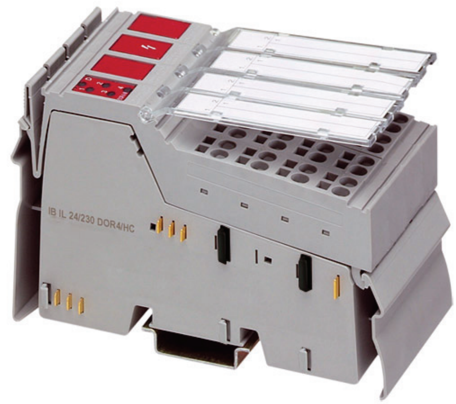
IB IL 24/230 DOR4/HC-PAC



Inline terminal with four relay outputs

AUTOMATION

Data sheet
7609_en_01

1 Description

The terminal is designed for use within an Inline station. It has four floating relay outputs.

> The terminal can be used in the SELV area and in the AC area. Observe the appropriate regulations and safety notes when using the terminal in the AC area.

Features

- Floating connections for four actuators
- Nominal current of 10 A;
  at the individual outputs up to 16 A with derating
- Inrush current of 30 A;
  inrush peak current (20 ms) of 80 A
- Safe isolation according to EN 50178
- Low power consumption through use of bistable relays
- 3 different operating modes can be configured individually for each relay
- Communication via process data
- Diagnostic and status indicators

1.1 Operating modes

- **Monostable, default state opened**
  (default upon delivery)
  The contact is opened in the event of a voltage failure or faulty bus communication. This operating mode corresponds to the behavior of a normal N/O contact.
- **Monostable, default state closed**
  The contact is closed in the event of a voltage failure or faulty bus communication. This operating mode is similar to the behavior of a normal N/C contact, however, control via the process data is not inverted. If the "Relay x" bit is set, the "Set" command always closes the contact – regardless of the set operating mode.
- **Bistable**
  The contact holds its switching state in the event of a voltage failure or faulty bus communication.

> This data sheet only is valid in connection with the IL SYS INST UM E user manual (see "Documentation" on page 2).

> Make sure you always use the latest documentation.
> It can be downloaded at www.phoenixcontact.net/download.

> This data sheet is valid for the products listed on the following page:

2 Ordering data

Product

Description	Type	Order No.	Pcs./Pkt.
Inline terminal with four relay outputs; complete with accessories (connectors and labeling fields)	IB IL 24/230 DOR4/HC-PAC	2897716	1

Accessories

Description	Type	Order No.	Pcs./Pkt.
Connector for digital single-channel, two-channel or 8-channel Inline terminals with AC voltage (gray, without color print) (as replacement item)	IB IL SCN-8-AC-REL	2740290	10
Inline distance terminal; complete with accessories (connectors and labeling fields)	IB IL DOR LV-SET-PAC	2861645	1 set (2 pcs.)

Documentation

Description	Type	Order No.	Pcs./Pkt.
"Automation terminals of the Inline product range" user manual	IL SYS INST UM E	2698737	1
"Configuring and installing the INTERBUS Inline product range" user manual	IB IL SYS PRO UM E	2743048	1

3 Technical data

General data	
Housing dimensions (width x height x depth)	48.8 mm x 120 mm x 72 mm
Weight	230 g (with connectors), 167 g (without connectors)
Operating mode	Process data mode with 1 byte
Connection method for actuators	At a floating relay N/O contact
Ambient temperatures (operation)	-10°C to +55°C (Attention: Deviation from the Inline specifications)
Ambient temperature (storage/transport)	-25°C to +85°C
Permissible humidity (operation/storage/transport)	75% on average, 85% occasionally (no condensation)
Permissible air pressure (operation)	80 kPa to 106 kPa (up to 2000 m above sea level)
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20 according to IEC 60529
Connection data for Inline connectors	
Connection method	Spring-cage terminals
Conductor cross-section	0.08 mm^2 to 1.5 mm^2 (solid or stranded), 28 - 16 AWG
Stripping length	8 mm

Mechanical requirements (Deviation from the Inline specifications)	
Vibration test Sinusoidal vibrations according to IEC 60068-2-6; EN 60068-2-6	2g load, 2 hours in each direction
Shock test according to IEC 60068-2-27; EN 60068-2-27	2g load for 11 ms, half sinusoidal wave, three shocks in each direction and orientation

