TECHDOCS

WAGO I/O System 750/753

Safe 2 channel relay output; 250 V; 6 A

750-1689

Product manual
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Every conceivable measure has been taken to ensure the accuracy and completeness of this documentation. However, as errors can never be fully excluded, we always appreciate any information or suggestions for improving the documentation.

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Table of Contents

1 Provisions

1.1 Scope of Applicability

This document applies to the following product:

750-1689 (2FRO 250V 6A) Safe 2-channel relay output; 250 V; 6 A

Product Detail Page	**www.wago.com/750-1689**

Note

Note applicable documents!

The complete operating instructions for the product consists of several, applicable documents. The product must only be installed and operated in accordance with the complete operating instructions. Knowledge of all applicable documents is required for proper use. You can find all documents and information on the product detail page.

Applicable document

System Manual I/O System 750/753

- Provisions
- Safety
- Planning
- Transport and Storage
- Assembly and Disassembly
- Conductor Termination
- Decommissioning

2 Safety

2.1 General Safety Regulations

- All activities and all configurations of functional safety devices, as a result of which the behavior of the functional safety is changed, may only be performed by persons who are competent in safety matters.

2.2 Indirect Safety

- Always check the safe state of your system before starting work.
- After every change to your system, all functional safety functions must be checked for effectiveness.

3 Overview

The 750-1689 safe relay output module (F RO module) can be used to implement safety applications in accordance with the following standards:

- IEC 61508 Parts 1-7, up to SIL3
- EN ISO 13849 Parts 1-2, up to Cat. 4/PL e
- IEC 62061, up to SIL3

The following loads can be operated on the relay outputs of the F RO module (see **Connection Examples [▸ 21]**):

- Resistive loads
- Inductive loads per DC-13 in accordance with EN 60947-5-1
- Inductive loads per AC-15 in accordance with EN 60947-5-1

The F RO module has the following features:

- 2 safety-oriented relay outputs
- Visualization of the switched statuses via LED indicators

A relay is activated by applying a control voltage from the outside with a safety-oriented semiconductor output and switching the relay on or off via the process image of the safe relay output module.

The safety function of the relay outputs is to switch off the actuators connected to the relay outputs.

The safe state of the relay outputs is the switched-off state.

The relay outputs are controlled with integrated reverse polarity protection.

All of the relay's normally open contacts, all of the relay's control voltages and the system voltage are electrically isolated from each other.

Any arrangement of the potential groups and of the individual I/O modules within the potential groups is possible when configuring the fieldbus node.

The 750-1689 F RO module can be used on any head stations on which the F I/O module that is required to control the relays can be used.

4 Properties

4.1 View

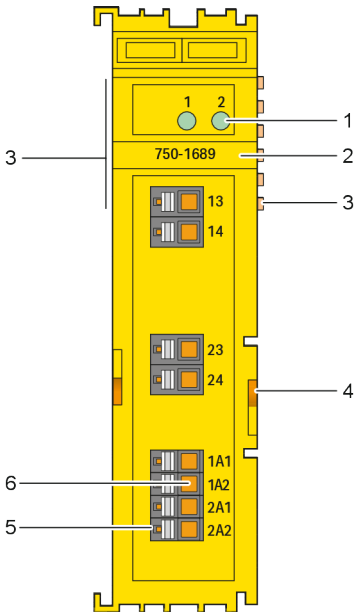


Figure 1: View

1	Indicators	Indicators [▸ 9]
2	Item number	Scope of Applicability [▸ 5]
3	Data contacts	System Manual I/O System 750/753
4	Release tab	System Manual I/O System 750/753
5	Access to open the associated Push-in CAGE CLAMP® connection	System Manual I/O System 750/753
6	Push-in CAGE CLAMP® connection	Wiring Interfaces [▸ 10] and System Manual I/O System 750/753

4.2 Indicators

The LEDs indicate the switched statuses of the relay outputs.

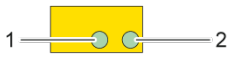


Figure 2: Relay Output Indicators

LED	Function
1	Status indicator, relay output O1
2	Status indicator, relay output O2

The meanings of the status indications are described section **Visualization of the switched statuses via Indicators [▸ 24]**.

4.3 Wiring Interfaces

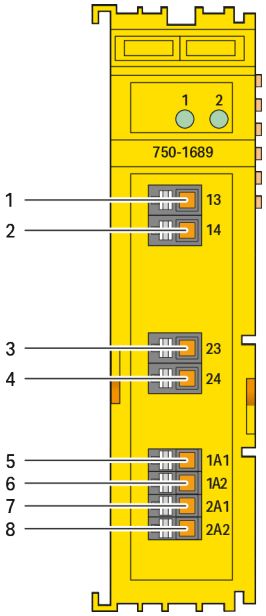


Figure 3: Wiring Interfaces

Designation	Channel	No.	Connection	Function
Relay output 1	RO 1	1	13	Contact A of relay output 1
		2	14	Contact B of relay output 1
		5	1A1	Control voltage for relay 1, positive connection
		6	1A2	Control voltage for relay 1, negative connection
Relay output 2	RO 2	3	23	Contact A of relay output 2
		4	24	Contact B of relay output 2
		7	2A1	Control voltage for relay 2, positive connection
		8	2A2	Control voltage for relay 2, negative connection

