

## Switching, control, visualization

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## Switching, control, visualization

### SmartWire-DT communication system

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#### Connect don't wire

The main part of a control system for a machine is these days carried out by a PLC. Typically the PLC is mounted in a control panel at a central position in the system. The control of the switchgear is carried out via special cables from the input and output terminals of the PLC for the control and return signals. With a decentralized configuration the switchgear and the remote input/output system are connected in the same way.

The SmartWire-DT communication system replaces the control wiring previously required between the PLC inputs/outputs and the switching devices. In this way, the inputs/outputs of the PLC are relocated to the switching devices. Pluggable communication modules are used for this task. The communication is implemented via an 8-pole ribbon cable. Special device plugs are used for connecting the communication modules to the cable. The switchgear is supplied on the control circuit side by the connection cable.

The SmartWire-DT system

- reduces the time required for the control wiring and wiring test,
- saves space in the control cabinet because cable ducts are unnecessary and
- reduces the number of inputs/outputs required at the PLC.

The length of a SmartWire-DT network can be extended up to 600 meters. Up to 99 stations can be connected.

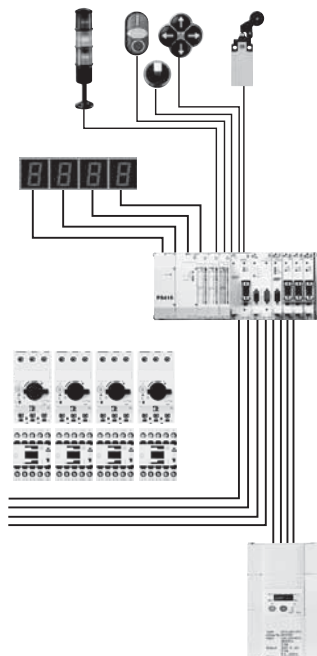
You can use the SmartWire-DT technology flexibly. The connection via standard fieldbus systems (e.g. PROFIBUS, CANopen) enables SWD gateways to be used on the controller platforms of many manufacturers. Another option is the use of Eaton automation components (e.g. XV100 visualization system) with an integrated SmartWire-DT interface.

