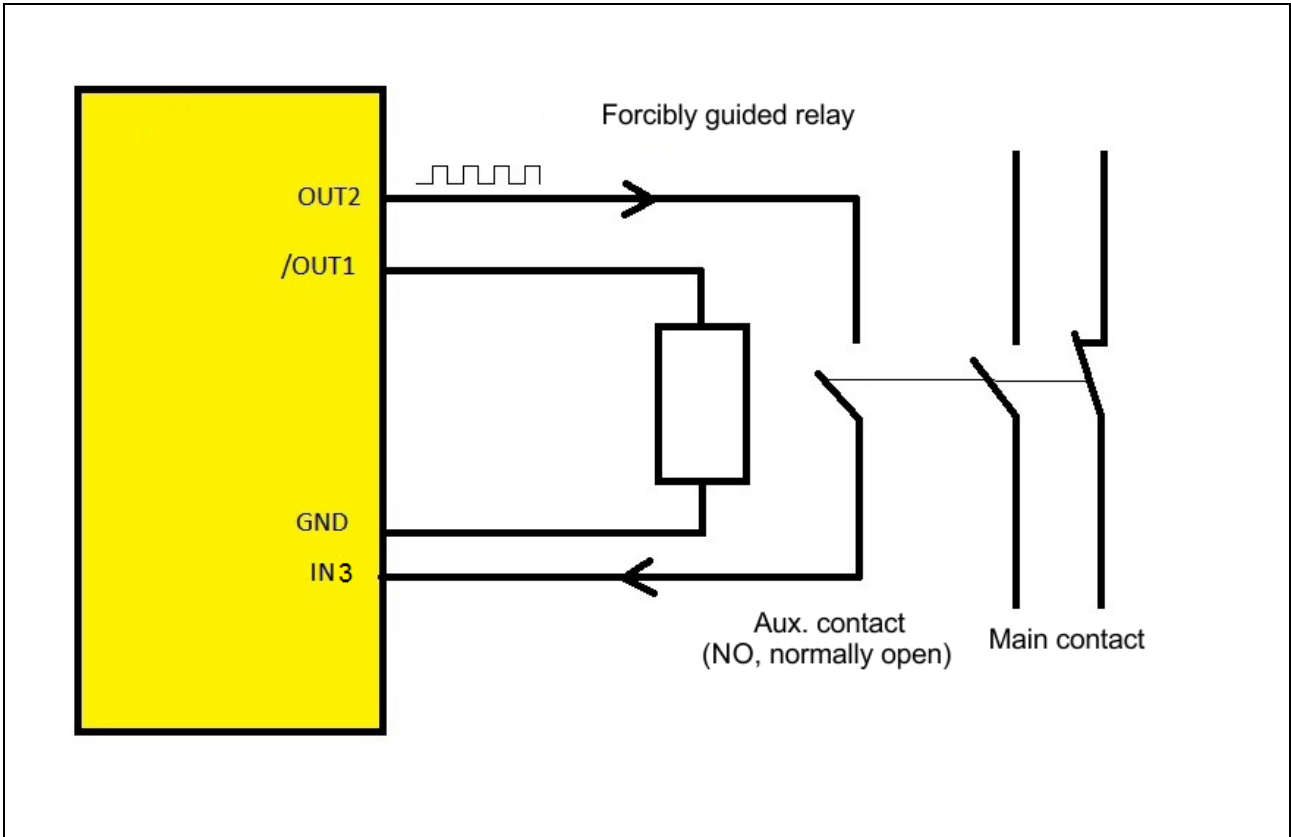
Relevant Parameters	Remarks
Read Back OUT	Possible inversion of the relay control
Switch Mode XXXX	Output for controlling the relay coil
Switch Mode XXXX	Clock output
Output Mode	= 0
IN Function	Specification of the relay control
IN Config	Specification of the clock read back
Input Mode	Configuration of the read back input (single input for read back)



- • X24 (IN3,/IN3, IN4,/IN4) must be used for clock read back

16.1 EDM: 1 external relay on x4 with SIL1

Precondition: 1 relay, 2 control outputs, 1 control input, auxiliary contact NO:



Parameter	Setting	Description
Switch Mode OUT	0	OUT1 to detect overspeed
Switch Mode OUT2	9	OUT2 to generate clock signal
Read Back OUT	1	Inversion (connection to /OUT1 via NO contact)
IN3 Function	17	Adaption to OUT1 (overspeed)
IN3 Config	14	Adaption to clock output OUT2 (via X24/2 contact)
Input Mode 2	2	4 single inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse configuration

Function:

With normal operation speed the inverted output /OUT1 is in HIGH state and the relay is energized. The forcibly guided aux. contact therefore is closed and the clock signal is conducted to the input. Upon overspeed output /OUT1 will descend to LOW and the remote relay will drop.

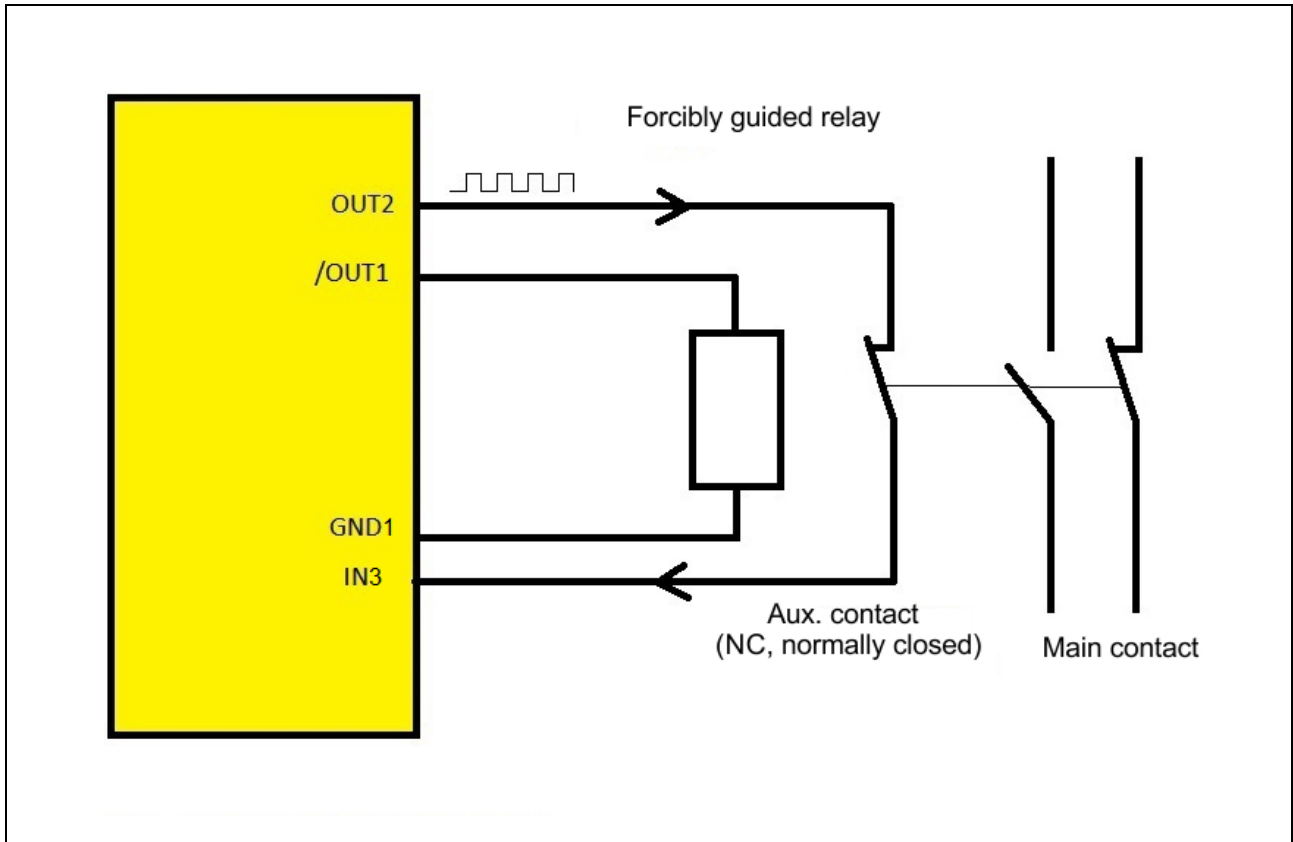
Errors in the clock circuit can only be detected while the relay is energized. Under error condition the SMCx monitor will set all digital outputs to LOW, i.e. the remote relay will be de-energized, which will signal "overspeed". With errors occurring under normal operating speed, the unit will take an error state which signals "overspeed" again (Safety Integrity Level = 1).

The main contacts can be used as opener or closer depending on the application.



16.2 EDM: External relay at X4 with SIL1.

Precondition: 1 relay, 2 control outputs, 1 control input, auxiliary contact NC:



Parameter	Setting	Description
Switch Mode OUT1	0	OUT1 to detect overspeed
Switch Mode OUT2	9	OUT2 to generate clock signal
Read Back OUT	0	No inversion (connection to /OUT1 via NC contact)
IN3 Function	17	Adaption to OUT1 (overspeed)
IN3 Config	14	Adaption to clock output OUT2 (via X24/2) contact)
Input Mode 2	2	4 single inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse configuration

Function:

With normal operation speed the inverted output /OUT1 is in HIGH state and the relay is energized. The forcibly guided aux. contact therefore is open and the clock signal is disconnected from to the input. Upon overspeed output /OUT1 will descend to LOW and the remote relay will drop.