4.4 Schematic Circuit Diagram

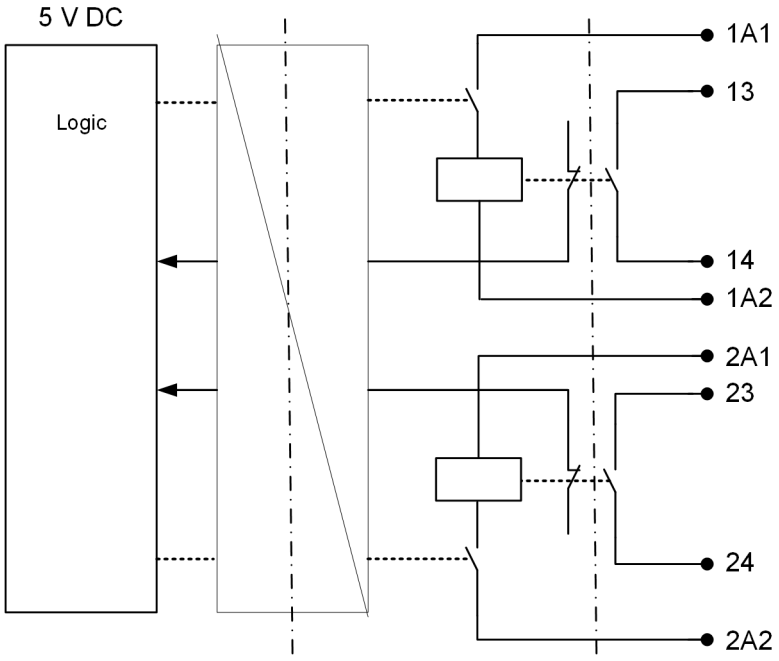


Figure 4: Schematic Representation

4.5 Safety Parameters

The safety parameters PFH and $MTTF_d$ for the relay outputs RO_n (RO_1 ... RO_2) depend on the application and must be calculated using the $B10_d$ values of the relays and the operating values for the specific application.

For an example of how to calculate the safety parameters, see **Examples of Calculating Safety Parameters [▸ 25]**.

4.5.1 Single-Channel Safety Application

Table 1: Safety Parameters for Single-Channel Safety Application

Maximum safety integrity level per IEC 62061	SIL2
Maximum safety integrity level per IEC 61508	SIL 2
Maximum performance level per EN ISO 13849-1	Cat. 2/PLd
Maximum duration of use	20 years
DC_{RO} (diagnostic coverage level of relay)	99 %
Hardware fault tolerance HFT for single-channel application (IEC 61508/ EN ISO 13849-1)	0 (1 error in the application can lead to a failure of the safety equipment)

4.5.2 Two-Channel Safety Application

Table 2: Safety Parameters for Dual-Channel Safety Application

Maximum safety integrity level per IEC 62061	SIL3
Maximum safety integrity level per IEC 61508	SIL 3
Maximum performance level per EN ISO 13849-1	Cat. 4/PLe
Maximum duration of use	20 years
DC_{RO} (diagnostic coverage level of relay)	99 %
Hardware fault tolerance HFT for dual-channel application (IEC 61508/ EN ISO 13849-1)	1 (1 error in the application does not yet lead to a failure of the safety function)

4.5.3 B10d Values for Relay Outputs

Table 3: $B10_d$ Values for Relay Outputs

$B10_d$ Values for Relay Outputs	For AC1	6 A	230 VAC	600,000
		3 A		6,000,000
		2 A		10,000,000
		1 A		12,000,000
	for DC1	6 A	24 VDC	4,000,000
		3 A		10,000,000
		2 A		14,000,000
		1 A		20,000,000
	For AC15	3 A	230 VAC	6,000,000
		2 A		10,000,000
		1 A		12,000,000
		0.5 A		20,000,000
	for DC13	2 A	24 VDC	4,000,000
		1 A		8,000,000
		0.5 A		15,000,000

4.6 Safety Response Time

The safety response time of the relay outputs indicates the amount time between when the voltage switches off and when the relay switches off. It is one component of the overall response time of a safety application.

The safety response time of the relay outputs is 50 ms.

To prevent personal injury and property damage, the execution times of all components involved must be taken into account when calculating the safety response time.

4.7 Contact Service Life of Relay Outputs

When designing a system with the 750-1689 F RO module, take into account the contact life of the relay outputs as a function of the switching current.