# Switching, control, visualization

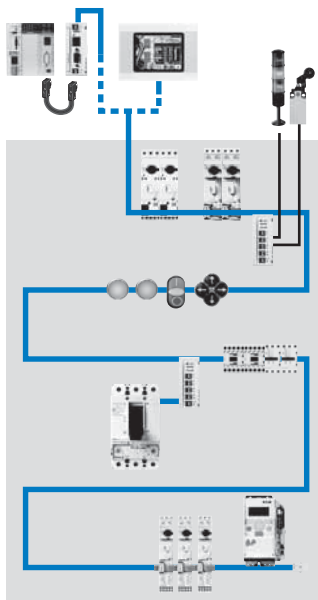
## SmartWire-DT communication system

### Evolution in the switchboard

**Before**



**Today**

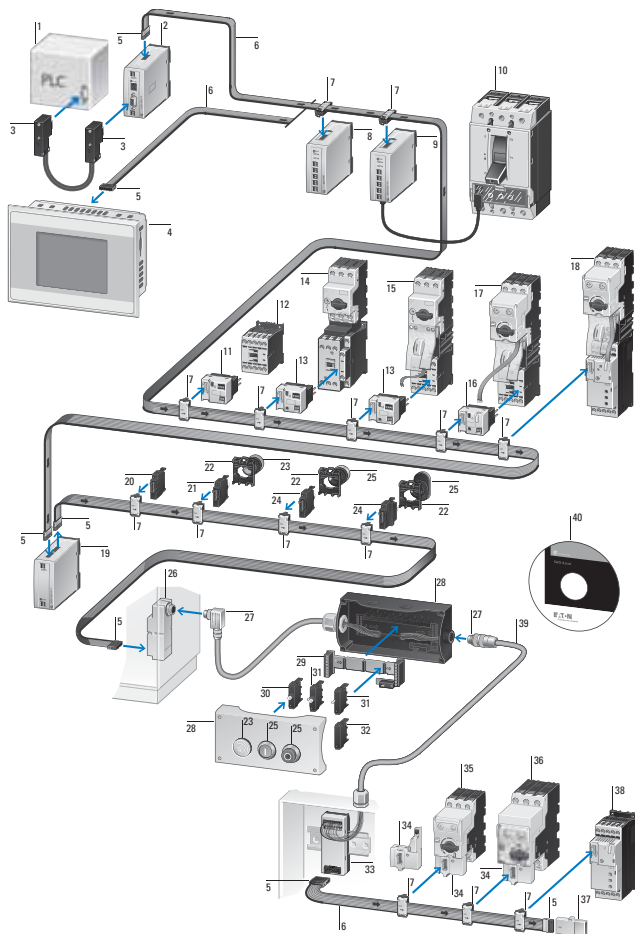


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# Switching, control, visualization

## SmartWire-DT communication system

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## Switching, control, visualization

### SmartWire-DT communication system

- |   |  |
|---|--|
| 1 Programmable logic controller PLC   | 29 SmartWire-DT card for function elements, base-fixing                  |
| 2 SmartWire-DT gateway  | 30 SmartWire-DT LED elements for base fixing                             |
| 3 Data plugs Sub-D 9 pole   | 31 SmartWire-DT function elements for base fixing                        |
| 4 SmartWire-DT HMI-PLC  | 32 SmartWire-DT universal station for base fixing                        |
| 5 SmartWire-DT blade terminal 8 pole  | 33 SmartWire-DT adapter for ribbon/round cable for top-hat rail mounting |
| 6 SmartWire-DT ribbon cable 8 pole  | 34 SmartWire-DT PKE module (motor-protective circuit-breaker)            |
| 7 SmartWire-DT device plug 8 pole   | 35 PKZ12, PKE32 motor-protective circuit-breaker                         |
| 8 SmartWire-DT I/O modules  | 36 PKE 65 motor-protective circuit-breaker                               |
| 9 SmartWire-DT connection for NZM   | 37 Network termination for 8 pole ribbon cable                           |
| 10 NZM circuit-breaker  | 38 DS7 soft starter  |
| 11 SmartWire-DT contactor module  | 39 SmartWire-DT round cable, 8-pole                                      |
| 12 DILM contactor   | 40 SmartWire-DT planning and ordering aid, SWD-Assist                    |
| 13 SmartWire-DT contactor modules with Manual-0-Automatic switch                  |  |
| 14 PKZM0 motor-protective circuit-breaker   |  |
| 15 SC motor-starter combination   |  |
| 16 SmartWire-DT PKE module (motor starter)  |  |
| 17 Motor-starter combination with PKE electronic motor-protective circuit-breaker |  |
| 18 DS7 Softstarter with PKE electronic motor-protective circuit-breaker           |  |
| 19 SmartWire-DT powerfeed module  |  |
| 20 SmartWire-DT universal station, front fixing                                   |  |
| 21 SmartWire-DT LED elements, front fixing  |  |
| 22 RMQ-Titan fixing adapters for front mounting                                   |  |
| 23 RMQ-Titan indicator light  |  |
| 24 SmartWire-DT function elements for front fixing                                |  |
| 25 SmartWire-DT operating elements  |  |
| 26 SmartWire-DT control panel cable entry for ribbon to round cable               |  |
| 27 SmartWire-DT plug connector  |  |
| 28 RMQ-Titan surface mounting enclosure   |  |

## Switching, control, visualization

### SmartWire-DT communication system

#### PKE communication via SmartWire-DT

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Motor-starter combinations fitted with PKE can transfer the following information via SmartWire-DT:

I <sub>max</sub>	Maximum motor current (relative): shows the single-phase current (single-phase load) or the maximum current in the appropriate phase (three-phase load).
Thermal image of the motor	Shows the temperature curve of the motor; stated in %, "Overload warning" function possible
Type of trip block display	Shows the type of trip block currently in use.
Display of set Overload value	Shows the currently set value for the overload release.
Display of time-lag class value	Shows the currently set time-lag class (Class 5...20).
PKE switching state display	Shows the currently set ON/OFF switching state.
DILM contactor switching state	Shows the currently set ON/OFF switching state.
Trip indication overload	Shows a differentiated "Overload" fault indication.
Trip indication short-circuit	Shows a differentiated "Short-circuit" fault indication.
Trip indication Phase failure	Shows a differentiated "Phase failure" fault indication.
Trip indication Test	Shows a differentiated "Tripping via test function" fault indication.
ZMR function	Overload relay function: When the ZMR function is set, the contactor disconnects in the event of an overload. The PKE motor-protective circuit-breaker remains switched on (ON setting). The contact is reset with the MANUAL/AUTO function via PKE-SWD-32.