Interface	
Local bus	Via data routing
Transmission speed	500 kbps

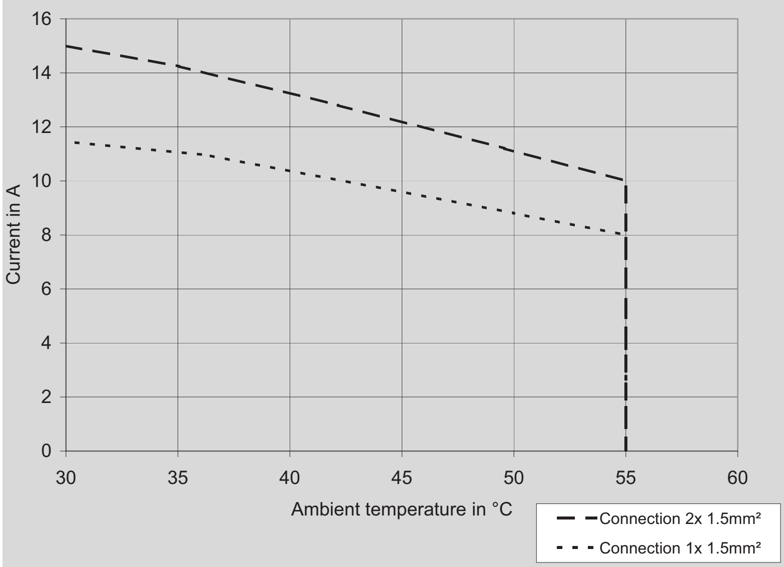
Power consumption	
Communications power U_L	7.5 V DC
Current consumption at U_L	
Relay OFF	23 mA
Relay ON	34 mA
Power consumption at U_L	
Relay OFF	0.17 W
Relay ON	0.26 W
I/O supply voltage U_{ANA}	24 V DC
Current consumption at U_{ANA}	10 mA; 55 mA, maximum during switching operation (duration 25 ms, approximately per switched relay)
Power consumption at U_{ANA}	0.46 W, maximum

Supply of the module electronics and I/O through bus coupler/power terminal	
Connection method	Through potential routing

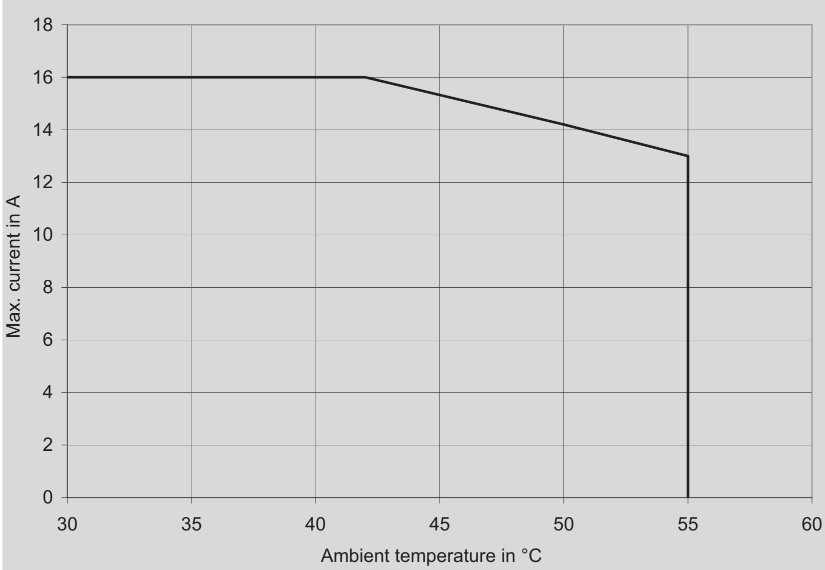
Relay output	
Number	4
Contact material	$AgSnO_2$, hard gold-plated
Limiting continuous current (at maximum ambient temperature)	8 A for single-wire connection (1.5 mm^2), 10 A for two-wire connection (2 x 1.5 mm^2)
Maximum switching voltage	253 V AC, 250 V DC
Maximum switching power	4000 VA
Minimum load	12 V; 100 mA
Inrush peak current (20 ms)	80 A
Maximum switching frequency	
Without load	60 cycles/minute
With nominal load	6 cycles/minute
Bouncing time	2 ms, typical
Common potentials	All contacts floating
Mechanical service life	2 x 10^7 cycles
Examples of contact service life	
Small load 24 V DC, 100 mA	> 10^7 cycles
Ohmic load, 250 V AC, 16 A	100,000 cycles, typical
Incandescent lamp 1150 W, 230 V AC, 5 A (I_{on} = 75 A)	> 20,000 cycles
Incandescent lamp 1000 W, 250 V AC, 4 A	80,000 cycles, typical
Incandescent lamps 250 V AC, 5 x 60 W	500,000 cycles, typical
Fluorescent lamps, not compensated or serial compensated 14 x 58 W	50,000 cycles, typical
Fluorescent lamps, duo circuit, 7 x (2 x 58 W)	50,000 cycles, typical
Fluorescent lamps, parallel compensated (7 µF), 1 x (2 x 58 W)	50,000 cycles, typical
Energy-saving lamps with conventional ballast 40 x 25 W	40,000 cycles, typical
Energy-saving lamps with electronic ballast, 3 x 18 W	40,000 cycles, typical
Motor load 250 V AC, 16 A, cos ϕ = 0.6	85,000 cycles, typical
Compressor, 230 V AC, $I_{on\_peak} \leq 21$ A, I_{off} = 3.5 A, cos ϕ = 0.5	230,000 cycles, typical

