Preliminary Draft

Safety Relay TETHYS IP65 SR

Operating Instructions

English translation

Errors and technical changes reserved

Correct Use

EN ISO 13849-1

EN IEC 62061
IEC 61511
IEC 61508

EN 746 - 2
EN 50156 - 1

Product Safety
Functional
Safety
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REGULATORY
APPROVAL
PENDING

The TETHYS IP65 SR is a universal emergency stop safety switching device with three safe relay contacts that can quickly and safely stop the moving parts of a machine or system in case of danger.

The Device is water and dust proof according to IP65 and therefore intented for usage outside of control cabinets e.g. directly at the machine.

Applications for the TETHYS IP65 SR include single or dual-channel emergency stop circuits and guard monitoring on machines and plants according to EN ISO 13849-1, EN IEC 62061, IEC 61508, IEC 61511. It is also certified for the use in furnaces and ancillary equipment in continuously mode according to EN 50156-1 and EN 746-2.

- *3 safe, redundant, diverse relay contacts*
  1 auxiliary contact (signaling contact)
  1 auxiliary semiconductor output (signaling output)
- *Connection of:*
  - *Emergency stop buttons*
  - *Safety switches*
  - *Non-contact safety switches*
  - *OSSD-Outputs*
  - *Tactile sensors e.g. safety mats*
- *Single and dual-channel operation possible*
- *Feedback loop for monitoring downstream contactors or expansion modules*
- *Cyclical monitoring of the output contacts*
- *Indication of the switching state via LED*
- *2 start behaviors possible:*
  - Monitored, manual start
  - Automatic start
- *Short circuit and earth fault monitoring*
- *Internal overcurrent and overvoltage protection*
- *Water and dust proof according to IP65*
- *Reinforced isolation (6kV, OVC III, EN 60664-1)*
- *Up to PL e, SIL 3, category 4*

Function

The safety emergency stop relay TETHYS IP65 SR is designed for the safe isolation of safety circuits in accordance with EN 60204-1 and thus performs the safety-related stop function up to PL e / SIL 3 in accordance with EN ISO 13849-1 / IEC 61508. If the emergency stop circuit (e.g. safety door or emergency stop button) is closed, the machine can be enabled via the TETHYS IP65 SR. When the safety function is requested via the emergency stop circuit (e.g. safety door open), the enable current paths of the TETHYS IP65 SR are opened immediately and thus safely switch off the machine. The redundant use of forcibly guided relays ensures that a single fault within the device does not lead to the loss of the safety function and that this is detected by cyclical self-monitoring the next time the safety function is requested.

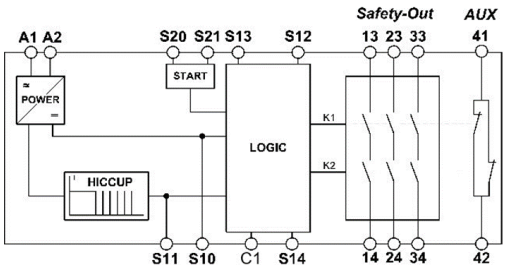

Fig. 1 Block diagram TETHYS IP65 SR

Installation

The device can operate outside of control cabinets due to its IP65 degree of protection.

There are two mounting variants, installation via screws or lashing. A maximum of three screws per side ensured maximum durability against induced shocks.

The shock ratings are reached by using two screws per side.

The following should be noted:

- Ensure the mounting variant (screws or lashing) and the mounting surface is strong enough to support the device, including cabling, and inducted loads while machine operation.
- Use at least one screw or strap on each side.
- Ensure sufficient heat dissipation around the device

Safety Precautions

- Installation and commissioning of the device must be performed **only by authorized personnel**.
- Observe the country-specific regulations when installing the device.
- The electrical connection of the device is only allowed to be made with the device isolated.
- The wiring of the device must comply with the instructions in this user information, otherwise there is a risk that the safety function will be lost.
- It is not allowed to open the device, tamper with the device or bypass the safety devices.
- All relevant safety regulations and standards are to be observed.
- The overall concept of the control system in which the device is incorporated must be validated by the user.
- Failure to observe the safety regulations can result in death, serious injury and serious damage.
- Note down the version of the product (see label “Ver. X”) and check it prior to every commissioning of a new device. If the version has changed, the overall concept of the control system in which the device is incorporated must be validated again by the user.
- The year of manufacture can be found on the type label on the device. It is located at the end of the line of the voltage specification, below the ID number.