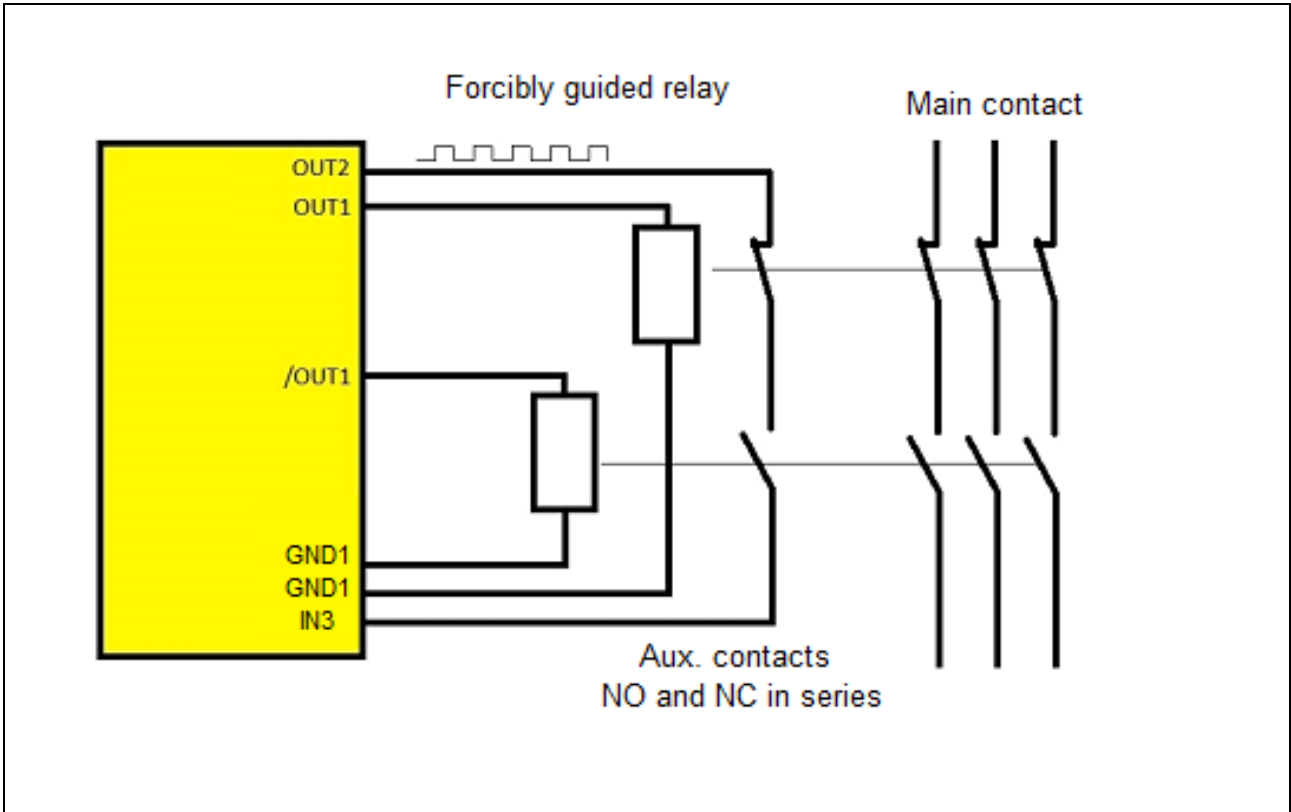


Errors in the clock circuit can only be detected while the relay is de-energized. Under error condition the SMCx monitor will set all digital outputs to LOW, i.e. the remote relay will be de-energized, which will signal "overspeed". With errors occurring under overspeed conditions, the unit will take an error state which signals "overspeed" again (Safety Integrity Level = 1).

The main contacts can be used as opener or closer depending on the application.

16.3 EDM: 2 external relays at X4 with SIL2

Precondition: 2 relays, 2 control outputs, 1 control input, auxiliary contact NC, NO:



Parameter	Setting	Description
Switch Mode OUT1	0	OUT1 to detect overspeed
Switch Mode OUT2	9	OUT2 to generate clock signal
Read Back OUT	1	Inversion
IN3 Function	17	Adaption to OUT1 (overspeed)
IN3 Config	14	Adaption to clock output OUT2 (via X24/2 contact)
Input Mode 2	2	4 single control-inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse configuration



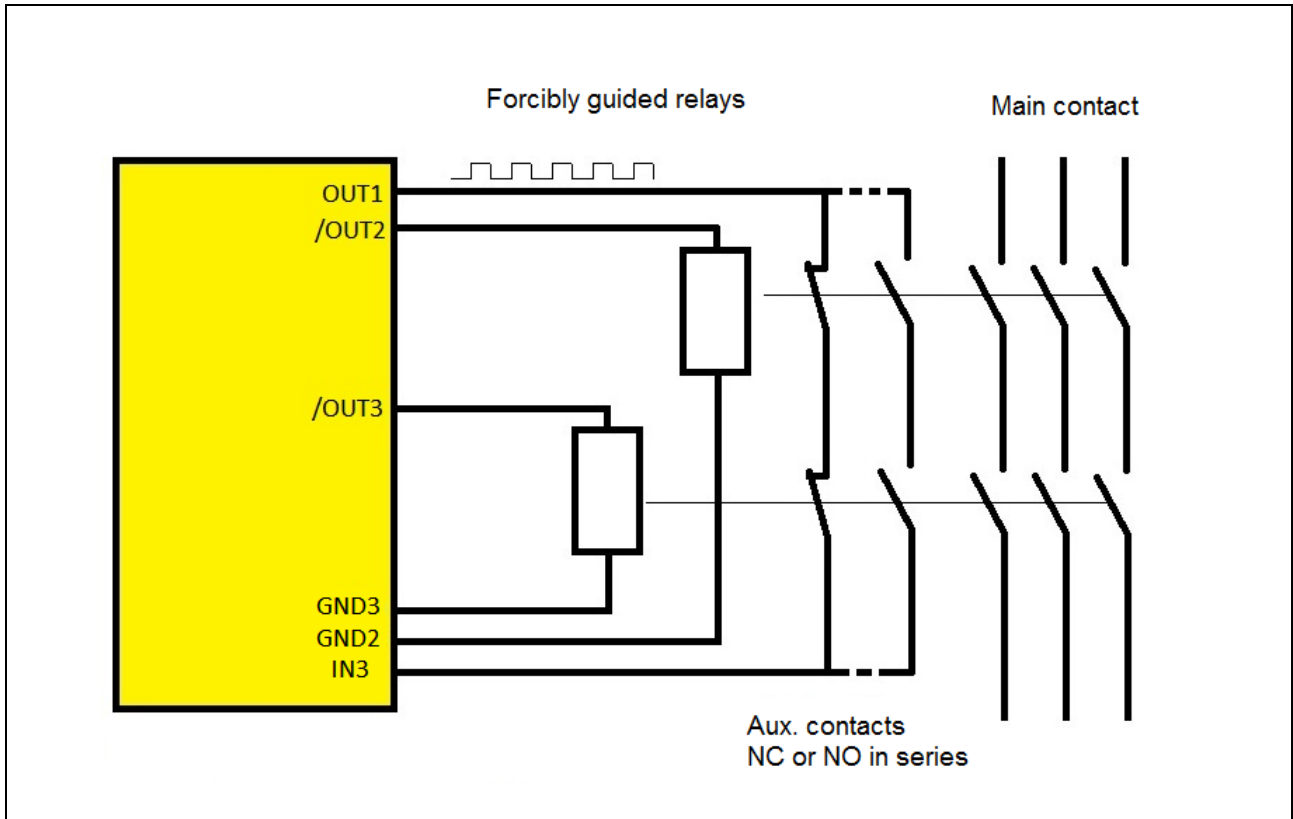
Function:

With normal operation speed, output /OUT1 is in HIGH state and output OUT1 is in LOW state. With overspeed, output /OUT1 is in LOW state and output OUT1 is in HIGH state. Therefore, at any time one of the relays is energized while the other one is de-energized.

The clock loop is closed with normal speed and interrupted with overspeed. The GND lines of the two relays must be independent one from each other. Errors in the clock circuit can only be detected with the clock loop closed. In case of errors the SMCx monitor will set all digital outputs to LOW, i.e. both relays will drop and overspeed will be indicated. In case of errors in the clock loop during overspeed, an error signal will be produced and overspeed will be indicated. (Safety Integrity Level = 2).

The main contacts can be used as opener or closer depending on the application.