Relay output (continued)

Maximum switching current depending on the temperature; all channels simultaneous and with the same current



Maximum switching current of an individual channel depending on the temperature



In the event of different loads, a higher current is permitted on individual channels.

The following conditions must be observed:

Two-wire connection 2 x 1.5 mm^2 for currents above 8 A.

The maximum current must not exceed the value in the diagram above.

Relay output (continued)

The load currents I_L of the individual channels must meet the following condition:

$I_{L1}^2 + I_{L2}^2 + I_{L3}^2 + I_{L4}^2 = 400\ A^2$

Example:

What is the maximum permissible load current at 50°C and what is the load that the other three channels may carry?

The diagram shows a maximum permissible load current of around 14 A. This leaves the following for the other channels:

$400\ A^2 - (14\ A)^2 = 400\ A^2 - 196\ A^2 = 204\ A^2$

Therefore, another channel could carry 14 A and the other two channels could carry 2 A each:

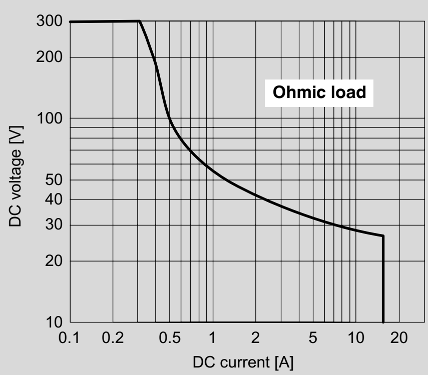
$(14\ A)^2 + (2\ A)^2 + (2\ A)^2 = 196\ A^2 + 4\ A^2 + 4\ A^2 = 204\ A^2$

Alternatively, equally distributing the load between the remaining three channels results in a maximum permissible current of:

$\sqrt{(204\ A2/3)} = \sqrt{(68\ A2)} \approx 8.2\ A$

DC load limit curve

In the case of DC loads, the DC load limit curve can also limit the maximum permissible current.



Power dissipation

Formula to calculate the power dissipation of the terminal

$P_{TOT} = P_{BUS} + P_{REL} + P_L$

With:

$P_{BUS} = 0.5\ W$

$P_{REL} = 66\ mWs \times (f1 + f2 + f3 + f4)$

$P_L = (I_{L1}^2 \times D_1 + I_{L2}^2 \times D_2 + I_{L3}^2 \times D_3 + I_{L4}^2 \times D_4) \times 0.006\ \Omega$

Where

P_{TOT}	Total power dissipation in the terminal
P_{BUS}	Power dissipation through bus operation
P_{REL}	Power dissipation through switching relays
P_L	Power dissipation through the load current via the contacts
f_n	Switching frequency (cycles per time) of output n
I_{Ln}	Load current of output n
D_n	Operating time of the current at channel n: $D_n = t_{on} \times f_n$

Error messages to the higher-level control or computer system

I/O error message in the event that the I/O supply voltage U_{ANA} is not reached

Protective equipment

None

Air and creepage distances (according to EN 50178, VDE 0109, VDE 0110)			
Isolating distance	**Clearance**	**Creepage distance**	**Test voltage**
Relay contact/bus logic	≥ 5.5 mm	≥ 5.5 mm	4 kV, 50 Hz, 1 min.
Contact/contact	≥ 3.1 mm	≥ 3.1 mm	1 kV, 50 Hz, 1 min.
Contact/PE	≥ 3.1 mm	≥ 3.1 mm	1 kV, 50 Hz, 1 min.