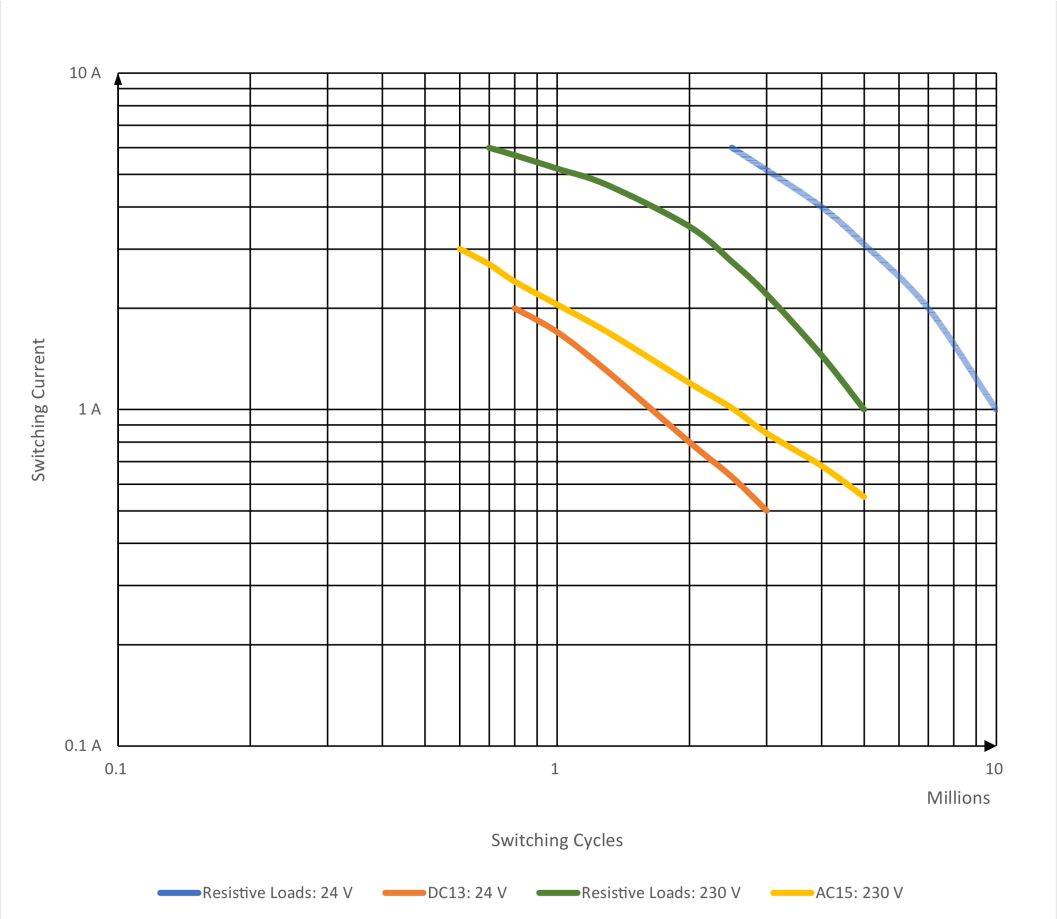


Figure 5: Contact Service Life of Relay Outputs

4.8 Load Limit Curve of Relay Outputs

When designing a system with the 750-1689 F RO module, take into account the load limit of the relay outputs as a function of the switching voltage.

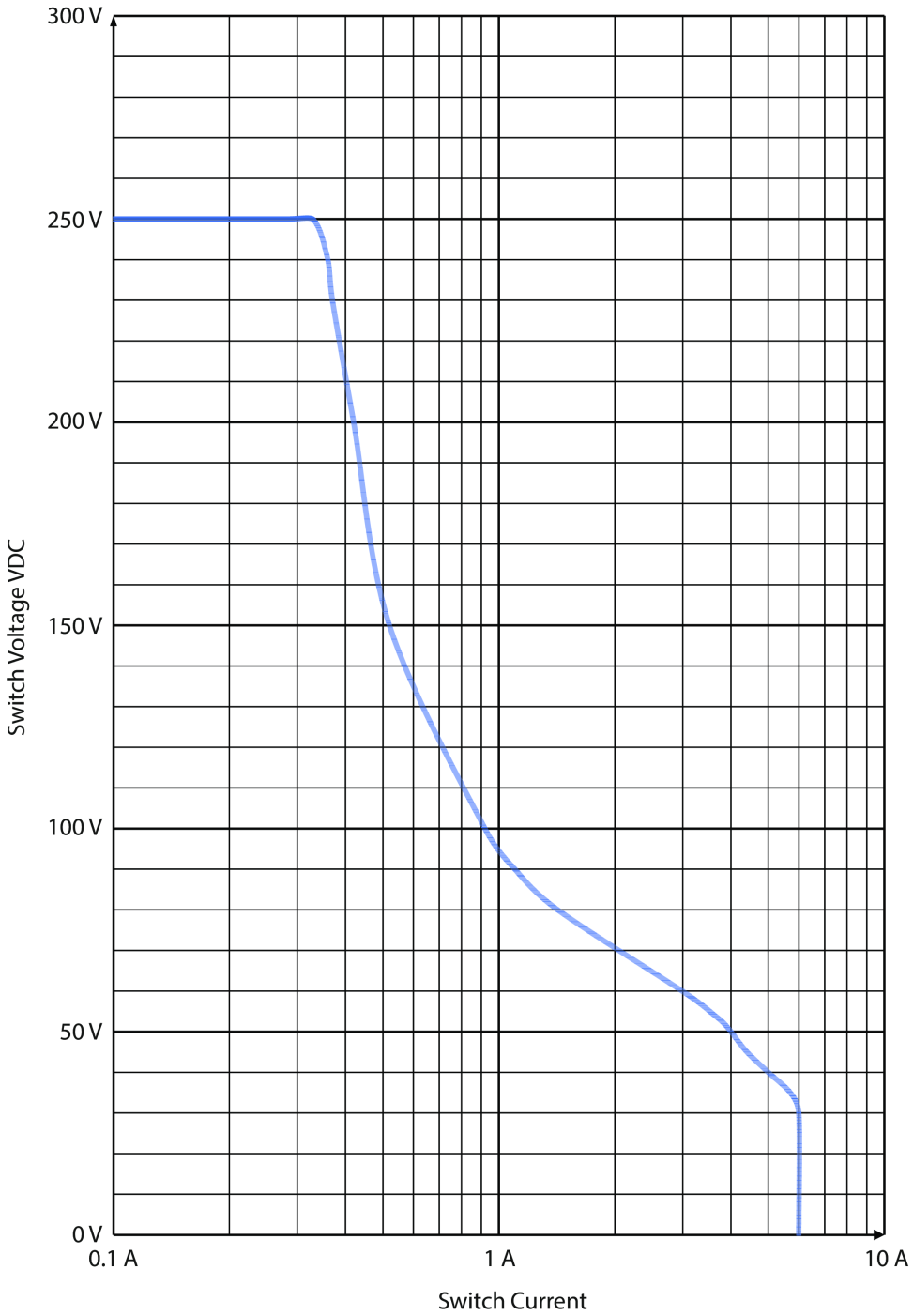


Figure 6: Load Limit Curve of Relay Outputs

4.9 Normally Open Contacts

The minimum current of the normally open contacts is 2 mA.

After the normally open contacts have been used once for a current higher than 300 mA or for a switching capacity of 12 W or 12 VA, the minimum current increases to 10 mA.