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Ver. A
E61-607-00

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Applications

Depending on the application or the result of the risk assessment according to EN ISO 13849-1, the device must be wired as shown in Fig. 2 to Fig. 9.

Emergency Stop Circuit

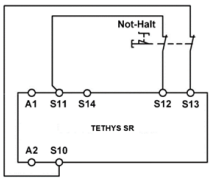


Fig. 2:
Two-channel emergency stop circuit with short circuit and earth fault monitoring.
(category 4, up to PL e)

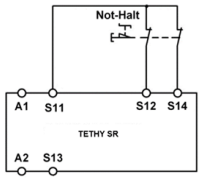


Fig. 3:
Two-channel emergency stop circuit with earth fault monitoring.
(category 3, up to PL d)

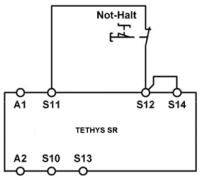


Fig. 4:
Single-channel emergency stop circuit with earth fault monitoring.
(category 1, up to PL c)

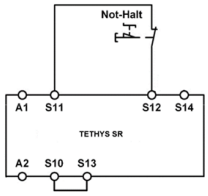


Fig. 5:
Single-channel emergency stop circuit with earth fault monitoring.
(category 1, up to PL c)

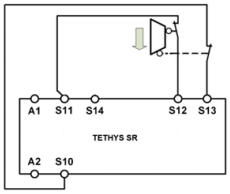


Fig. 6:
Two-channel sliding guard monitoring with short circuit and earth fault monitoring.
(category 4, up to PL e)

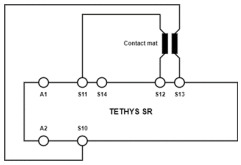


Fig. 7:
Two-channel tactile sensor monitoring with short circuit and earth fault monitoring.
(category 3, up to PL d)

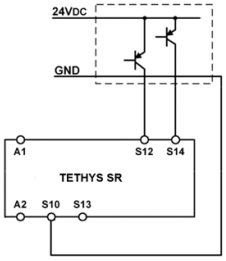


Fig. 8:
Two-channel emergency stop with pnp-outputs/OSSD-outputs ***with*** *short circuit monitoring.*
(category 4, up to PL e)

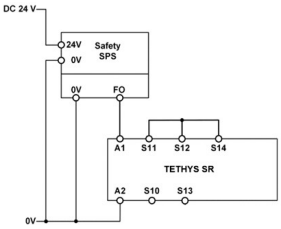


Fig. 9:
Connecting to a safety PLC
(category 4, up to PL e)
Prerequisite:
Fault exclusion for cross-circuit (e.g. according to EN ISO 13849-2; Table D4 - wiring in protected wiring space) and PLC also meets requirements for category 4, PL e.

Notice:

- The earth connection of the power supply unit must be on the secondary side
- It must be ensured that any switch-on pulses (light test) sent by the signal generator do not lead to a short activation of the safety relay and should therefore basically be deactivated
- For the applications according Fig. 8 and 9, make sure that the reference potential of the signal generator and the TETHYS IP65 SR is the same

Starting Behavior

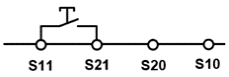
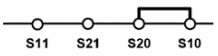


Fig. 10:
Monitored manual start.

It is monitored that the start button was opened before the emergency stop button closes.
(Prerequisite: operating voltage must not be interrupted.)
Start is executed at button release (falling edge detection).



Warning:
Safety contacts switch immediately when the power supply is connected.

Fig. 11:
Automatic start.

Max perm. delay during closing of the safety switches on S12 and S13:
S12 before S13: 500 ms
S13 before S12: any

Feedback Loop

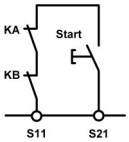


Fig. 12:
Feedback loop for monitored manual start:
The feedback loop monitors contactors or the expansion modules .

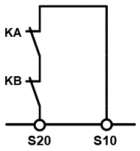


Fig. 13:
Feedback loop for automatic start:
The feedback loop monitors contactors or the expansion modules .