16.4 EDM: 2 external relays at X4 with SIL2



Parameter	Setting	Description
Switch Mode OUT1	9	OUT1 to generate clock signal
Switch Mode OUT2	0	OUT2 to signal overspeed
Switch Mode OUT3	0	OUT3 to detect overspeed
Read Back OUT	0/6	Inversion yes or no, depending on type of aux. contact
IN3 Function	18/19	Adaption to OUT2 or OUT3 (overspeed)
IN3 Config	12	Adaption to clock output OUT1 (via X24/2 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse operation

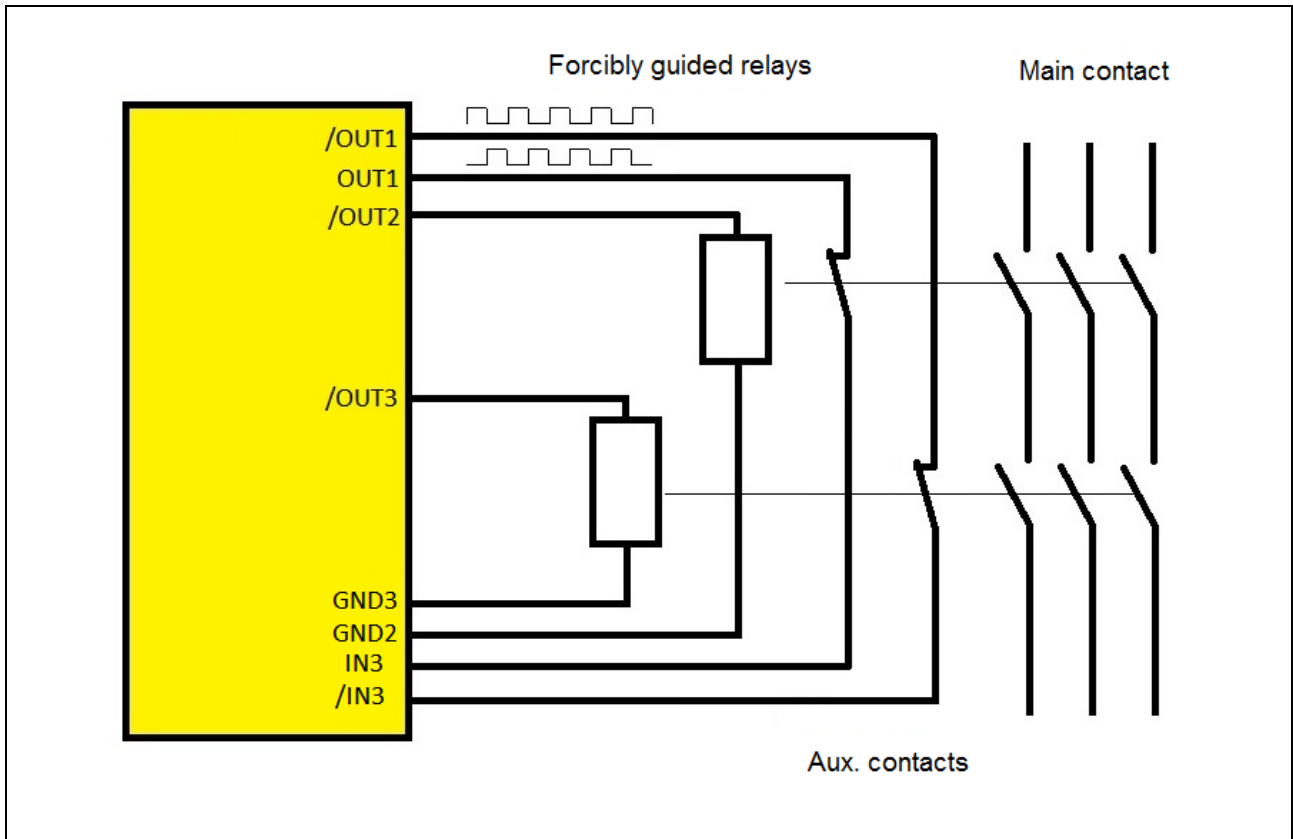


Function:

This application uses two independent outputs /OUT2 and /OUT3 with fully identical configuration concerning their switching characteristics. The basic function is similar to the application with one relay. The auxiliary contacts of both relays are connected in series to conduct the clock signal to an input. Parameter *IN2 Function* can be set to 18 or 19, since the switching behavior of both outputs must be identical. The GND lines of the two relays must be independent one from each other (Safety Integrity Level = 2). The main contacts can be used as opener or closer depending on the application.

16.5 EDM: 2 external relays at X4 with SIL3

Precondition: 2 relays, 3 control outputs, 2 control inputs, auxiliary contact NC:



Parameter	Setting	Description
Switch Mode OUT1	9	OUT1 to generate clock signal
Switch Mode OUT2	0	OUT2 to signal overspeed
Switch Mode OUT3	0	OUT3 to detect overspeed
Read Back OUT	0	No inversion (connection via NC contact)
IN3 Function	18	Adaption to OUT2 (overspeed)
IN3 Config	12	Adaption to clock output OUT1 (via X24/2 contact)
/IN3 Function	19	Adaption to OUT3 (overspeed)
/IN3 Config	13	Adaption to clock output /OUT1 (via X24/3 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse operation



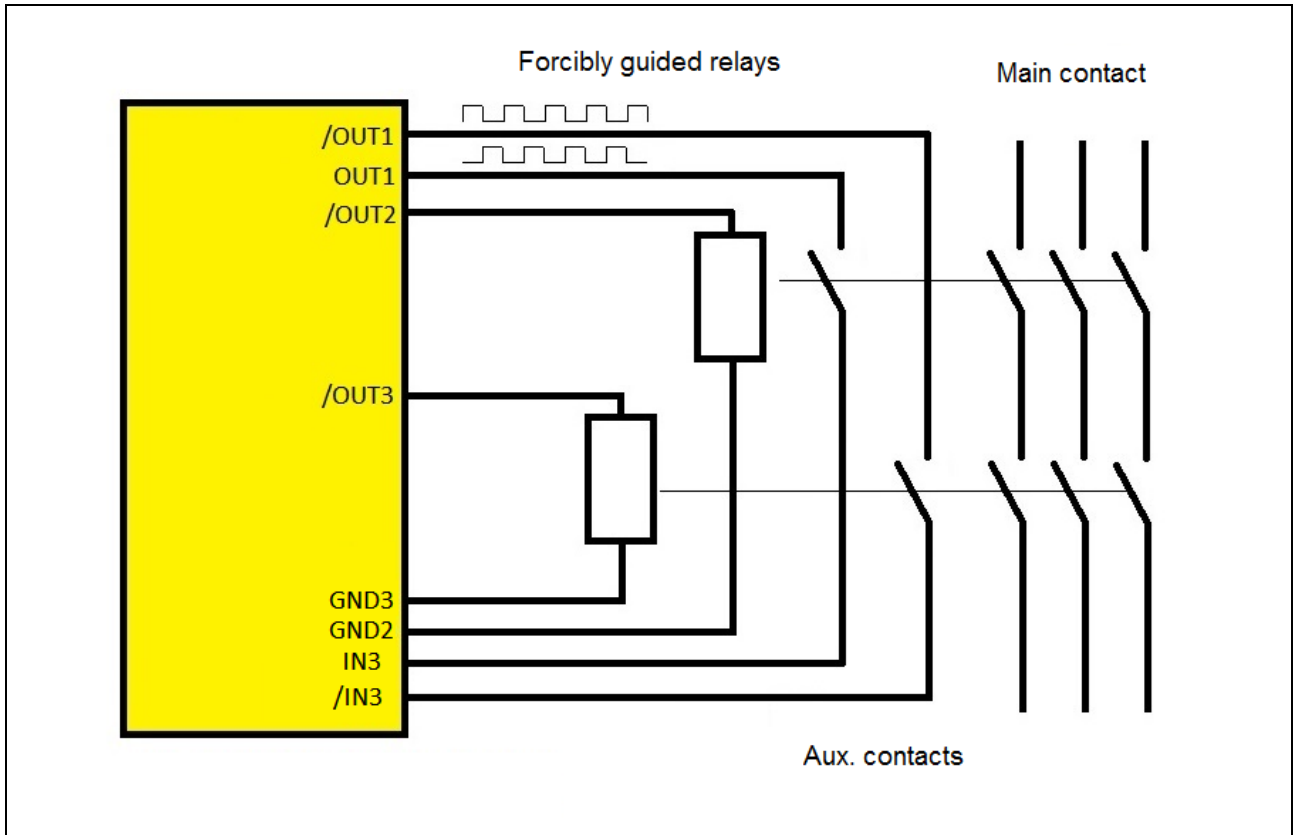
Function:

This application uses two independent outputs /OUT2 and /OUT3 with fully identical configuration concerning their switching characteristics. The basic function is similar to the application with one relay. The auxiliary contacts of both relays are individually connected to a separate input each. The GND lines of the two relays must be independent one from each other (Safety Integrity Level = 3).

The main contacts can be used as opener or closer depending on the application.