4.10 Derating Depending on Conductor Cross-Section

To comply with the specifications for additional heat generation at the clamping points (see 🕮 System Manual I/O System 750/753), the following derating must be taken into account.

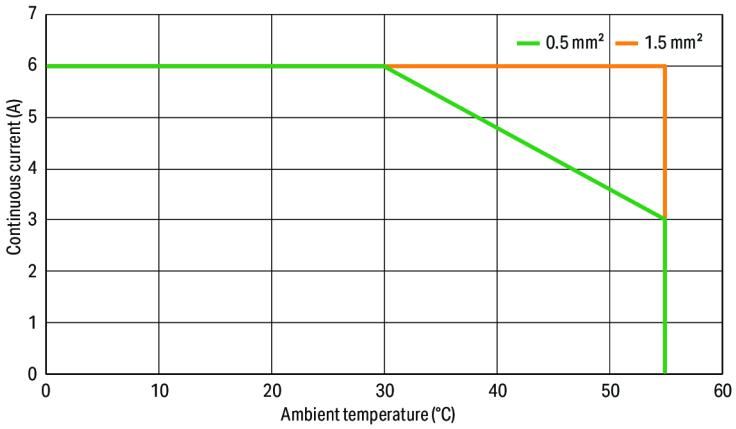


Figure 7: Derating depending on conductor cross-section

5 Functions

5.1 Signal Processing

The relays must be controlled with safe semiconductor outputs. For example, the outputs of the WAGO 75x-667/000-104 or 750-1665/000-004 Modules can be used to control the relays.

It is essential to ensure that the safety parameters of the semiconductor output used in conjunction with the safety parameters of the relays are appropriate for the intended use.

It is also possible to control both relays in parallel using a SIL3/Cat.4/PLe output.

5.2 Process Image

In the higher-level safe PLC, the safe relay output module occupies one byte in the input and output process image.

Table 4: Non-Safe Process Image – Input

Bit	Channel	Description	
0	RO 1	Readback:	
		0	Normally open contact closed
		1	Normally open contact open
1	RO 1	Inverted readback	
2	RO 2	Readback:	
		0	Normally open contact closed
		1	Normally open contact open
3	RO 2	Inverted readback	
4	RO 1	Temperature diagnostic, RO 1:	
		0	No overtemperature
		1	Overtemperature
5	RO 2	Temperature diagnostic, RO 2:	
		0	No overtemperature
		1	Overtemperature
6	–	Reserved	
7	–	Reserved	

Table 5: Non-Safe Process Image – Output for all Controllers/Fieldbusses except PROFINET and PROFIBUS

Bit	Channel	Description
0 … 3	Reserved	
4	RO 1	Enable relay 1
5	RO 2	Enable relay 2
6 … 7	Reserved	

Table 6: Non-Safe Process Image – Output for usage under PROFINET and PROFIBUS Fieldbusses

Bit	Channel	Description
0	RO 1	Enable relay 1
1	RO 2	Enable relay 2
2 … 7	Reserved	

5.3 Monitoring Function

The 750-1689 F RO module itself does not monitor the states of the relays. Therefore, a safety module in the safe PLC must monitor the relay to ensure its switched status is correct. In this connection, see section Behavior of the F I/O module in the Event of an Error (Safety Module). **Relay Error (Safety Module) [▸ 23]**.

6 Planning

6.1 Compatibility

The 750-1689 F RO module can be used on any head stations on which the F I/O module that is required to control the relays can be used.

6.2 Requirements for Wiring and Accessories

The length of the cables between the control connections of the F-RO module and the controlling F-DO module must not exceed 3 m.

The relays must be controlled by safety-oriented semiconductor outputs of an external F I/O module with diagnostics of the outputs and DC ≥ 90 %.

To prevent the relay from deactivating during a test pulse, the test pulse duration of the safe semiconductor output that controls the relay must be set to 1 ms for operation on F I/O modules with adjustable test pulse duration or readback time.

Particular Requirements for the Relay Outputs

Note

Check safety function of relay outputs regularly

Check the safety function of the relay outputs regularly. To do so, trigger a signal change and read back the process state.

this check must be performed at least once a month, to meet the requirements of SIL3/Cat. 4/PLe. The check must be carried out at least one hundred times more frequently than the demand rate of the safety function to achieve SIL2/Cat. 2/PL d.

The relay outputs must be protected by an external fuse or equivalent protection (fuse/circuit breaker), see table Fuses [▸ 28].

When appraising safety, it must be noted that external short circuits at the relay outputs (13, 14, 23 and 24) are not detected.

To achieve PL d, the affected relay output must be kept in a safe state by the safe control system via the controlling safe semiconductor output until it is acknowledged by the user.

6.3 Connection Examples

This section provides examples of basic connection options.

Connecting Actuators, Single-Channel

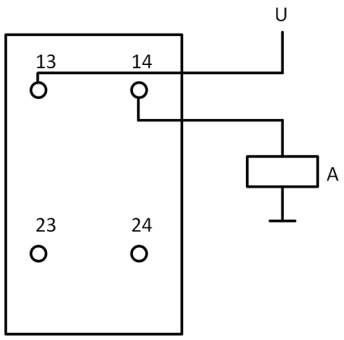


Figure 8: Connecting One Actuator, Single-Channel

You can connect an actuator to a relay output. It can be connected to both outputs.

You can use this circuit to read back the process state, which is protected by the F-RO module, SIL2/Cat. 2/PL d.