## Switching, control, visualization

### SmartWire-DT communication system

#### Overload relay function (ZMR)

The ZMR function enables the motor to be switched off by the connected contactor in the event of an overload. To do this the PKE sends the switch off command for the contactor to the PKE-SWD-32 via the data cable of the PKE32-COM.

The trip in response to a motor overload occurs if the thermal motor image of the PKE reaches 110 %.

This value remains set until the thermal motor image has gone below the 100 % level and the operational readiness of the contactor is restored.

The reclosing readiness of the contactor can be selected by the two manual and automatic operating modes of the ZMR function.

The ZMR function can only be used in position "A" of the 1-0-A switch.

In the event of a phase unbalance and activated ZMR function, the value of the thermal motor image is raised from 100 % to 110 % after a trip.

The switched off contactor's readiness to reclose is restored when the value falls below 100 %.

The ZMR function must not be activated with reversing starters since this operation does not ensure the disconnection of the second contactor in the event of an overload.

#### ZMR Manual mode

In "manual" ZMR operating mode, the retriggering of the contactor must be acknowledged beforehand.

#### ZMR Automatic mode

In "automatic" ZMR mode, the contactor is ready to reclose immediately after the thermal image drops below 100 %.

#### **Danger!**

If the switch on command for the contactor is sent in "automatic" ZMR mode, the motor starts up automatically after the thermal motor image falls below 100 %.

Never disconnect the communication link between the PKE-SWD-32 and the PKE trip block after an overload with the ZMR function activated, as this can cause the contactor to switch on if a switch command is present.

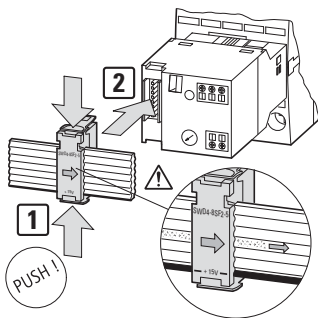
## Switching, control, visualization

### SmartWire-DT communication system

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#### DOL starter with PKZ

The DOL starters are assembled from a PKZM0 and a DILM7 to DILM32 contactor. The connection to SmartWire-DT is implemented with the DIL-SWD-32... module. This is fitted directly on the contactor and connected via the SWD device plug with the SWD communication cable.



In addition to contactor control, two feedback signals can be sent to the SmartWire-DT system on each SmartWire-DT module for DILM.

The SmartWire-DT module for DILM drives the contactor so that terminals A1-A2 must no longer be wired.

The auxiliary contact X3-X4 is factory fitted with a link. If electrical interlocks are envisaged in the application, the link can be removed and a potential-free contact can be connected.

Two feedback inputs to the programmable logic controller are provided at the three-pole terminal X0-X1-X2. If required, potential-free auxiliary contacts of the PKZ

motor protective circuit-breaker can be connected to these two feedback inputs (e.g. NHI-E-...-PKZ0 standard auxiliary contact, AGM2-...-PKZ0 differential trip-indicating auxiliary contact).

→ Figure, page 1-10

#### Reversing starter with PKZ

The reversing starters are made up of a PKZM0 motor-protective circuit-breaker and two DILM7 to DILM32 contactors. A DIL-SWD-32-... SmartWire-DT module is fitted to each contactor and connected to the SWD communication cable via the SWD external device plug.

In addition to contactor control, two feedback signals can be sent to the SmartWire-DT system on each SmartWire-DT module for DILM.

The SmartWire-DT modules for DILM drive the contactors so that the connection terminals A1-A2 of the contactors need no further wiring, with the exception of the DILM12-XEV link. The auxiliary contact X3-X4 is factory fitted with a link. For the electrical interlocking of the two contactors this bridge is removed and the auxiliary breaker (contacts 21-22) of the other contactor is linked in as a potential-free contact.