16.6 EDM: 2 external relays at X4 with SIL3

Precondition: 2 relays, 3 control outputs, 2 control inputs, auxiliary contact NO:



Parameter	Setting	Description
Switch Mode OUT1	9	OUT1 to generate clock signal
Switch Mode OUT2	0	OUT2 to signal overspeed
Switch Mode OUT3	0	OUT3 to detect overspeed
Read Back OUT	6	Inversion (connection via NO contact)
IN3 Function	18	Adaption to OUT2 (overspeed)
IN3 Config	12	Adaption to clock output OUT1 (via X24/2 contact)
/IN3 Function	19	Adaption to OUT3 (overspeed)
/IN3 Config	13	Adaption to clock output /OUT1 (via X24/3 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse operation



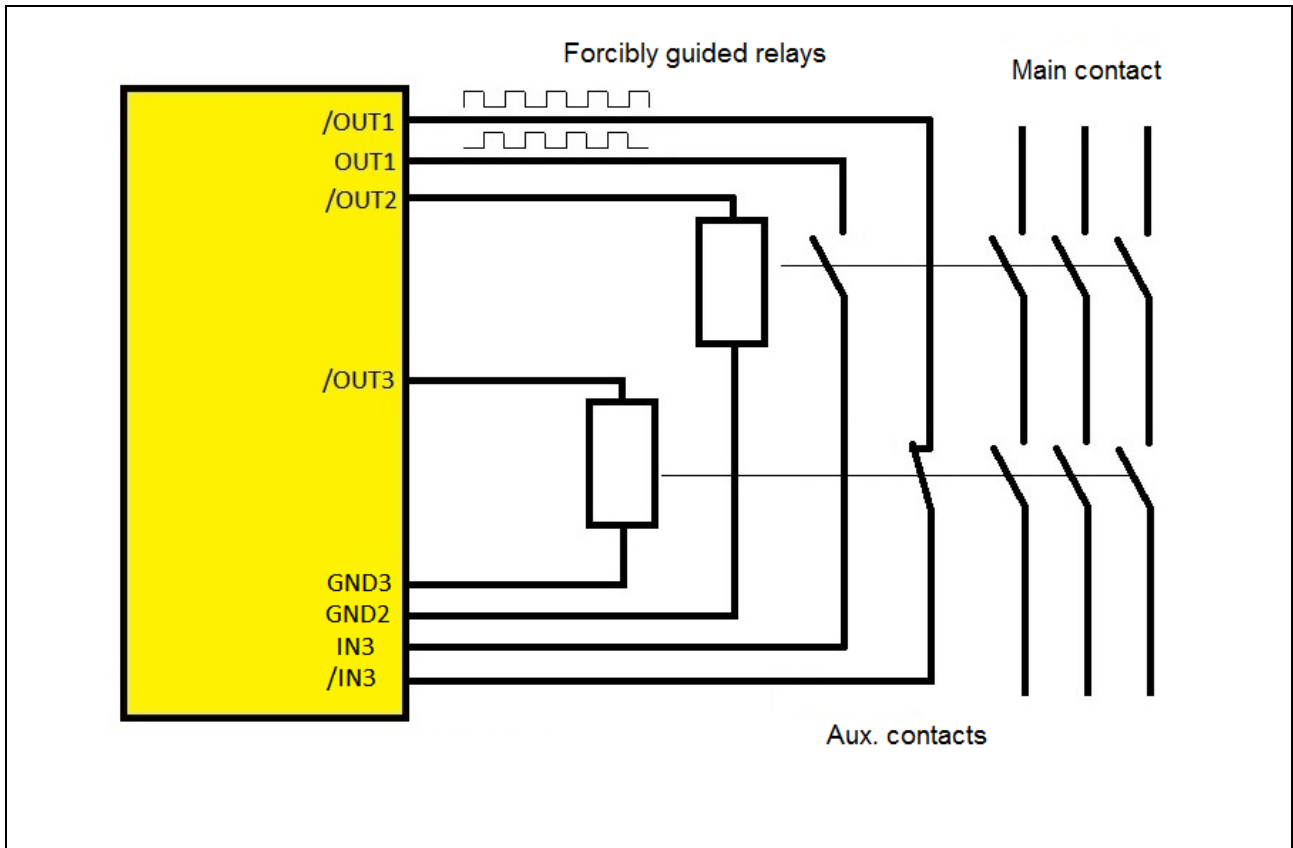
Function:

This application uses two independent outputs /OUT2 and /OUT3 with fully identical configuration concerning their switching characteristics. The basic function is similar to the application with one relay. The auxiliary contacts of both relays are individually connected to a separate input each. The GND lines of the two relays must be independent one from each other (Safety Integrity Level = 3).

The main contacts can be used as opener or closer depending on the application.

16.7 EDM: 2 external relays at X4 with SIL3

Precondition: 2 relays, 3 control outputs, 2 control inputs, auxiliary contact No and NC:



Parameter	Setting	Description
Switch Mode OUT1	9	OUT1 to generate clock signal
Switch Mode OUT2	0	OUT2 to signal overspeed
Switch Mode OUT3	0	OUT3 to detect overspeed
Read Back OUT	2	Inversion (connection via NO, NC contact)
IN3 Function	18	Adaption to OUT2 (overspeed)
IN3 Config	12	Adaption to clock output OUT1 (via X24/2 contact)
/IN3 Function	19	Adaption to OUT3 (overspeed)
/IN3 Config	13	Adaption to clock output /OUT1 (via X24/3)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,050	Delay 50 ms to obviate contact bouncing
Output Mode	0	Inverse operation



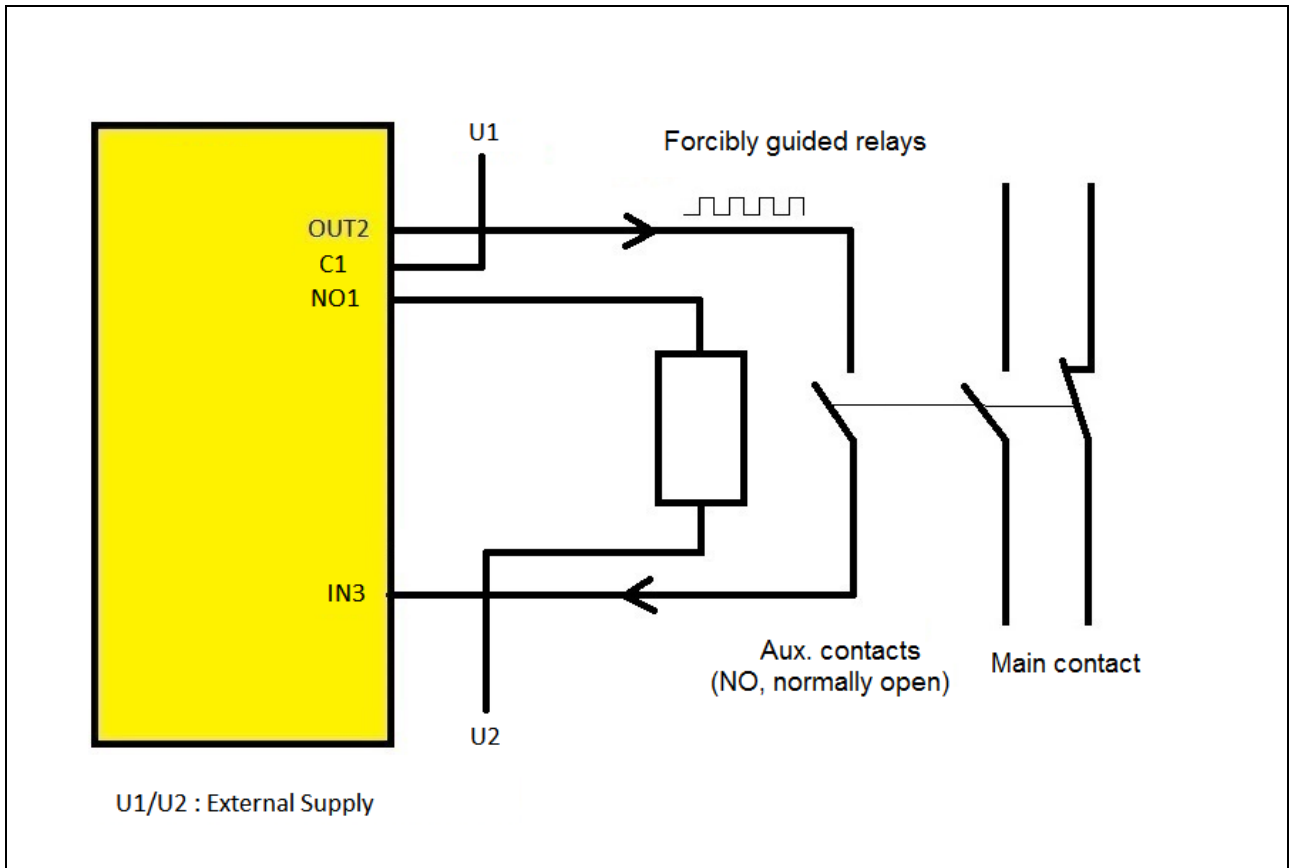
Function:

This application uses two independent outputs /OUT2 and /OUT3 with fully identical configuration concerning their switching characteristics. The basic function is similar to the application with one relay. The auxiliary contacts of both relays are individually connected to a separate input each. The GND lines of the two relays must be independent one from each other (Safety Integrity Level = 3).

The main contacts can be used as opener or closer depending on the application.