Connecting Actuators, Dual-Channel

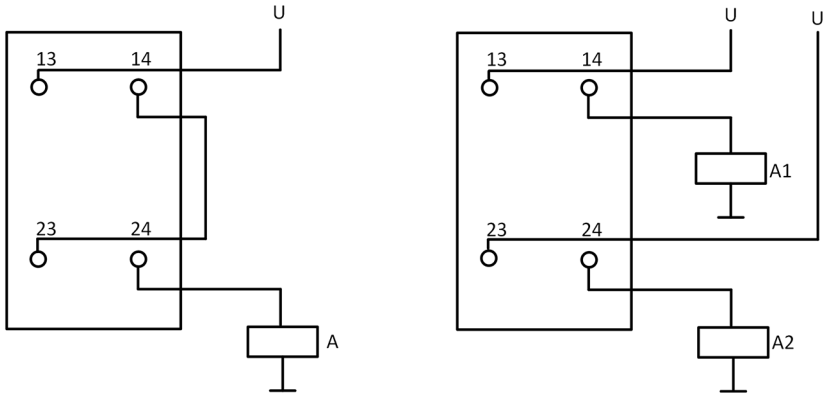


Figure 9: Connecting Actuators, Dual-Channel

Using two relay outputs allows the setup of a two-channel structure. Both relays can be connected in series, as well as two actuators can be controlled by one relay.

With a two-channel structure and by reading back the process state of the two relays, you can achieve up to SIL3/Cat. 4/PL e.

ⓘ Note

Do not connect recovery devices in parallel with the NO contacts of the relay.

Recovery devices must not be connected in parallel with the relay's normally open contacts, since a short circuit of the recovery device will disable the safety function. The required recovery devices must be connected in parallel to the load.

7 Commissioning

7.1 Enabling Relay Outputs with the Non-Safety-Oriented PLC

The two relay outputs are enabled by having the non-safety-oriented PLC set bit 4 or bit 5 and a safe digital output module (F DO module) supply 24 V control signals.

7.2 Use of the Safe Relay Output Module with a Safe Logic Module

To use the safe relay output module (F-RO module) with a safe logic module (F logic module), proceed as follows:

1. Connect the relay controller to a safety-oriented semiconductor output.
2. Configure the readback signals from the process image of the relays to the virtual outputs in the process image of the logic module.
3. If the logic module is used without PROFIsafe, use the "Quadruple AND" function block in the logic module to link the readback signals with a constant 1 signal so they can be converted to safe signals and linked to the monitoring inputs of the "External Device Monitoring" (EDM) function block.
4. Instantiate one EDM module per relay output and apply the converted readback signal associated with the relay in question to both monitoring inputs of the EDM module in parallel.
5. Determine the readback time of the relay and the corresponding delay in transmitting and processing the readback signal. Then set the readback time in the parameterization to the tolerance time on the EDM module.
6. Connect the output of the EDM module to the safety-oriented semiconductor output that controls the relay in question.
7. Connect the signal you want to use to control the relay in question to the switching input of the EDM module.
8. Connect the signal for operator acknowledgment to the reset input of the EDM module.
   CAUTION!
   The reset signal must not be activated until the error has been corrected.
9. Connect the overtemperature signal to the relay control in such a way that, in the event of overtemperature, the relay is switched off until it is acknowledged. This can be done by having the overtemperature error generate a readback error in the EDM module, for example.

8 Diagnostics

8.1 Behavior of the F-RO Module in the Event of an Error

8.1.1 Relay Error (Safety Module)

The control voltages for the two relays are provided via a safe digital output module (F-DO module). The safe relay output module (F-RO module) provides the switched statuses of the relays and the state of the temperature as readback values via the input process image.

In the safety program of the safe PLC, the readback value of both relays of the safe relay output module must be compared to the control states. For this purpose, a safety module must be used for relay monitoring. This can be a PLCopen module such as "External Device Monitoring" or a comparable module, for example. You can use the "External Device Monitoring" function block from the PLCopen, Safety Software, Part 1, V2.01 specification as a reference. If a safety-critical state is detected, the relevant relay must be safely switched off.

If the control voltage of the safe digital output module falls below the minimum voltage required to activate the relays, or if the line to the input connections is interrupted, the relays are deactivated, and the readback value is now read back with "1" instead of "0." This error is only detected if the control voltage is switched on.

If the load contact of the relay no longer opens, then "0" is read back as the readback value of the relay in question. This readback value is compared to the setpoint "1" in the safety program of the controller, and the error is detected. This error is only detected if the control voltage is switched off.

The readback does not work when the system voltage is switched off.

8.1.2 Overtemperature

If the F-RO module detects a temperature higher than permitted, then the relays must switch off. The relays must remain switched off until acknowledged by the user. This must be ensured by technical measures in the PLC.

The overtemperature is indicated by status bits in the process image (see **Process Image [▸ 18]**).

8.2 Diagnostics via Process Image

Readback Values

Table 7: Readback Values – Bit 0 (RO 1), Bit 2 (RO 2)

Value	Explanation
0	Normally open contact closed
1	Normally open contact open

Temperature Diagnostics

Table 8: Temperature Diagnostics – Bit 4 (RO 1), Bit 6 (RO 2)

Value	Explanation
0	No overtemperature
1	Overtemperature

8.3 Visualization of the switched statuses via Indicators

The indicators of the F RO module provide information about possible states and error cases. The table below explains the signal evaluation.

If a relay fails (failure to open), the corresponding LED lights up even if no control voltage is present.

When the system voltage is switched off, the indicators do not correctly indicate the status of the relay outputs.

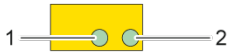


Figure 10: Relay Output Indicators

Table 9: Diagnostics via Indicators

Channel	LED	Status	Description
RO1	1	Off	Normally open contact open
		Green	Normally open contact closed
RO2	2	Off	Normally open contact open
		Green	Normally open contact closed

9 Service

9.1 Examples of Calculating Safety Parameters

Examples of calculating the PFH and PFD values of the F-RO module are shown below.