Power supply and Safety contacts

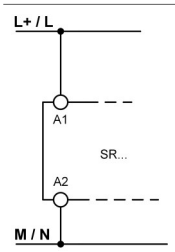


Fig. 14:
Power supply A1 and A2.

(Power supply according to techn. Data)

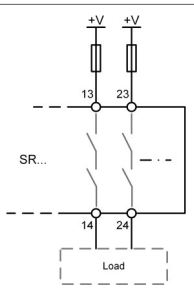


Fig. 15:
Connecting load to safety contacts.

(Figure shows example.
Voltage „+V“ according to techn. Data)

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Commissioning Procedure

Note: *The items listed under "Electrical connection" must be observed during commissioning.*

1. Input circuit:
Depending on the risk evaluation choose one of the wiring diagrams in „Applications" (Fig. 2 to 9).

2. Choose start mode:
Wire the start circuit according to the examples in Fig. 10 or 11 to set the starting behavior.

Warning:
If "Automatic start" is set, bear in mind that the safety contacts will switch immediately after the power supply is connected.
If "Monitored manual start" is set, the start button must be released after pushing.

3. Feedback loop:
If your application provides for external contactors or expansion modules, connect them to the device according to the examples in Fig. 12 or 13.

4. Power supply:
Connect the power supply to A1 and A2 (Fig. 14).
Caution: Power must not yet be activated.

5. Starting the device:
Switch on the operating voltage. LED PWR is lit.
Warning:
If the "Automatic start" starting behavior is set, the safety contacts will close immediately.
If the "Monitored manual start" starting behavior is set, push and release the start button to close the safety contacts.
LEDs ***K1*** and ***K2*** are lit.

6. Triggering safety function:
Open the emergency stop circuit by actuating the connected safety switch. The safety contacts open immediately.

7. Reactivation:
Close the emergency stop circuit.
If "Automatic start" is selected, the safety contacts will close immediately.
If the "Monitored manual start" starting behavior is set, push and release the start button to close the safety contacts.

Check and Maintenance

No maintenance is required for the device itself.
But the following checks are regularly required to ensure proper and continuous functioning:

- Check the switch function
- Check for signs of manipulation and safety function bypassing
- Check if the device is mounted and connected securely
- Check for soiling

Check if the safety device is working properly, in particular:

- Every time after initial commissioning
- Every time after replacing a component
- After every fault in the safety circuit

Irrespective of this, the safe function of the protective device should be checked at suitable intervals, e.g. as part of the system's maintenance program. Maintenance work on the device itself is not required.

What to do in Case of a Fault?

Device does not switch on:

- Check the wiring by comparing it to the wiring diagrams.
- Check the safety switch used for correct function and adjustment.
- Check whether the emergency stop circuit is closed.
- Check whether the start button (with manual start) is closed.
- Check the operating voltage at A1 and A2.
- Is the feedback loop closed?

Device cannot be switched on again after an emergency stop:

- Check whether the emergency stop circuit was closed again.
- Was the start button pushed and released (with manual start)?
- Is the feedback loop closed?

If the fault still exists, perform the steps listed under "Commissioning Procedure".
If these steps do not remedy the fault either, return the device to the manufacturer for examination.
Opening the device is impermissible and will void the warranty.

Proof-Test

In order to check the proper function of the device, the following steps have to be carried out

- Demand the safety function by opening the safety circuit. Check that the relay contact (13-14; 23-24; 33-34) opened by activation of the safety function.
- Close the safety circuit and start the device again. Check that the safety contacts (13-14; 23-24; 33-34) closed again.

If the device doesn't switch on again, the proof-test failed.
ATTENTION:
If the proof-test fails, the device must be replaced. Otherwise there is a risk of loss of functional safety.