16.8 EDM: 1 external relay at X1/2 with SIL1

Precondition: 1 relay, 1 control and 1 relay output, 1 control input, contact NO:



Parameter	Setting	Description
Switch Mode REL1	0	REL1 to detect overspeed
Switch Mode OUT2	9	OUT2 to generate clock signal
Read Back OUT	16	Inversion (connection to X1/2 via NO contact)
IN3 Function	22	Adaption to REL1 (overspeed)
IN3 Config	14	Adaption to clock output OUT2 (via X1/2 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,100	Delay 100 ms to obviate double contact bouncing
Output Mode	0	Inverse configuration



Function:

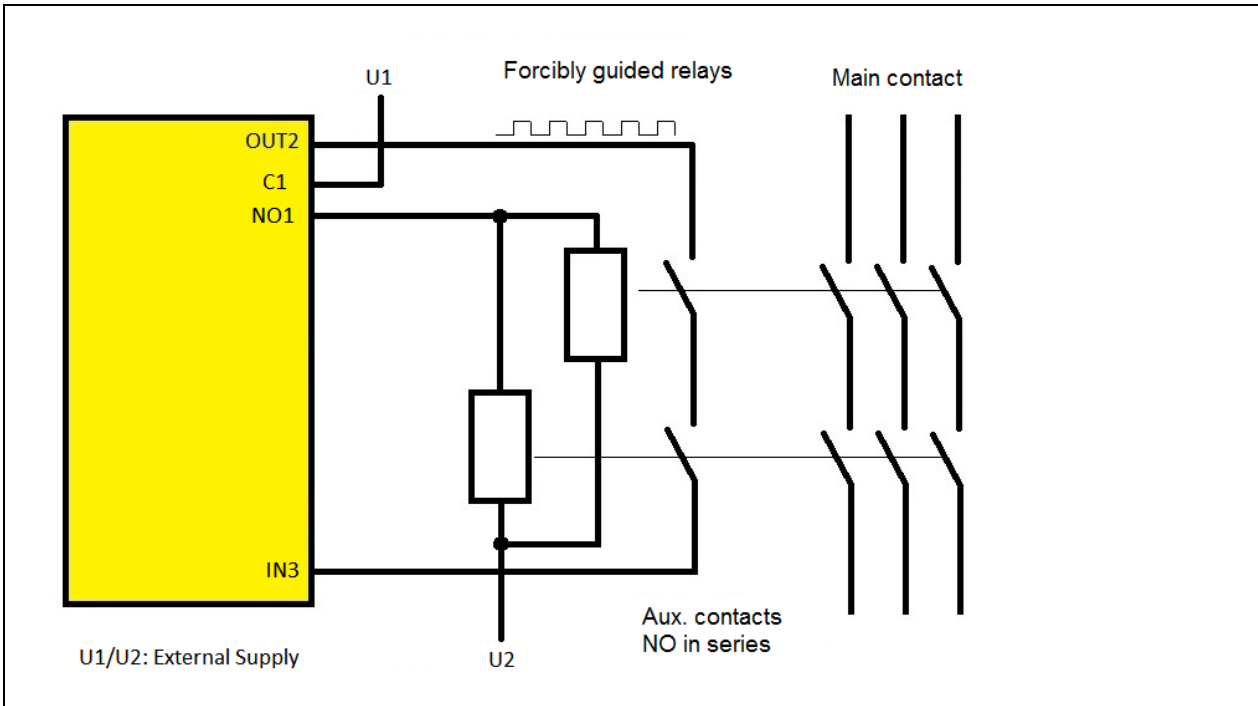
With normal operation speed the relay output X1 is closed, the external relay therefore is energized. Upon overspeed the relay output X1 is open and the remote relay will drop. The forcibly guided aux. contact is closed, when the relay output X1 is energized and the clock signal is conducted to the input.

Under error condition the SMCx monitor will open the relay output X1, the remote relay will be de-energized, which will signal "overspeed". With errors occurring under normal operating speed, the unit will take an error state which signals "overspeed" again (Safety Integrity Level = 1).

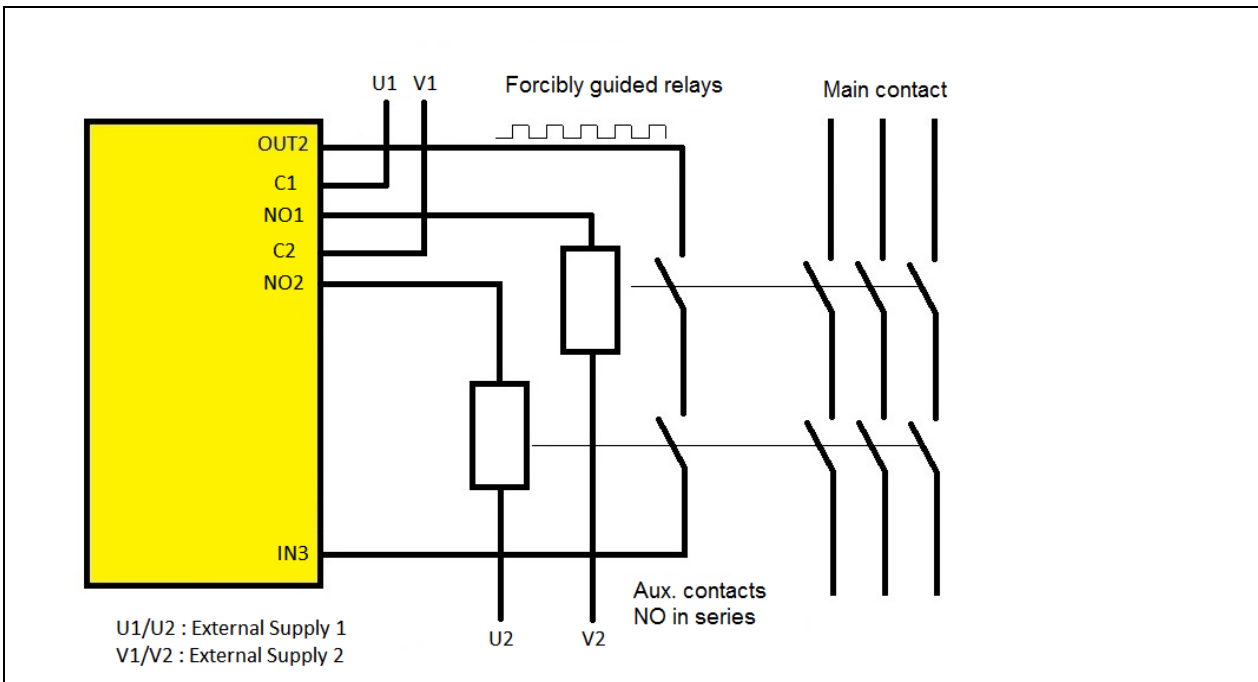
The main contacts can be used as opener or closer depending on the application.

16.9 EDM: 2 external relays at X1/2 with SIL2

Precondition: 2 relays, 1 control and 1 relay output, 2 control inputs, auxiliary contact NO:



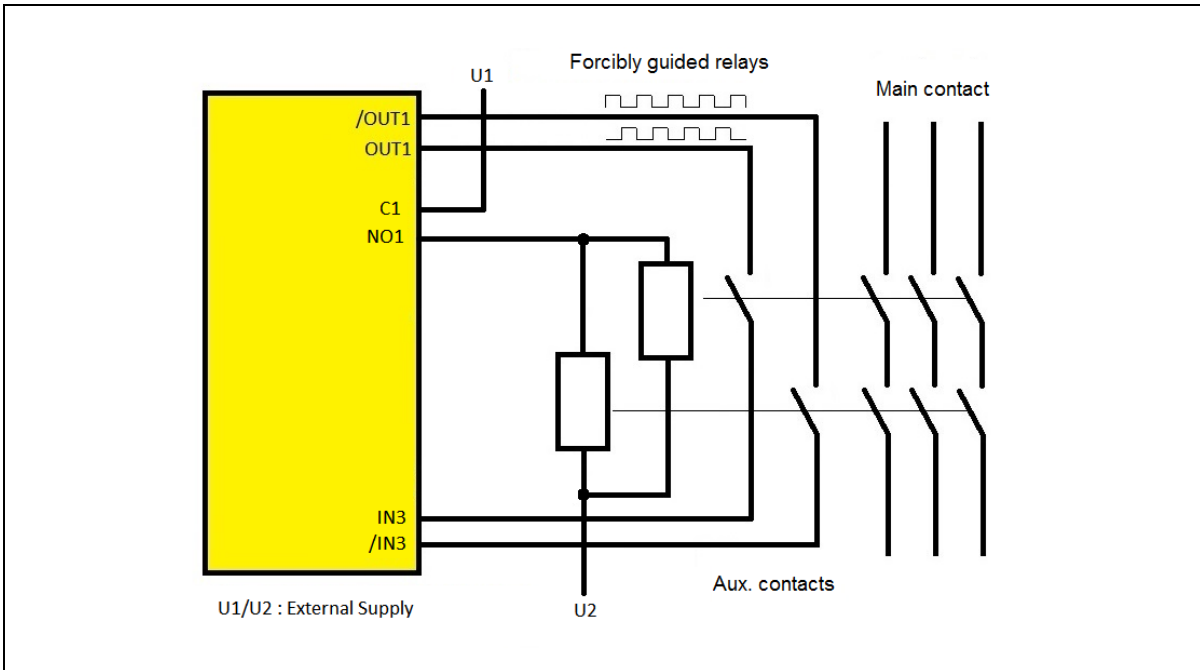
Precondition: 2 relays, 1 control and 2 relay outputs, 2 control inputs, auxiliary contact NO:



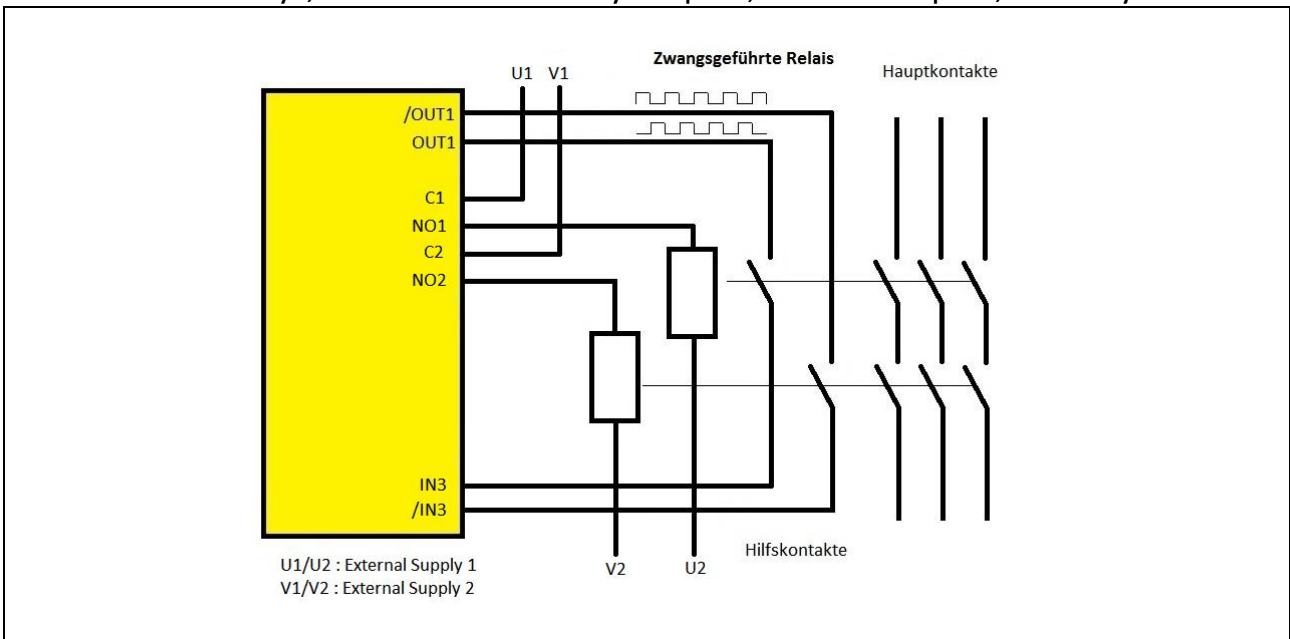
Parameter	Setting	Description
Switch Mode REL1	0	REL1 to detect overspeed
Switch Mode OUT2	9	OUT2 to generate clock signal
Read Back OUT	16	Inversion (connection to X1/2 via NO contact)
IN3 Function	22	Adaption to REL1 (overspeed)
IN3 Config	14	Adaption to clock output OUT2 (via X1/2 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,100	100ms delay due to the double relay bounce
Output Mode	0	Inverse circuit

16.10 EDM: 2 external Relays at X1/2 with SIL3

Precondition: 2 relays, 2 control and 1 relay output, 2 control inputs, auxiliary contact NO:



Precondition: 2 relays, 2 control and 2 relay outputs, 2 control inputs, auxiliary contact NO:



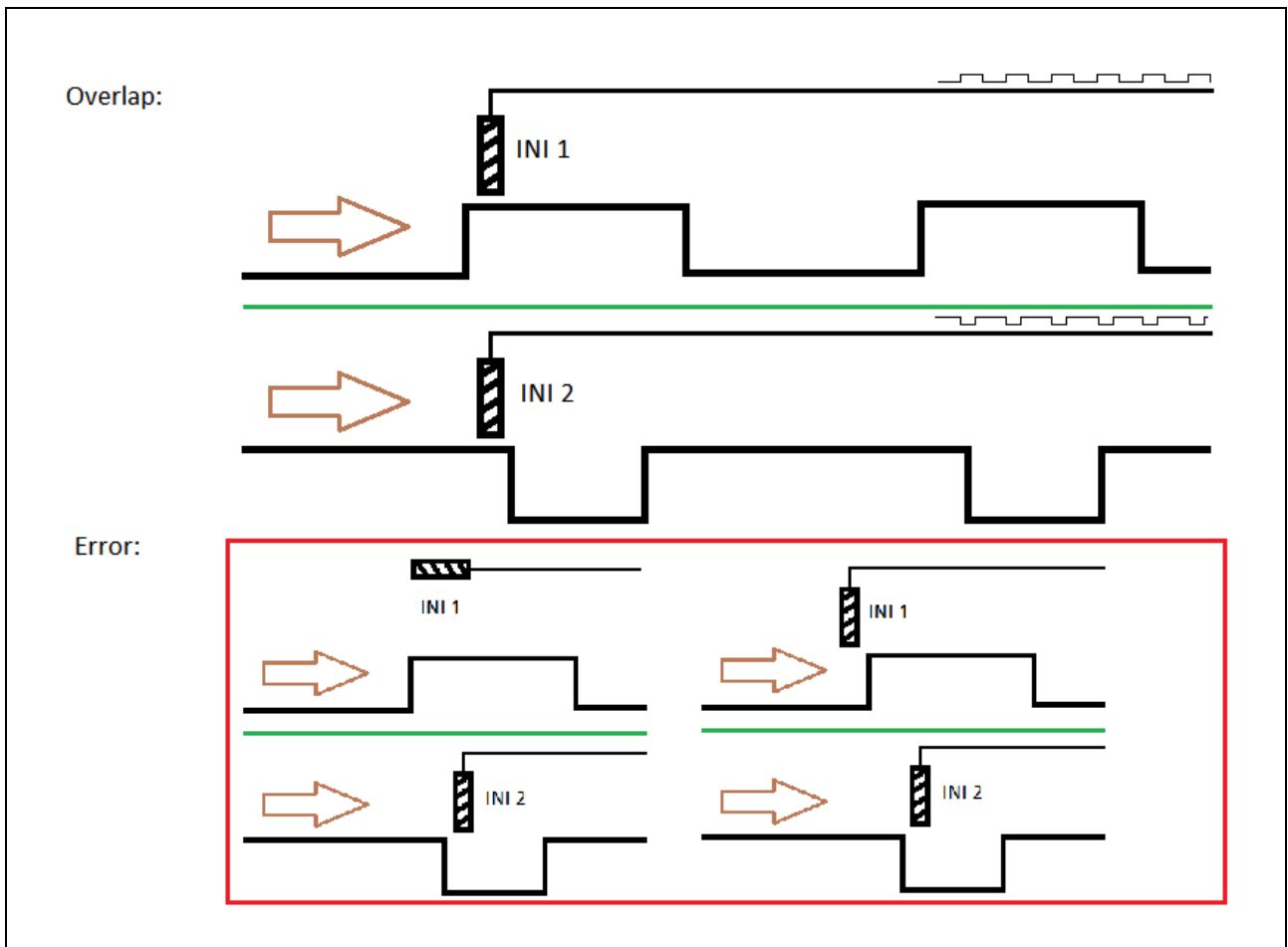
Parameter	Setting	Description
Switch Mode REL1	0	REL1 to detect overspeed
Switch Mode OUT1	9	OUT1 to generate clock signal
Read Back OUT	16	Inversion (connection to X1/2 via NO contact)
IN3 Function	22	Adaption to REL1 (overspeed)
IN3 Config	12	Adaption to clock output OUT2 (via X1/2 contact)
/IN3 Function	22	Adaption to REL1 (overspeed)
/IN3 Config	13	Adaption to clock output OUT2 (via X1/2 contact)
Input Mode 2	2	4 single control inputs for free use
Read Back Delay	0,100	100ms delay due to the double relay bounce
Output Mode	0	Inverse circuit

17 Overlap

Using the sensor parameter „Sensor Overlap“, Overlap monitoring can be activated. The Overlap function can only be performed if the "Op Mode"= 3 is activated, i.e. both sensors work with a HTL signals.

If the sensors are proximity switch, the recesses of both sensors must be installed in such a way that only three of the four possible output states occur during the run-off. The picture below shows that there is never a condition where both proximity switch are uncovered. If a sensor fails, an error can be triggered in the uncovered phase of the other sensor, because both sensors display the state uncovered. Removing both sensors or a cable break can also cause an error.

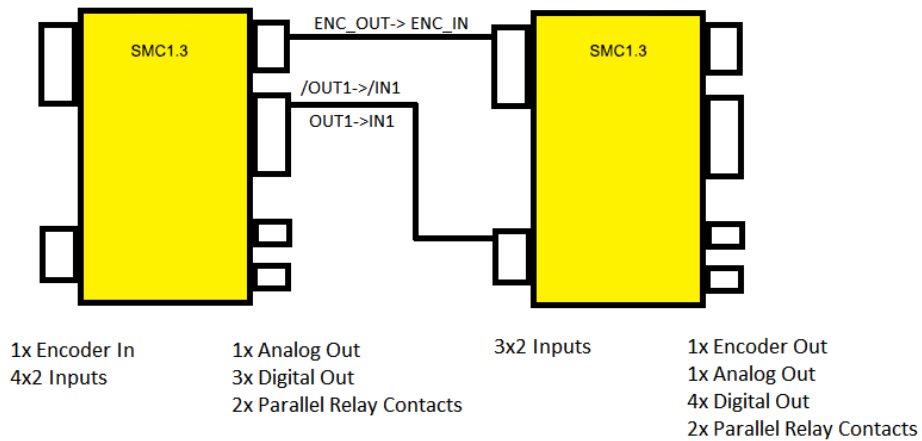
The type of recess can cause an error while at the same time covered or at the same time uncovered state. By choosing the proximity switch PNP opener or PNP closer, the polarity can be adjusted to the input of the SMCX (SMCX input open corresponds to low).