Approvals

For the latest approvals, please visit www.phoenixcontact.net/catalog

4 Internal basic circuit diagram

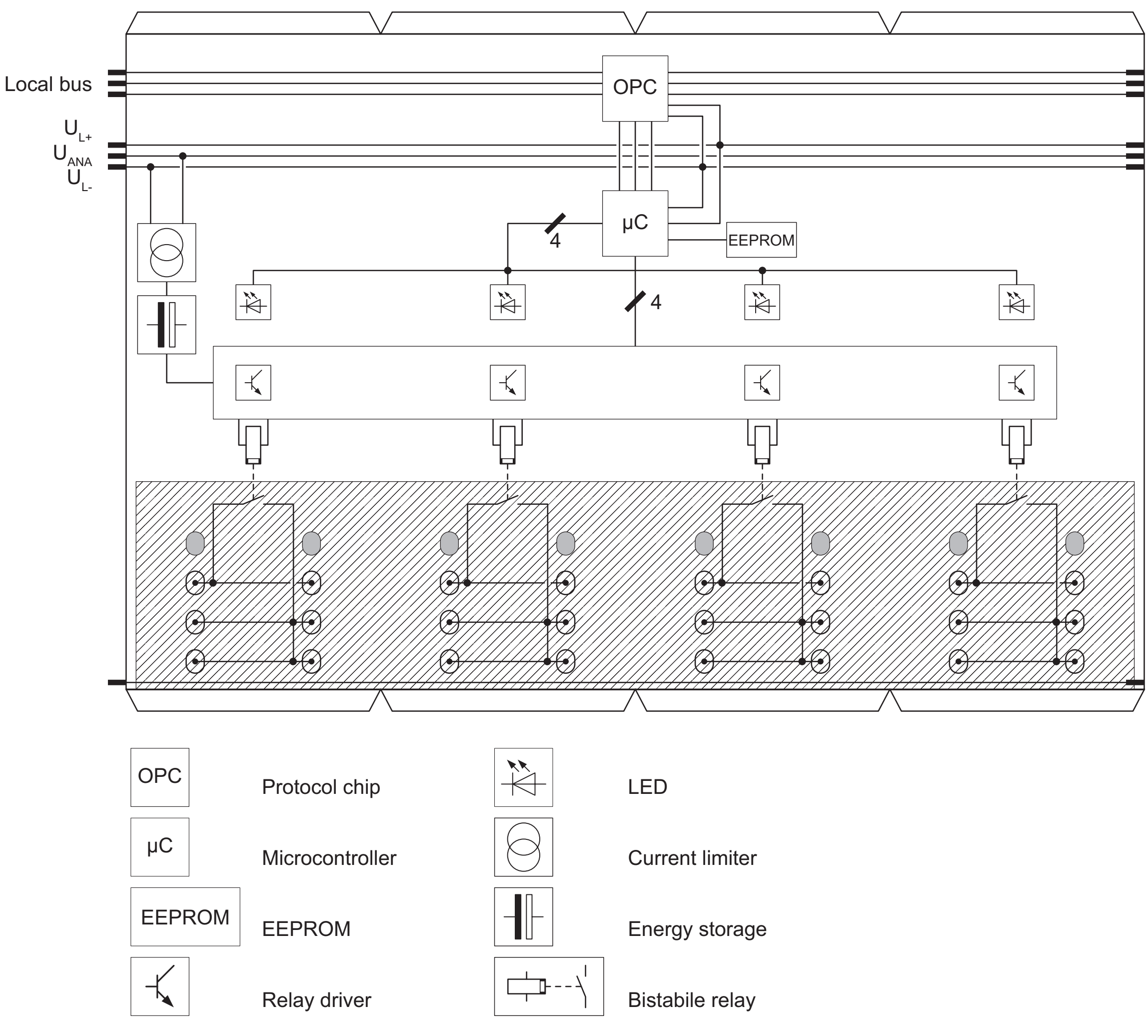


Figure 1 Internal wiring of the terminal points

Other symbols used are explained in the IL SYS INST UM E user manual.

5 Safety notes for Inline terminals used in areas outside the SELV area (AC area)

> Only qualified personnel may work on Inline terminals in the AC area.

Qualified personnel are people who, because of their education, experience and instruction and their knowledge of relevant standards, regulations, accident prevention and service conditions, have been authorized by those responsible for the safety of the plant to carry out any required operations and who are able to recognize and avoid any possible dangers.
(Definitions for skilled workers according to EN 50110-1:1996).

> The instructions given in this data sheet as well as the IL SYS INST UM E user manual must be strictly observed during installation and startup.

Technical modifications reserved.

6 Correct usage

The terminal is only to be used within an Inline station as specified in this data sheet as well as the IL SYS INST UM E user manual or the Inline system manual for your bus system. Phoenix Contact accepts no liability if the device is used for anything other than its designated use.

> **WARNING: Dangerous contact voltage**
>
> Please note that there are dangerous contact voltages when switching circuits that do meet SELV requirements.
>
> Only remove and insert the AC terminals when the power supply is disconnected.
> When working on the terminals and wiring, always switch off the supply voltage and ensure it cannot be switched on again.

7 Installation instructions and notes

> **WARNING: Dangerous contact voltage**
>
> Install the system according to the requirements of EN 50178.