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Technical Data

Corresponds to the standards	EN 60204-1; EN ISO 13849-1; EN 62061; EN 50156-1; EN 746-2; IEC 61508 Parts 1-2, 4-7; IEC 61511-1
Operating voltage	DC 24 V
Permissible deviation	+10%/-15%
Power consumption	**DC 24 V** typ. 2.4 W
Control voltage at S11	DC 24 V
Control current S11...S14	typ. 50 mA
Start logic	Monitored manual start: falling edge detection on S21 Automatic start: static low level on S20
Auxiliary output	1 semiconductor output
Auxilary output logic	Inverted to safety contacts, active low
Auxiliary output voltage	DC 24 V +10%/-20%
Auxilary output current	DC 100 mA max
Safety contacts	3 NO contacts
Auxiliary contacts	1 NC contact
Max. switching voltage NO contacts	AC 250 V
Max. switching voltage NC contacts	AC 25 V DC 60V
Safety contact breaking capacity (13-14, 23-24, 33-34) (6 switching cycles/ min)	AC: 250 V, 2000 VA, 8 A for ohmic load 250 V, 3 A for AC-15 DC: 40 V, 320 W, 8A for ohmic load 24 V, 3 A, for DC-13 Max. total current through all 3 contacts: 15 A (13-14, 23-24, 33-34)
Auxiliary contact breaking capacity (41-12)	AC: 250 V, 500 VA, 2 A for ohmic load DC: 40 V, 80 W, 2 A for ohmic load
Minimum contact load	5 V, 10 mA
Contact fuses	10 A gG 6 A gG for applications acc. to EN 50156-1 (See Chapter 10.5.5.3.4)
Contact material	$AgSnO_2$
Contact service life	mech. approx. 1×10^7
Max. line cross section	0.14 - 2.5 mm^2
Tightening moment X1 … X5 (Min. / Max.)	0,8 Nm / 1,3 Nm
Typ. switch-on delay / switch-off delay for NO contacts requested via safety circuit	< 25 ms / < 10 ms
Typ. switch-on delay / switch-off delay for NO contacts requested via A1	< 50ms / < 30ms
Max. length of control line	1000m with 0.75 mm^2
Rated insulation voltage	AC 250 V
Degree of contamination	2 (EN 60664-1)
Overvoltage category	3 (EN 60664-1)
Max. altitude	≤ 2000 m (above sea level)
Rated impulse withstand voltage / air– and creepage distance, in between NO contacts	6 kV / 5.5 mm (EN 60664-1)
Rated impulse withstand voltage / air– and creepage distance, between NO contacts and SELV signals	6 kV / 5.5 mm (EN 60664-1)
Rated impulse withstand voltage / air– and creepage distance, between NC contacts and SELV signals	330 V / 0.2 mm (EN 60664-1)
Degree of protection	IP65
Temperature range	-25 °C bis +55 °C
Weight	320 g
Mounting	Fixed screw connection or lashing

Electrical Connection

- Consider the information in the section "Technical data"
- A safety transformer according to EN 61558-2-6 or a power supply unit with electrical isolation from the mains must be connected. (SELV)
- External fusing of the safety contacts must be provided
- If the device does not function after commissioning, it must be returned to the manufacturer unopened. Opening the device will void the warranty
- Use adequate protective circuit for inductive loads (e.g. free-wheeling diode)

A1:	*Power supply*
A2 :	*Power supply*
S11:	*DC 24 V control voltage*
S10:	*Control line*
S20:	*Start control line*
S21:	*Start control line*
S13:	*Control line*
S14:	*Control line*
S12:	*Control line*
13-14:	*Safety contact 1*
23-24:	*Safety contact 2*
33-34:	*Safety contact 3*
41-42:	*Auxiliary contact*
C1:	*Auxiliary Output*

Fig. 16 Connections

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Disclaimer and warranty

If the above mentioned conditions for appropriate use are not complied with or if the safety instructions are not followed or if any maintenance operations are not carried out as required, this shall lead to an exclusion of liability and loss of warranty.

ATTENTION!

We would like to point out that it is the full responsibility of the operator to ensure a plant availability. Using the TETHYS IP65 SR, a safety emergency stop relay according to

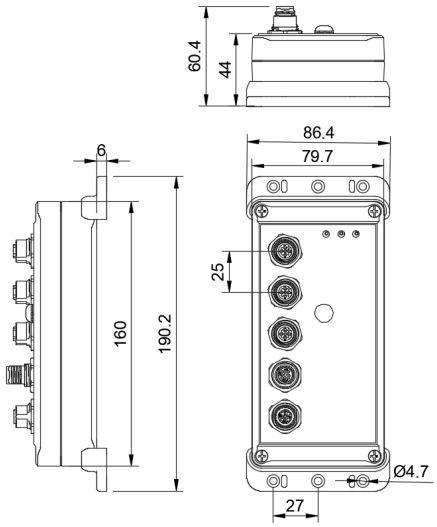
- EN ISO 13849-1
- EN IEC 62061
- IEC 61508
- EN 50156-1
- EN 746-2
- IEC 61511-1

is used, which will be brought into the safe state when the safety function is requested.