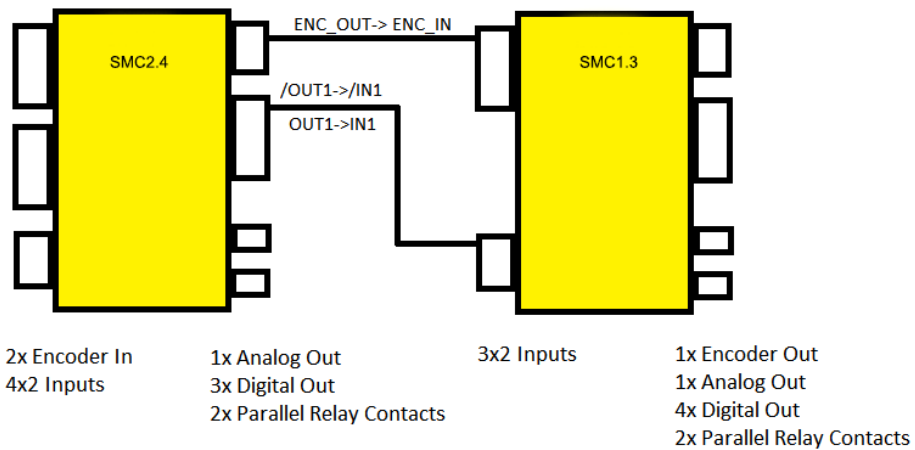
18 Cascading

By cascading two units, the number of control inputs and outputs can be increased. Errors of the first stage are forwarded via the Encoder output or via the digital output. Both connections must be present. The parameter "Split. Level" of the first unit must be set to 0 (5V) and the parameter "Power-CAS delay" must also be set to zero. The „Power-Cas Delay” parameter of the second unit should be set to about 20s.

Cascade Two Units:



Cascade Two Units:



19 Technical Specifications

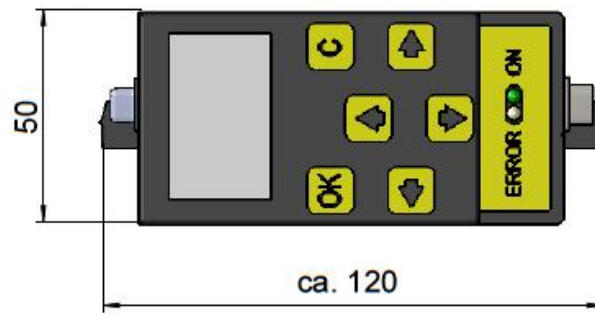
Technical Specifications:		
Power supply:	Input voltage: Protective circuit: Ripple: Power consumption: Protection: Connections:	18 ... 30 VDC reverse polarity protection Max. 10 % at 24 VDC approx. 150 mA (unloaded), approx. 2000 mA (loaded) external fuse (3.15 A, medium time-lag) necessary screw terminal, 1.5 mm ² / AWG 16
Encoder supply:	Number: Output voltage: Output current: Protective circuit:	2 5 VDC / 24 VDC (approx. 2 VDC ... 3VDC less the input voltage) Max. 200 mA per encoder short-circuit-proof
Incremental inputs:	Number of inputs: Format: Frequency: Connections:	2 Encoder (A, /A, B, /B, Z, /Z), (1 Encoder at SMC1.3) HTL differential - $U_{Diff} = \text{min. } 5V$ / HTL single ended - $U_H > 14V$, $U_L < 5V$ / RS422 - $U_{Diff} = \text{min. } 1,5V$ max 500 kHz screw terminal, 1.5 mm ² / AWG 16
Control inputs:	Number of inputs: Application: Signal level: Load: Frequency: Connections:	8 (single lane) or 4 (two-channel, inverse/homogeneous) Control signals HTL PNP (10 ... 30 V) max. 15 mA max. 1 kHz screw terminal, 1.5 mm ² / AWG 16
Incremental output: (safety related)	Splitter output: Format: Frequency: Connections:	1 encoder (A, /A, B, /B, Z, /Z) HTL differential/ HTL single ended/ RS422 max 500 kHz screw terminal, 1.5 mm ² / AWG 16
Analogue output: (safety related)	Current output: Resolution: Accuracy: Connections:	4 ... 20 mA (load max. 270 Ohm) 14 Bit $\pm 0,1\%$ screw terminal, 1.5 mm ² / AWG 16
Control outputs: (safety related)	Number of outputs: Output voltage: Output current: Switching character.: Protective circuit: Connections:	8 (single lane) or 4 (two-channel, inverse/homogeneous) HTL (approx. 2 ... 3 VDC less than input voltage) Max. 500 mA per output, shared max 1000 mA push-pull short-circuit-proof screw terminal, 1.5 mm ² / AWG 16
Relay output: (safety related)	Number of relays: Switching capability: Switching capacity: Connections:	1 double relay output, force-actuated (2x NO) 5 ... 250 VAC/ VDC 5 mA ... 5 A screw terminal, 1.5 mm ² / AWG 16
USB interface:	Version/connection: Operating System:	USB 1.0 / Type B (female) WIN7 /8 / 10 (tested with (1511 build 10586.104)
LEDs:	Green / yellow:	„ON“ / „ERROR“
Switches:	DIL switch:	1 x 3-pin

Technical Specifications:									
Conformity and standards:	MR 2006/42/EC: EMC 2014/30/EU: Vibration resistance: Shock resistance: RoHS (II) 2011/65/EU RoHS (III) 2015/863:	EN ISO 13849-1, EN 61508, EN 62061,EN 60947-5-1 EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61326-3-1, EN 61326-3-2 EN 60068-2-6 (sine, 7 g, 10 – 200 Hz, 20 cycles) EN 60068-2-27 (half sine, 30 g, 11 ms, 3 shocks) EN 60068-2-27 (half sine, 17 g, 6 ms, 4000 shocks) EN IEC 63000							
Safety characteristic data:	Classification: Approved Safety Function: System structure: System architecture: DC _{avg} : SFF: MTTF _D : PFH: $\lambda_{SD} / \lambda_{SU} / \lambda_{DD} / \lambda_{DU}$: Safety functions:	Up to SIL3/PLe (depends on the used encoder/sensor arrangement) Certification No.: 44 207 14018601 dual-channel Cat. 3 / HFT = 1 98,7 % 98,99 % 156,5 Jahre $5,73 * 10^{-9} h^{-1}$ $1,29 * 10^{-7} h^{-1} / 5,3 * 10^{-8} h^{-1} / 7,2 * 10^{-7} h^{-1} / 9,22 * 10^{-9} h^{-1}$ equivalent to EN 61800-5-2 for SS1, SS2, SOS, SLS, SDI, SSM, SLI, SBC, STO, SMS (depending on the used encoder input signals)							
Classification test impulses:	Classification: Class: Test Pulse Duration: Test Pulse interval: Input impedance: Input capacity:	by ZVEI CB24I <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>drain:</td> <td>C1</td> <td></td> <td>source:</td> <td>C1</td> <td>C2</td> <td>C3</td> </tr> </table> max. 1 ms min. 2,5 ms min. 18 kOhm max. 1 nF	drain:	C1		source:	C1	C2	C3
drain:	C1		source:	C1	C2	C3			
Enclosure:	Material: Mounting: Dimensions: Protection class: Weight:	plastic 35 mm top hat rail (according to EN 60715) 50 x 100 x 165 mm, 19,68 x 39,37 x 64,96", (w x h x d) IP20 ca. 400 g							
Ambient temperature:	Operation: Storage:	-20 °C ... +55 °C / -4 °F ... +131 °F (without condensation) -25 °C ... +70 °C / -13 °F ... +158 °F (without condensation)							
Mainten ance:	Interval:	Switch on/off for at least 1 times a year (at continuous operation)							
SMCB.1 unit: (optional)	Display / Operation:	OLED-Display / Touch screen							

19.1 Dimensions

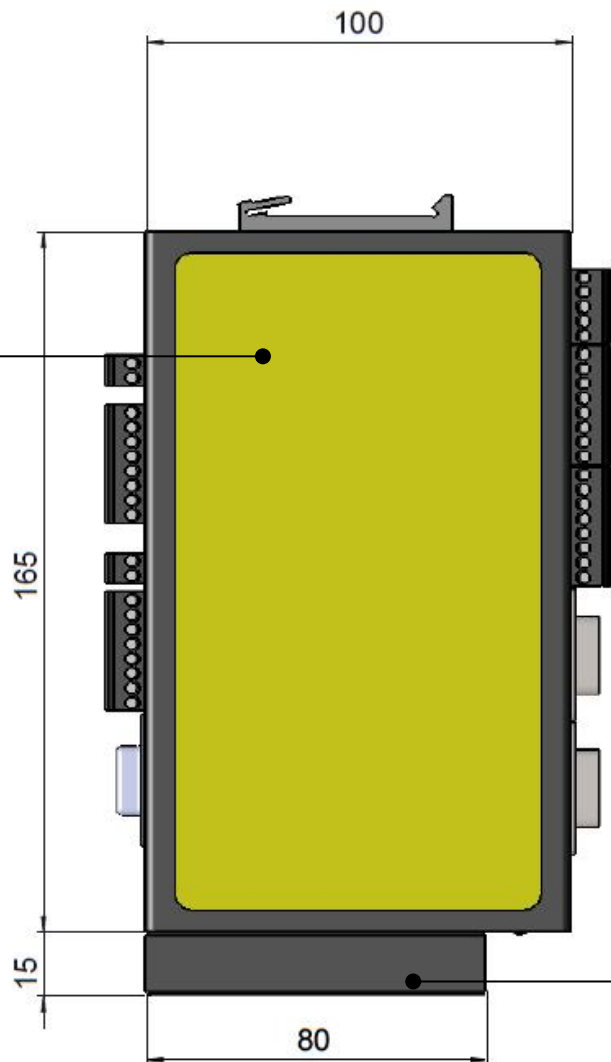
(incl. SMCB.1 on front)