Two feedback inputs to the programmable logic controller are provided at the three-pole terminal X0-X1-X2. If required, potential-free auxiliary contacts of the PKZ motor protective circuit-breaker can be connected to these two feedback inputs (e.g. NHI-E-...-PKZ0 standard auxiliary contact, AGM2-...-PKZ0 differential trip-indicating auxiliary contact).



## Switching, control, visualization

### SmartWire-DT communication system

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The wiring sets DILM12-XRL and PKZM0-XRM12 must only be used to create a reversing starter when the reversing linksDOL starters with PKZ are replaced with DILM12-XR. The A2 connections of the contactors must not be bridged.

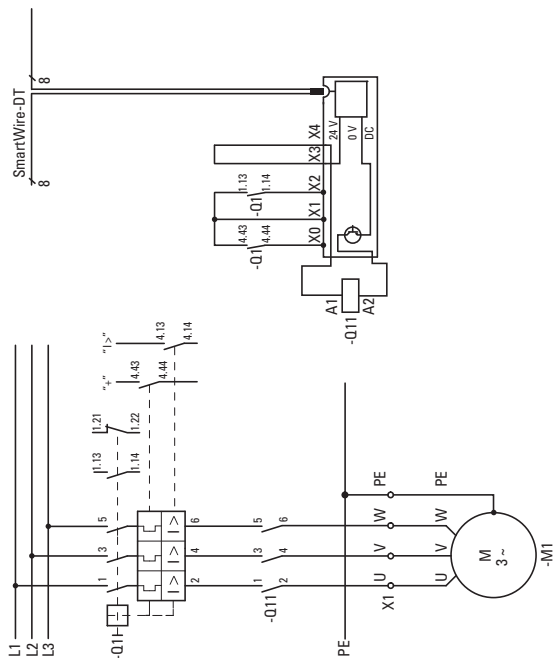
→ Figure, page 1-11

# Switching, control, visualization

## SmartWire-DT communication system

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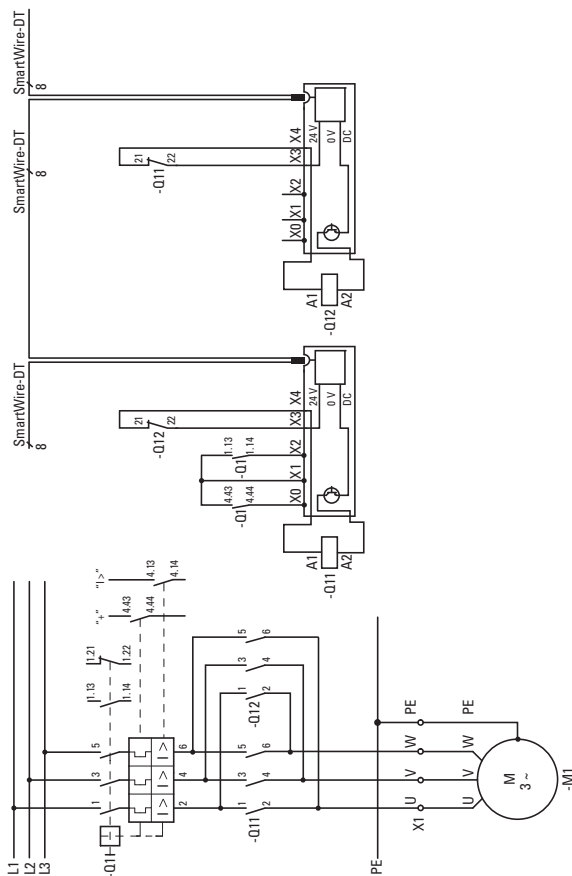
DOL starters with PKZ



# Switching, control, visualization

## SmartWire-DT communication system

### Reversing starter with PKE



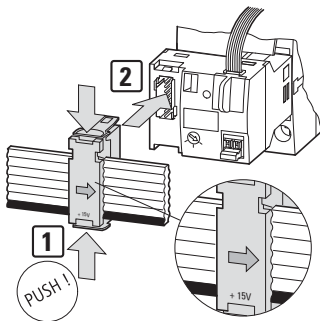
## Switching, control, visualization

### SmartWire-DT communication system

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#### DOL starter with PKE

The DOL starters are assembled from a PKE12/ PKE32 with the PKE-XTUA-... trip block and a DILM7 to DILM32 contactor. The connection to SmartWire-DT is implemented with the PKE-SWD-32 module. This is fitted to the contactor and connected to the SWD communication cable via the SWD device plug.