> **WARNING: Dangerous contact voltage in the event of ground faults**
>
> Inline AC terminals must only be operated in grounded AC networks.

> **Read the user manual**
>
> Observe the installation instructions and notes in the IL SYS INST UM E user manual, especially the notes on the low voltage area.

8 Special features of the terminal

The terminal can be used to switch loads up to 230 V.

> **NOTE: Malfunction**
>
> Please note that the terminal interrupts the potential jumpers U_M, U_S, and GND (24 V area) or L and N (120 V/230 V areas). If required, these supply voltages must be resupplied/provided using an appropriate power terminal after the relay terminal.

Switching loads in the 230 V area

To switch voltages outside the SELV area, an AC area must be created according to the installation instructions and notes provided in the user manual.

> **WARNING:**
>
> Operate the terminal from a single phase on an AC network.

Switching voltages that are not available in the segment

A relay terminal can be used to switch voltages that are not available in the segment in which the terminal is located (e.g., switching 230 V AC within a 24 V DC segment). In this case, place a distance terminal before and after the terminal (see "Ordering data" on page 2). The isolating distances between the individual areas are thus maintained.

See also "Example station structure" on page 10.

9 Local diagnostic and status indicators and terminal point assignment

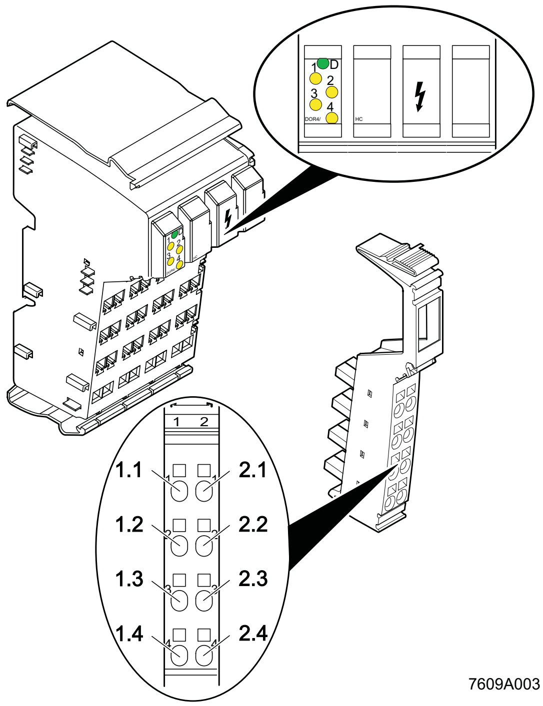


Figure 2 Terminal with one of the appropriate connectors

9.1 Local diagnostic and status indicators

Des.	Color	Meaning
D	Green	Diagnostics
1, 2, 3, 4	Yellow	Status indicator of the output LED ON: Contact closed

9.2 Function identification

Red with lightning bolt

9.3 Housing/connector color

Dark gray housing

Dark gray connector

9.4 Terminal point assignment for each connector

Terminal points	Assignment
1.1, 2.1	Not used (no contact present)
1.2, 2.2	Relay main contact
1.3, 2.3, 1.4, 2.4	Relay N/O contact

Adjacent contacts 1.2/2.2, 1.3/2.3, and 1.4/2.4 are jumpered in the corresponding IB IL SCN-8-AC-REL connector.

Terminal points not used by the terminal must not be wired.

10 Connection notes

For currents greater than 8 A a two-wire connection is recommended. A single-wire connection with currents > 8 A is permitted according to the derating diagram in the technical data, however, the correct connectors must be used (included in the scope of supply). These connectors are already internally jumpered between terminal points 1.2 and 2.2, 1.3 and 2.3, and 1.4 and 2.4.

For two-wire connection, it is important that current distribution between both wires is as even as possible, i.e., wherever possible, both connections should have the same resistance to the conductor loop. The following measures must be observed:

– Equal conductor cross-section of 1.5 mm^2
– Equal cable length
– Equal number of additional terminal points

> If connections 1.3, 2.3, 1.4, and 2.4 are used for jumpering, the current per terminal point must not exceed 8 A.