Front:



Rear:

SMC2.4



SMCB.1 (option)

20 Certificate



ZERTIFIKAT CERTIFICATE

Hiermit wird bescheinigt, dass die Firma / This is to certify, that the company

Fritz Kübler GmbH
Schubertstrasse 47
78054 Villingen-Schwenningen
Deutschland

berechtigt ist, das unten genannte Produkt mit dem abgebildeten Zeichen zu kennzeichnen.
is authorized to provide the product described below with the mark as illustrated.

Fertigungsstätte: **Details siehe Anlage 2**
Manufacturing plant: *Details see Annex 2*

Beschreibung des Produktes: **Safety-M compact:**
(Details s. Anlage 1) **Wächter Serie zur sicherheitsgerichteten Überwachung**
Description of product: **von Drehzahl, Stillstand und Drehrichtung.**
(Details see Annex 1) *Monitor series for safety-related monitoring of speed, standstill*
and direction of rotation.

Geprüft nach: **EN ISO 13849:2015 – Kat. 3, PL e**
Tested in accordance with: **EN 61508:2010 – SIL 3**
EN 62061:2005+Cor.:2010+A1:2013+A2:2015 – SILCL 3



Registrier-Nr. / Registered No. 44 207 14202301
Prüfbericht Nr. / Test Report No. 3527 0559
Aktenzeichen / File reference 8003019337

Gültigkeit / Validity
von / from 2020-06-10
bis / until 2025-06-09


Zertifizierungsstelle der TÜV NORD CERT GmbH
Certification body of TÜV NORD CERT GmbH

Essen, 2020-06-10

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.de machinery@tuev-nord.de

Bitte beachten Sie auch die umseitigen Hinweise
Please also pay attention to the information stated overleaf

Hinweise zum TÜV NORD- Zertifikat

Dieses TÜV NORD - Zertifikat gilt nur für die umseitig bezeichnete Firma und das angegebene Produkt. Es kann nur von der Zertifizierungsstelle auf Dritte übertragen werden.

Notwendige Bedienungs- und Montageanweisungen müssen jedem Produkt beigelegt werden.

Jedes Produkt muss deutlich einen Hinweis auf den Hersteller oder Importeur und eine Typenbezeichnung tragen, damit die Identität des geprüften Baumusters mit den serienmäßig in den Verkehr gebrachten Produkten festgestellt werden kann.

Der Inhaber des TÜV NORD - Zertifikates ist verpflichtet, die Fertigung der Produkte laufend auf Übereinstimmung mit den Prüfbestimmungen zu überwachen und insbesondere die in den Prüfbestimmungen festgelegten oder von der Zertifizierungsstelle geforderten Kontrollprüfungen ordnungsgemäß durchzuführen.

Bei Änderungen am geprüften Produkt ist die Zertifizierungsstelle umgehend zu verständigen.

Bei Änderungen und bei befristeten Zertifikaten ist das Zertifikat nach Ablauf der Gültigkeit urschriftlich an die Zertifizierungsstelle zurückzugeben. Die Zertifizierungsstelle entscheidet, ob das Zertifikat ergänzt werden kann oder ob eine erneute Zertifizierung erforderlich ist.

Für das TÜV NORD - Zertifikat gelten außer den vorgenannten Bedingungen auch alle übrigen Bestimmungen des allgemeinen Vertrages. Es hat solange Gültigkeit, wie die Regeln der Technik gelten, die der Prüfung zu Grunde gelegt worden sind, sofern es nicht auf Grund der Bedingungen des allgemeinen Vertrages früher zurückgezogen wird.

Dieses TÜV NORD - Zertifikat verliert seine Gültigkeit und muss unverzüglich der Zertifizierungsstelle zurückgegeben werden, falls es ungültig wird oder für ungültig erklärt wird.

Hints to the TÜV NORD - Certificate

This TÜV NORD - certificate only applies to the firm stated overleaf and the specified product. It may only be transferred to third parties by the certification body.

Each product must be accompanied by the instructions which are necessary for its operation and installation.

Each product must bear a distinct indication of the manufacturer or importer and a type designation so that the identity of the tested sample maybe determined with the product launched on the market as a standard.

The bearer of the TÜV NORD - Certificate undertakes to regularly supervise the manufacturing of products for compliance with the test specifications and in particular properly carry out the checks which are stated in the specifications or required by the test laboratory.

In case of modifications of the tested product the certification body must be informed immediately.

In case of modifications and expiration of validity the original certificate must be returned to the certification body immediately. The certification body decides if the certificate can be supplemented or whether a new certification is required.

In addition to the conditions stated above, all other provisions of the General Agreement are applicable to the TÜV NORD - Certificate. It will be valid as long as the rules of technology on which the test was based are valid, unless revoked previously pursuant to the provisions of the General Agreement.

This TÜV NORD - Certificate will become invalid and shall be returned to the certification body immediately in the event that it shall expire without delay when it has expired or revoked.

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zum Zertifikat Registrier-Nr. / to Certificate Registration No. 44 207 14202301

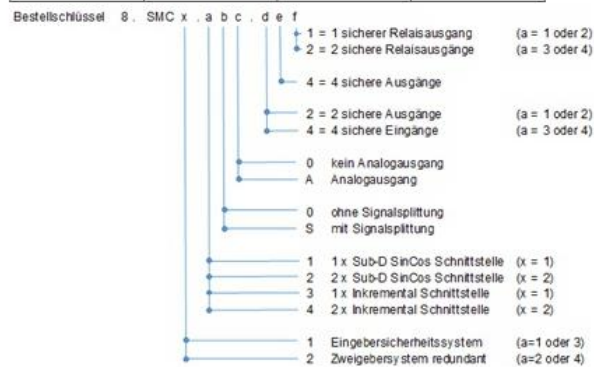
Produktbeschreibung:
Product description:

Redundante Auswerteeinheit zum Erfassen, Verarbeiten und Weiterleiten von sicherheitsgerichteten Ein- und Ausgangsgrößen in sicherheitsgerichteten Applikationen bezogen auf Drehzahl, Stillstand und Drehrichtung.
Redundant safety monitor for measuring, processing and forwarding safety-related input and output values on safety related applications with regards to speed, standstill and direction of rotation.

Typbezeichnung:
Type designation:

Safety-M compact:

SMC1.100.241	SMC2.200.241	SMC1.300.442	SMC2.400.442
SMC1.10A.241	SMC2.20A.241	SMC1.30A.442	SMC2.40A.442
SMC1.1S0.241	SMC2.2S0.241	SMC1.3S0.442	SMC2.4S0.442
SMC1.1SA.241	SMC2.2SA.241	SMC1.3SA.442	SMC2.4SA.442



Essen, 2020-06-10


Zertifizierungsstelle der TÜV NORD CERT GmbH
Certification body of TÜV NORD CERT GmbH

TÜV NORD CERT GmbH Langemarckstraße 20 45141 Essen www.tuev-nord-cert.de machinery@tuev-nord.de

ANLAGE ANNEX

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zum Zertifikat Registrier-Nr. / to Certificate Registration No. 44 207 14202301

Produktbeschreibung:
Product description:

Redundante Auswerteeinheit zum Erfassen, Verarbeiten und Weiterleiten von sicherheitsgerichteten Ein- und Ausgangsgrößen in sicherheitsgerichteten Applikationen bezogen auf Drehzahl, Stillstand und Drehrichtung.
Redundant safety monitor for measuring, processing and forwarding safety-related input and output values on safety related applications with regards to speed, standstill and direction of rotation.

Hinweise:
Remark:

Weitere Technische Daten sind dem zugehörigen Safety-Manual zu entnehmen.
Further technical data can be found in the corresponding Safety Manual.

Zur Realisierung einer SIL 3 / SILCL 3 / PL e bzw. SIL 2 / SILCL 2 / PL d Sicherheitsfunktion ist bei der Variante SMC1.1 und SMC1.3 ein gleichermaßen zertifizierter Sensor zu verwenden
To implement a SIL 3 / SILCL 3 / PL e or SIL 2 / SILCL 2 / PL d safety function, an equally certified sensor must be used with the SMC1.1 and SMC1.3 versions.


Zertifizierungsstelle der TÜV NORD CERT GmbH
Certification body of TÜV NORD CERT GmbH

Essen, 2020-06-10

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