The PKE32-COM is used as a communication link between the PKE-SWD-32 and the PKE trip block. The PKE-SWD-32 receives the data of the PKE trip block via the PKE32-COM and makes this available as input data on the SmartWire-DT network.

The PKE32-COM is fitted on the PKE basic device (PKE12 or PKE32) and is connected with the appropriate interface of the PKE-SWD-32.

The auxiliary contact for the electrical enable X3-X4 is connected at the factory with a link. If electrical locks are envisaged in the application, the link can be removed and a potential-free contact can be connected.

The auxiliary contact for the electrical enable can be used on the PKE-SWD-32 for safety-related control sections (e.g. safety shutdown of the drive).

→ Figure, page 1-14

## Switching, control, visualization

### SmartWire-DT communication system

#### Reversing starter with PKE

The reversing starters are made up from a PKE12/PKE32 with a PKE-XTUA-... trip block and two contactors DILM7 to DILM32. The PKE-SWD-32 is fitted on one of the two contactors of the reversing starter. Unlike DOL starters, the control of the second contactor for reversing starters must be implemented with a SmartWire-DT contactor module (DIL-SWD-32-...). Both SWD modules are then connected to the SWD communication cable via the SWD device plug.

The "Enable" X3-X4 auxiliary contact is factory fitted with a link. For the electrical interlocking of the two contactors this link is removed and the auxiliary breaker (contacts 21-22) of the other contactor is linked in as a potential-free contact.

The auxiliary contact for the electrical enable X3-X4 can be used on the PKE\_SWD-32 for safety-related control sections. The wiring sets DILM12-XRL and PKZM0-XRM12 must not be used for the assembly of the reversing starters.

The A2 connections of the contactors must not be bridged.

→ Figure, page 1-15

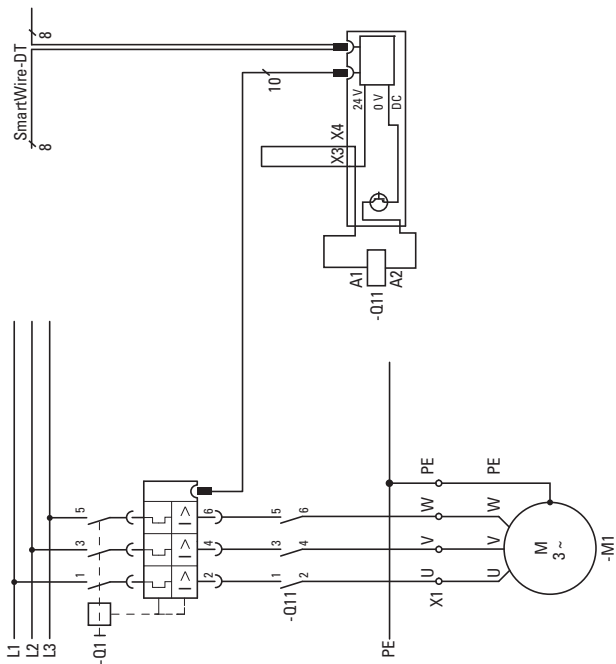
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# Switching, control, visualization