For the entire safety function, the PFH and PFD values of the following components must also be taken into account:

- Safe PLC
- F DO module used to control the relay
- Connected sensors
- Connected actuators

9.1.1 Calculating the PFH Value

This calculation example is based on the following data:

Table 10: Example of Calculating the PFH Value – Data

Components	Example Value
Relay switching cycles (RO_X) $B10_d$	4,000,000 (DC1, 6 A, 24 V)
Mean operating time / year d_{op}	220 days
Mean operating time / day h_{op}	14 hours
Cycle time (in seconds) t_{cycle}	2400 (every 40 minutes)
Common Cause Factor ß	2 %

The PFH value for the relay block is calculated according to EN ISO 13849-1:

- $B10_d$: mean number of cycles until 10 % of the test specimens fail dangerously (cycles)
- $MTTF_d$: mean time to dangerous failure (years)
- n_{op}: mean number of annual operations (cycles/year)
- d_{op}: mean operating time (days/year)
- h_{op}: mean operating time (hours/day)
- PL: Performance Level

From the $B10_d$ values of relay outputs RO_1 … RO_2 (load-dependent), the PFH and $MTTF_d$ values for the relay outputs are calculated with the application's example data.

A defect in a relay (e.g., failure to open) is detected by a function block (External Device Monitoring) in the safe PLC. The common cause factor ß for the F-RO module is 2%.

The mean number of annual operations (n_{op}) is calculated as follows:

$$n_{op} = \frac{d_{op} \times h_{op} \times 3600\ \frac{s}{h}}{t_{Cycle}} = \frac{220\ \frac{d}{a} \times 14\ \frac{h}{d} \times 3600\ \frac{s}{h}}{2400\ s} = 4620\ \frac{1}{a}$$

The mean time to dangerous failure of a relay ($MTTF_{dRO}$) is calculated as follows:

$$MTTF_{dRO} = \frac{B10_d}{0.1 \times n_{op}} = \frac{4{,}000{,}000}{0.1 \times 4620\ \frac{1}{a}} = 8658\ a$$

The relay failure rate (λ_{dRO}) is calculated as follows:

$$\lambda_{dRO} \approx \frac{0.1 \times n_{op}}{B10_d}$$

The PFH value of the relay without taking the diagnostics into account is calculated as follows:

$$PFH_{RO} = \lambda_{dRO} \times (1 - DC_{RO}) = \frac{0.1 \times n_{op} \times (1 - DC_{RO})}{B10_d} = \frac{1 - DC_{RO}}{MTTF_{dRO}} = \frac{1 - 0.99}{8658\ a}$$
$$= 1.16 \times 10^{-06}\ \frac{1}{h}$$

The PFH value for the F-RO module is calculated as follows for single-channel use of the relay outputs (relay RO_1 or relay RO_2):

$$PFH = PFH_{ROx}$$

The PFH value for the F-RO module is calculated as follows for dual-channel use of the relay outputs (relay RO_1 and relay RO_2):

$$PFH = ß \times \frac{(PFH_{RO1} + PFH_{RO2})}{2} = 0.02 \times \frac{(1.16 \times 10^{-6} + 1.16 \times 10^{-6})}{2}$$

9.1.2 Calculating the PFD Value

This calculation example is based on the following data:

Table 11: Example of Calculating the PFD Value – Data

Components	Example Value
Relay switching cycles (RO_x) $B10_d$	4,000,000 (DC1, 6 A, 24 V)
Mean number of annual operations n_{op}	1
Mean time to repair MTTR	100 hours
Mean repair time MRT	1 hour
Common Cause Factor ß	2 %
Proof test T1 / service life	20 years
DC Diagnostic Coverage Level	99 %

The PFD value for the relay block is calculated according to IEC 61508-6 and EN ISO 13849-1:

- $B10_d$: mean number of cycles until 10 % of the test specimens fail dangerously (cycles)
- $MTTF_d$: mean time to dangerous failure (years)
- n_{op}: mean number of annual operations (cycles/year)

The proof test interval T1 corresponds to the service life of the F-RO module. The F-RO module must be replaced with a new F-RO module after its service life has expired.

From the $B10_d$ values of relay outputs RO_1 ... RO_2 (load-dependent), the PFH and $MTTF_d$ values for the relay outputs are calculated with the application's example data.

The mean time to dangerous failure of a relay ($MTTF_{dRO}$) is calculated as follows:

$$MTTF_{dRO} = \frac{B10_d}{0.1 \times n_{op}}$$

The relay failure rate (λ_{dRO}) is calculated as follows:

$$\lambda_{dRO} \approx \frac{0.1 \times n_{op}}{B10_d}$$

The PFH value for the F-RO module is calculated as follows for single-channel use of the relay outputs (relay RO_1 or relay RO_2):

$$PFD_{AVG1oo1} = \lambda_{dRO} \times (1 - DC) \times \left(\frac{T1}{2} + MRT\right) + \lambda_{dRO} \times DC \times MTTR$$

The PFH value for the F-RO module is calculated as follows for dual-channel use of the relay outputs (relay RO_1 and relay RO_2):

$$t_{CE} = (1 - DC) \times \left(\frac{T1}{2} + MRT\right) + DC \times MTTR$$

$$t_{GE} = (1 - DC) \times \left(\frac{T1}{3} + MRT\right) + DC \times MTTR$$

$$PFD_{AVG1oo2} = 2 \times \left(\left(1 - \frac{ß}{2}\right) \times \lambda_{dRO} \times DC + (1 - ß) \times \lambda_{dRO} \times (1 - DC)\right)^2 \times t_{CE} \times t_{GE} + \frac{ß}{2} \times \lambda_{dRO} \times DC \times MTTR + ß \times \lambda_{dRO} \times (1 - DC) \times \left(\frac{T1}{2} + MRT\right)$$

10 Appendix

10.1 Technical Data, Approvals, Guidelines and Standards

Note

Subject to changes!