11 Connection assignment

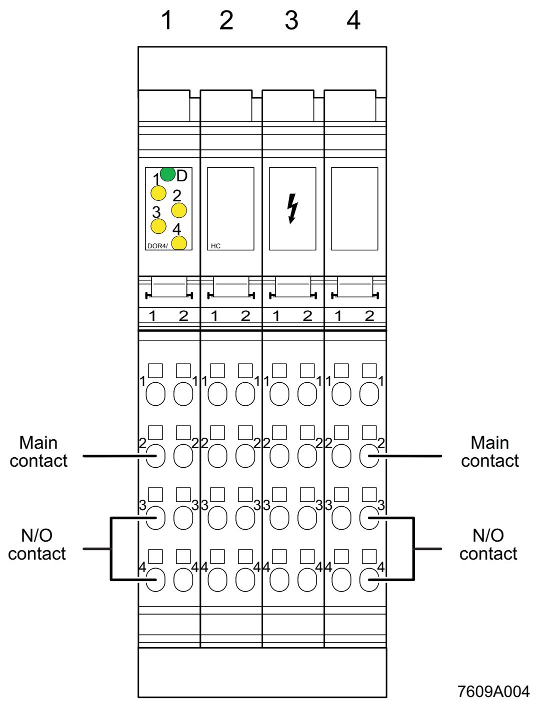


Figure 3 Connection assignment

12 Example station structure

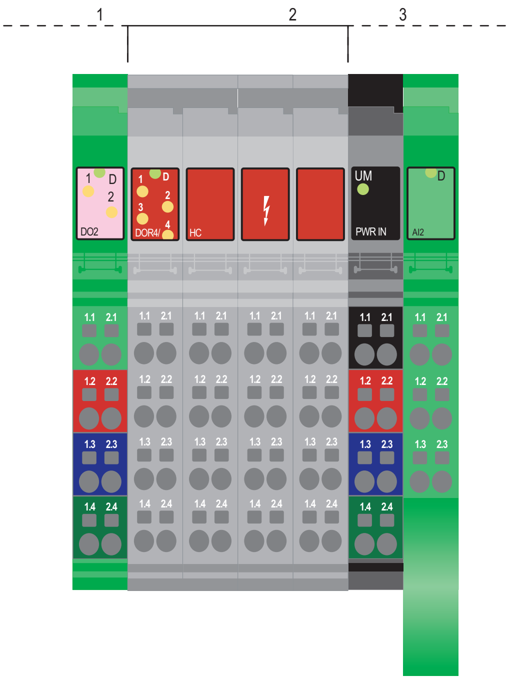


Figure 4 Switching 24 V within a 24 V area

1 24 V area consisting of station head and I/O terminals
2 Relay terminal in the 24 V area
3 24 V area consisting of a power terminal and I/O terminals

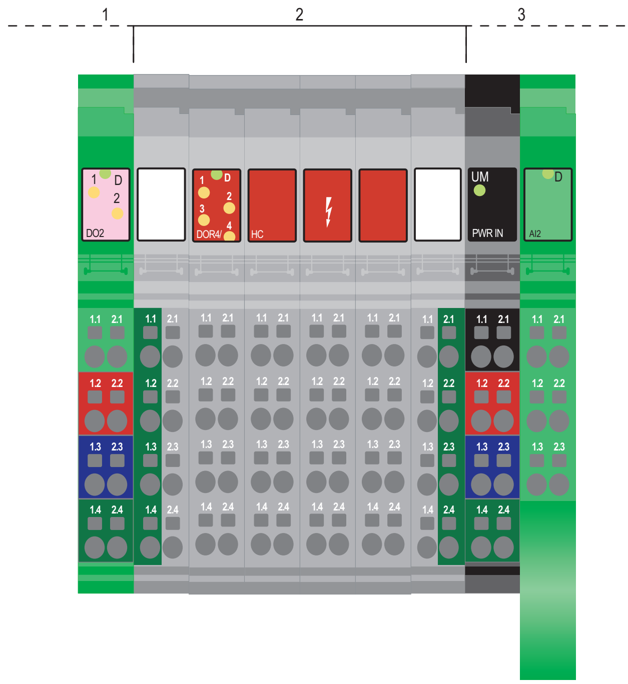


Figure 5 Example: Switching 230 V within a 24 V area

1 24 V area consisting of station head and I/O terminals
2 Relay terminal separated by Inline distance terminals
3 24 V area consisting of a power terminal and I/O terminals

Figure 4 and Figure 5 illustrate the two basic types of application: with and without distance terminals. Distance terminals must be used to ensure the required safety distances between various voltage areas in the Inline station, e.g., between a 230 V AC area and the 24 V SELV area. If a relay terminal is to switch 230 V in a 24 V area (or vice versa), distance terminals are required. However, if the relay terminal is used to switch the same voltage as in the surrounding area, no additional distance terminals are required.

As the relay terminal interrupts the potential jumpers U_M, U_S, and GND (in the 24 V area) or L and N (120 V/230 V area), these supply voltages must be resupplied via suitable power terminals.

On an AC network, the terminal must only be operated from a single phase.

To switch several phases, separate areas must be created using distance terminals – one extra area for each phase.