This means that the connected load is switched off as soon as a request from connected sensor elements or diagnostic measures detects a dangerous state, e.g. caused by a component fault.

Since process-related applications in particular have high demands on availability, limited availability can also have significant consquences. It is therefore recommended to stock a second unit to avoid long downtimes in such a case. These are recommendations of the manufacturer, the evaluation of the importance of the plant availability is the sole responsibility of the operator.

Dimension Drawing



Pinout

Standard M12 connector configuration

X1 - Power

M12 A-coded, 5 Pin, Female

1	A1	Power supply +
2	41	Auxiliary contact NC +
3	A2	Power supply -
4	42	Auxiliary contact NC -
5	C1	Auxiliary semiconductor output

Pin-out is IO-Link compatible.

X2 - Start circuit

M12 A-coded, 5 Pin, Female

1	S11	+24 VDC, supply
2	S21	Monitored manual start, input
3	S13	0 VDC, supply
4	S20	Automatic start, input
5	n.c.	not used

X3 - Safety circuit

M12 A-coded, 5 Pin, Female

1	S11	+24 VDC, supply
2	S10	0 VDC, supply
3	S14	Safety circuit CH 2 +
4	S12	Safety circut CH 1 +
5	S13	Safety circuit CH 2 -

X4 - Safety Contacts High-Side

M12 S-coded, 3+1 Pin, Male

1	13	Safety Contact 1 + (High-Side)
2	23	Safety Contact 2 + (High-Side)
3	33	Safety Contact 3 + (High-Side)
4	n.c.	not used

X5 - Safety Contacts Low-Side

M12 S-coded, 3+1 Pin, Female

1	14	Safety Contact 1 - (Low-Side)
2	24	Safety Contact 2 - (Low-Side)
3	34	Safety Contact 3 - (Low-Side)
4	n.c.	not used

Note: Customer-specific pinout and connector types according to customer requirements are possible. Please contact our team for further information.

Variants

Order no. 476100	TETHYS IP65 SR	Standard M12 connector configuation

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Safety Charcteristics

Safety characteristics according to EN ISO 13849-1

Load - DC-13	**≤ 0.1 A**	**≤ 1A**	**≤ 2 A**
Max. duration of use [Years]	20	20	20
Category	4	4	4
PL	e	e	e
PFHd [1/h]	Pending	Pending	Pending
nop [Cycles / year]	Pending	Pending	Pending

Safety characteristics according to IEC 61508 - High Demand

Conditions: Days of operation/year: 365; Hours/Day: 24; Switching-Cycle/Hour: 1; Maximum load AC-15 / DC-13	
Max. duration of use [Years]	20
Proof-Test-Intervall [Years]	20
PFH [1/h]	Pending
SIL	3

Safety characteristics for alternate 1oo1 structure for process industry - High Demand

Conditions: Days of operation/year: 365; Hours/Day: 24; Switching-Cycle/Hour: 1; Maximum load AC-15 / DC-13	
Device type	A
HFT	1
SIL	3
SFF [%]	Pending
λ_{SD} [FIT]	Pending
λ_{SU} [FIT]	Pending
λ_{DD} [FIT]	Pending
λ_{DU} [FIT]	Pending
PFH [1/h]	Pending

Safety characteristics according to IEC 61508 - Low Demand

Conditions: Maximum load AC-15 / DC-13	
Max. duration of use [Years]	20
Proof-Test-Intervall [Years]	Pending
PFD_{AVG}	Pending
SIL	Pending

Safety characteristics for alternate 1oo1 structure for process industry - Low Demand

Conditions: Maximum load AC-15 / DC-13	
Device type	Pending
HFT	Pending
SIL	Pending
SFF [%]	Pending
λ_{SD} [FIT]	Pending
λ_{SU} [FIT]	Pending
λ_{DD} [FIT]	Pending
λ_{DU} [FIT]	Pending
PFD_{avg} (e.g. for T = 1 year)	Pending

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CE Declaration

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