Please also observe the further product documentation! You can generate the current datasheet at any time at: www.wago.com /<item number>.

Supplementary Technical Data for the Data Sheet

Table 12: Module designations in the device catalog

PROFIBUS	
F I/O module	750-1689 2FRO/DIA
PROFINET	
F I/O module	750-1689 2FRO,DIA
Submodule	2FRO APVL,DIA in I-PI
CODESYS V3.5	
F I/O module	2FRO 250V 6A

Table 13: Fuses

for relay outputs	max. 10 A slow-blow, approved at least for the used switching voltage

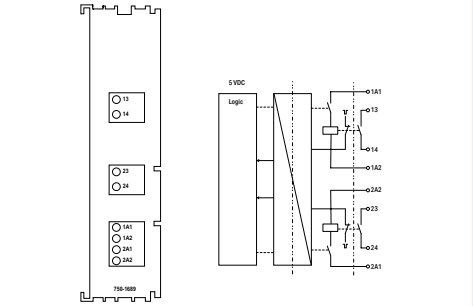
See also

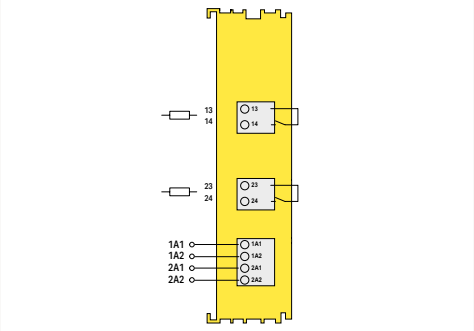
Data sheet 750-1689 [▶ 29]

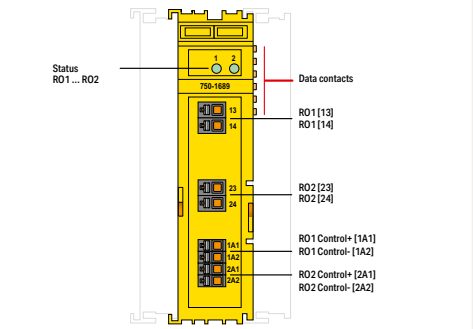
10.1.1 Data sheet 750-1689

750-1689

Safe Relay Output; 2 Channels; 250 V; 6 A







The module (Item No. 750-1689) has two independently switchable relay outputs (RO1 ... RO2) and is particularly suitable for applications that, e.g., individually electrically isolated Outputs are required, high loads must be switched or controlled with different voltage types (e.g., DC and AC voltage). The module supports operating voltages up to 250 VAC and 250 VDC.
The electrically isolated outputs can be freely combined with each other, so that Cat. 2 or Cat. 4 architectures up to SIL3 or PLe are possible. Details on possible wiring variants can be found in the product manual.
The relay outputs must be controlled via safe digital outputs (e.g., the outputs of the 75x-667/000-004, 750-1665/000-004 module), in which case an unsafe enable of the relay outputs must also be provided via the process image.

The status of the safe relay outputs and the temperature for each relay are detected and transmitted to the controller via the non-safe process image, where they must be evaluated as diagnostics.
The field and system levels are electrically isolated from each other.
The individual safe modules can be arranged in any configuration in the fieldbus node.
The module (Item No. 750-1689) was evaluated by UL in accordance with UL/CSA 61010-1, UL/CSA 61010-2-201 and UL 121201, CSA-C22.2 No. 213. The functional safety assessment according to the above standards was carried out by TÜV Rheinland.

Technical Data	
Indicators	LED (A/B) green: Status RO1 ... RO2
Number of F I/O modules per node (fieldbus coupler/controller)	See information in the manual for the respective fieldbus coupler/controller
Supply voltage (system)	5 VDC; via data contacts
Current consumption (system 5 VDC) max.	15 mA

Relay control signals	
Signal type	Digital
Cable length, control signal max.	3 m
Reverse voltage protection	Yes
Control voltage per channel	24 VDC (-25 ... +30 %)
Control current per channel max.	15 mA
Test pulse duration, control voltage max.	1 ms

Relay outputs	
Number of outputs	2
Output circuit version	Make contact/relay
Signal type	Digital
Actuator connection	2 x 2-wire