13 Interference suppression measures for inductive loads/switching relays

Each electrical load is a mix of ohmic, capacitive, and inductive elements. Depending on the proportion of the elements, switching these loads results in a larger or smaller load on the switch contact.

In practice, loads are often used with a large inductive element, such as contactors, solenoid valves, motors, etc. Due to the energy stored in the coils, voltage peaks of up to a few thousand volts may occur when the system is switched off. These high voltages cause an arc on the controlling contact, which may destroy the contact through material vaporization and material migration.

This pulse, which is similar to a square wave pulse, emits electromagnetic pulses over a wide frequency range (spectral elements reaching several MHz) with a large amount of power.

To prevent such arcs from occurring, the contacts/loads must be fitted with protective circuits. In general, the following protective circuits can be used:

– Contact protective circuit
– Load protective circuit
– Combination of both protective circuits

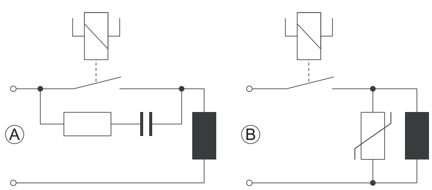


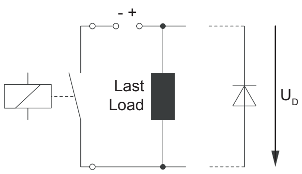
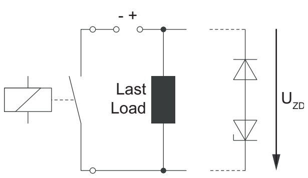
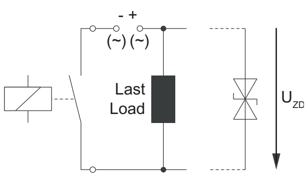
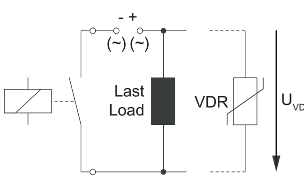
Figure 6 Contact protective circuit (A), load protective circuit (B)

If sized correctly, these circuit versions do not differ greatly in their effectiveness. In principle, a protective measure should be directly implemented at the source of the interference. The following points speak in favor of a load protective circuit:

– When the contact is open, the load is electrically isolated from the operating voltage.
– It is not possible for the load to be activated or to "stick" due to undesired operating currents, e.g., from RC elements.
– Shutdown voltage peaks cannot be coupled in control lines that run in parallel.

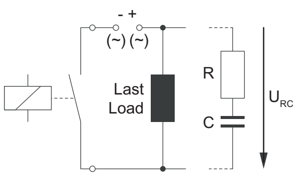
Phoenix Contact provides protective circuit solutions in the form of terminals or electronic housing (see "CLIPLINE" or "TRABTECH" catalogs). Other versions are available on request. In addition to this, today the majority of contactor manufacturers offer diode, RC or varistor elements that can be snapped on. For solenoid valves, connectors with an integrated protective circuit can be used.

13.1 Circuit versions

Load wiring	Additional dropout delay	Defined induction voltage limitation	Bipolar effective attenuation	Advantages/disadvantages
Diode 	Large	Yes (U_D)	No	**Advantages:** – Easy implementation – Cost-effective – No critical sizing – Low induction voltage **Disadvantages:** – Attenuation only via load resistor – High dropout delay
Series connection diode/Zener diode 	Medium to small	Yes (U_{ZD})	No	**Advantages:** – No critical sizing **Disadvantages:** – Attenuation only above U_{ZD}
Suppressor diode 	Medium to small	Yes (U_{ZD})	Yes	**Advantages:** – Cost-effective – No critical sizing – Limitation of fast peaks – Suitable for AC voltages **Disadvantages:** – Attenuation only above U_{ZD}
Varistor 	Medium to small	Yes (U_{VDR})	Yes	**Advantages:** – High energy absorption – No critical sizing – Suitable for AC voltages **Disadvantages:** – Attenuation only above U_{VDR}

13.2 RC circuit versions

- RC series connection

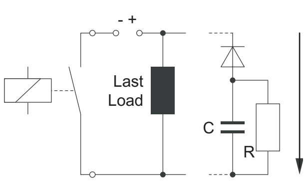
Load wiring	Additional dropout delay	Defined induction voltage limitation	Bipolar effective attenuation	Advantages/disadvantages
RC combination 	Medium to small	No	Yes	**Advantages:** – HF attenuation due to energy absorption – Suitable for AC voltages – Level-independent attenuation – Reactive-current compensation **Disadvantages:** – Precise sizing required – High inrush current flow

Sizing:

– Capacitor: $C \approx L_{Load}/(4 \times R_{Load}^2)$

– Resistor: $R \approx 0.2 \times R_{Load}$

- RC parallel connection with series diode

Load wiring	Additional dropout delay	Defined induction voltage limitation	Bipolar effective attenuation	Advantages/disadvantages
RC combination with diode 	Medium to small	No	No	**Advantages:** – HF attenuation due to energy absorption – Level-independent attenuation – Current reversal not possible **Disadvantages:** – Precise sizing required – Only suitable for DC voltages

Sizing:

– Capacitor: $C \approx L_{Load}/(4 \times R_{Load}^2)$

– Resistor: $R \approx 0.2 \times R_{Load}$

13.3 Switching AC/DC loads

Switching large AC loads

When switching large AC loads, the relay can be operated up to the corresponding maximum values for the switching voltage, current, and power. The arc that occurs during shutdown depends on the current, voltage, and phase relation. This shutdown arc switches off automatically the next time the load current passes through zero.

In applications with an inductive load, an effective protective circuit must be provided, otherwise the service life of the system will be reduced considerably.

To prolong the life of the terminal as much as possible when using lamp loads or capacitive loads, the current peak must not exceed 30 A when the load is switched on.

Switching large DC loads

In DC operation, a relay can only switch a relatively low current compared with the maximum permissible alternating current. This maximum DC value is also highly dependent on the voltage and is determined in part by design conditions, such as the contact distance and contact opening speed.

A non-attenuated inductive load further reduces the values for switching currents given here. The energy stored in the inductance can cause an arc to occur, which forwards the current via the open contacts. Using an effective contact protection circuit, virtually the same currents can be switched as for an ohmic load and the service life of the relay contacts is the same.

14 Programming data/ configuration data

14.1 Local bus (INTERBUS)

ID code	BF_{hex} (191_{dec})
Length code	81_{hex}
Process data channel	8 bits
Input address area	1 byte
Output address area	1 byte
Parameter channel (PCP)	0 bytes
Register length (bus)	1 byte

14.2 Other bus systems

For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

15 Process data

OUT process data

7	6	5	4	3	2	1	0
0	Command			Relay 4	Relay 3	Relay 2	Relay 1

Command field in the OUT process data byte

Bit			Command	Description
6	5	4		
0	0	0	Set	Set the relays; when the bit is set, the relevant relay contact is closed
0	0	1	Read back	Read back the current logical relay state
0	1	0	Configuration 1 (relay type)	Relay type: 0 = Monostable, 1 = Bistable, must always be followed by configuration 2
0	1	1	Configuration 2 (default state)	Default state: 0 = Opened, 1 = Closed, only evaluated for monostable relays, must always be sent after configuration 1
1	0	0	Configuration 3 (refresh)	Refresh all relays, encoded in bit 0 Bit 0 = 0 Refreshing disabled, Bit 0 = 1 Refresh every 120 s, Bits 1 - 3 are reserved and must be set to 0
1	0	1	Reserved	
1	1	0		
1	1	1		

IN process data

7	6	5	4	3	2	1	0
Error	Command			Relay 4	Relay 3	Relay 2	Relay 1

The input byte mirrors the output byte. Bit 7 indicates an error when set.

Possible error causes

Command	Possible error causes
Set	Insufficient power supply for switching operation
Configuration 2	Configuration 1 command must be sent first
Configuration 3	Invalid parameter

16 Description of the configuration

Configuration example

The terminal should be configured as follows:

- Relay 1: Monostable, default state opened
- Relay 2: Monostable, default state closed
- Relays 3, 4: Bistable
- Refresh: Off

Example configuration sequence

Step	Process data	Meaning
1	OUT = $2C_{hex}$	Configuration 1 (relay type): Relays 3 and 4 bistable
2	Wait until IN = $2C_{hex}$	Wait for confirmation
3	OUT = 32_{hex}	Configuration 2 (default state): Relay 2 closed
4	Wait until IN = 32_{hex}	Wait for confirmation
5	OUT = 40_{hex}	Configuration 3: Refreshing off
6	Wait until IN = 40_{hex}	Wait for confirmation

The relay terminal permanently saves the configuration internally in a non-volatile memory (EEPROM). Reconfiguration is not necessary following a supply voltage failure or bus reset.

The configuration is only written to the EEPROM when the supply voltage starts to fail and only if the configuration has actually changed. In addition, multiple configuration modifications do not result in an EEPROM write cycle as long as the supply voltage is present.

A minimum of 100,000 write cycles are ensured for each EEPROM memory location. This corresponds to around 13 write cycles per day over a period of 20 years.

If one or more relays have been configured as bistable, in the event of a supply voltage failure their switching states are also saved in the EEPROM – provided the switching state differs from the previously saved value.