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Relay outputs	
Output characteristic	isolated
Switching voltage	250 VAC; 250 VDC
Switching power	AC: 0.1 VA ... 1500 VA; DC: 200 W; see load limit curve
Output current per channel	6 A at 250 VAC (resistive load); 6 A at 31,2 VDC (resistive load); 3 A at 60 VDC (resistive load); 0,8 A at 110 VDC (resistive load); 0,3 A at 250 VDC (resistive load); 2 A at 31,2 VDC (Pilot Duty); UL: R300 Pilot Duty according to UL508; UL: B300 Pilot Duty according to UL508
Switching capacity per IEC/EN 60947-5-1	3 A at 250 VAC (AC-15); 2 A at 31.2 VDC (DC-13)
Output current (module) max.	12 A
Limitation of the inductive switch-off voltage	No
Relapse time incl. bounce time	< 50 ms
Response time incl. bounce time	< 10 ms
Short-circuit resistance	1 kA / 250 VAC IEC/EN 60947-5-1
External fuse	Each channel requires its own fuse; max. 10 A slow; min. approved for the switching voltage used
Switching frequency max.	1 Hz; resistive load; 0.1 Hz; inductive load
Contact load (min.)	2 mA; 10 mA after a single overflow of 300 mA load current or a switching power of 12 W or 12 VA
Diagnostics	Relay status in the process image via force-guided contact
Electrical switching operations	> 10^5 switching operations (at 1 s on, 1 s off (see service life curve))
Mechanical switching operations	> 40 x 10^6 switching operations
Contact material	AgNi + 5µm Au
B10d values	Resistive load (at 230 VAC); 6 A: 600,000; 3 A: 6,000,000; 2 A: 10,000,000; 1 A: 12,000,000 switching cycles Resistive load (at 24 VDC); 6 A: 4,000,000; 3 A: 10,000,000; 2 A: 14,000,000; 1 A: 20,000,000 switching cycles AC-15 (at 230 VAC); 3 A: 6,000,000; 2 A: 10,000,000; 1 A: 12,000,000; 0.5 A: 20,000,000 switching cycles DC-13 (at 24 VDC); 2 A: 4,000,000; 1 A: 8,000,000; 0.5 A: 15,000,000 switching cycles
Safety and protection	
System voltage	≤250 V
Note on system voltage	The system voltage is derived from the line-to-neutral voltage for common MAINS supply systems.
Insulation coordination	
Overvoltage category per EN 60664-1	III
Overvoltage category per EN/UL 61010-2-201	II
Insulation type (relay)	Reinforced insulation
Insulation type (channel/channel)	Reinforced insulation
Insulation type (control/system)	Functional insulation
Test voltage	
Test voltage (relay)	3.51 kVAC, 50/60 Hz, 1 min.
Test voltage (control/system)	500 VDC, 1 min.
Rated impulse withstand voltage (relay)	6 kV
Functional Safety	
Achievable safety classes	Two-Channel Cat. 4/PL e per EN ISO 13849-1; SIL 3 per IEC 61508 / EN 62061; Single-Channel Cat. 2/PL d per EN ISO 13849-1; SIL 2 per IEC 61508 / EN 62061
Safety standards	IEC 61508-1 ... -7; EN ISO 13849-1; EN 62061; DIN EN 61810-1, DIN EN 61810-3
Service life	20 years
Connection data	
Connection technology: inputs/outputs	8 x Push-in CAGE CLAMP®
Connection type 1	Outputs
Connectable Conductor Materials	Copper
Solid conductor	0.14 ... 1.5 mm² / 28 ... 16 AWG
Fine-stranded conductor; with insulated ferrule	0.25 ... 0.75 mm²
Fine-stranded conductor; with uninsulated ferrule	0.25 ... 1.5 mm²
Strip length	8 ... 9 mm / 0.31 ... 0.35 inch
Geometric Data	
Width	24 mm / 0.944 inch
Height	100 mm / 3.937 inch
Depth	69.8 mm / 2.748 inch
Depth from upper-edge of DIN-rail	62.6 mm / 2.465 inch

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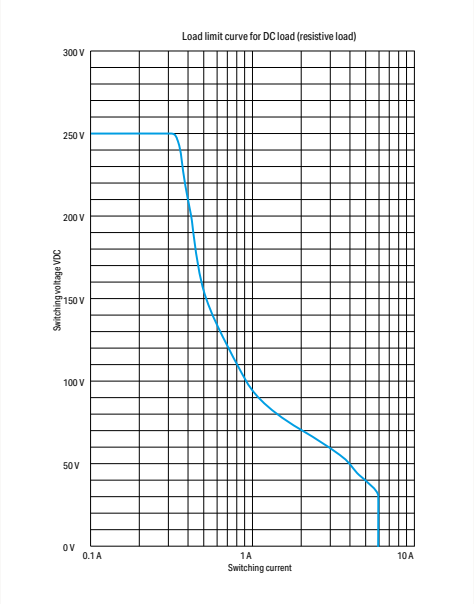
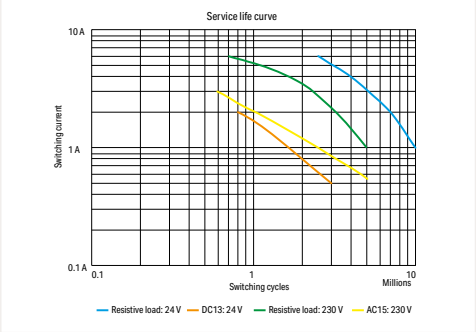
Mechanical data	
Mounting type	DIN-35 rail
Pluggable connector	fixed

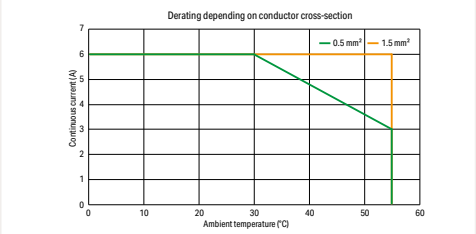
Material data	
Housing material	Polycarbonate, polyamide 6.6
Weight	approx. 100 g

Environmental Conditions	
Ambient temperature (operation)	0 … +55 °C
Ambient temperature (storage)	−40 … +85 °C
Protection type	IP20
Pollution degree	2 per IEC 61131-2
Protection class	II
Operating altitude	0 … 2000 m
Storage altitude	0 … 3000 m
Mounting position	Horizontal left, horizontal right, horizontal up, vertical top and vertical bottom
Relative humidity (without condensation)	95 %
Vibration resistance	4g per IEC 60068-2-6
Shock resistance	15g per IEC 60068-2-27
Marine applications	DNV
EU EMC Directive 2014/30/EU	
EMC immunity to interference	EN 61000-6-2; marine applications; EN 61000-6-7 (FS)
EMC emission of interference	EN 61000-6-4; marine applications; EN 61000-6-3
Exposure to pollutants	Per IEC 60068-2-42 and IEC 60068-2-43
Permissible H_2S contaminant concentration at a relative humidity < 75 %	10 ppm
Permissible SO_2 contaminant concentration at a relative humidity < 75 %	25 ppm

Conformity	
Conformity marking	CE; UKCA
EU Machinery Directive	2006/42/EC
EU Low Voltage Directive (LVD)	2014/35/EU







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