## SmartWire-DT communication system

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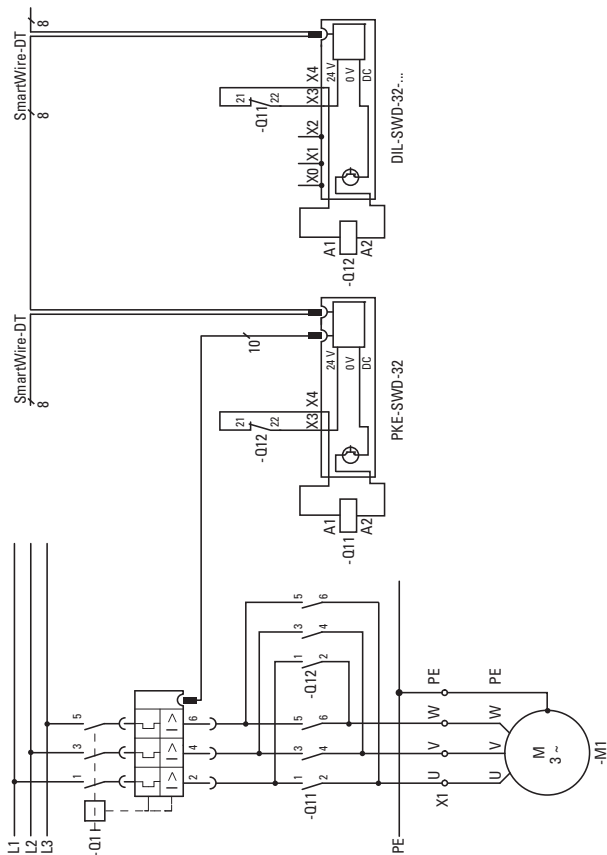
### DOL starters with PKE



# Switching, control, visualization

## SmartWire-DT communication system

### Reversing starter with PKE



## Switching, control, visualization

### SmartWire-DT communication system

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#### Star-delta starter

**1**

##### **With SmartWire-DT modules for DILM**

They control the contactors so that the terminals A1-A2 of the contactors do not have to be wired. A return signal is also given back to the SmartWire-DT system via the SWD contactor modules for DILM.

The terminals X3-X4 are supplied with a bridging connection. For the electrical interlocking of the two contactors this bridge is removed and the auxiliary breaker (contacts 21-22) of the other contactor is linked in as a potential-free contact.

→ Figure, page 1-18

##### **With SmartWire-DT I/O-module EU5E-SWD-4D2R**

The SmartWire-DT I/O module actuates the contactor Q11 via the digital relay output Q0. The further procedure is the same as that of a conventional star-delta starter.

The inputs of the SmartWire-DT I/O module are used to implement return signals to the SmartWire-DT system.

→ Figure, page 1-19

##### **With SmartWire-DT contactor module and ETR4-51 timing relay**

The SWD contactor module for DILM controls the mains contactor Q11 so that the terminals A1-A2 do not have to be wired. A return signal is also given back to the SmartWire-DT system via the SWD protective module for DILM.

The control and the changeover between star contactor and delta contactor have the same wiring and function as the conventional star-delta starter assembly.

→ Figure, page 1-20



## Switching, control, visualization

### SmartWire-DT communication system

#### With PKE and SWD modules for DILM

The star-delta starters are made up from a PKE12/PKE32 with a PKE-XTUA-... trip block and three contactors DILM7 to DILM32. The PKE-SWD-32 is fitted to the mains contactor of the star-delta starter. The star and delta contactor is actuated with SmartWire-DT contactor modules (DIL-SWD-32-...).

All SWD modules are then connected to the SWD communication cable via the SWD device plug.

The "Enable" X3-X4 auxiliary contact is factory fitted with a link. For the electrical interlocking of the star and delta contactor this link is removed and the auxiliary NC contact (contacts 21-22) of the other contactor is linked in as a potential-free contact.

The auxiliary contact for the electrical enable X3-X4 can be used on the PKE\_SWD-32 for safety-related control sections.

The wiring sets DILM12-XRL and PKZM0-XRM12 must not be used for the assembly of a star-delta starter.

The A2 terminals of star and delta connections must not be bridged.

→ Figure, page 1-21

#### With PKE, SWD modules for mains contactor DILM and ETR4-51 timing relay

The star-delta starters are made up from a PKE12/PKE32 with a PKE-XTUA-... trip block and three contactors DILM7 to DILM32. The PKE-SWD-32 is fitted to the mains contactor of the star-delta starter. The star-delta contactor is actuated in a conventional circuit. The PKE-SWD-32 module is connected to the SWD communication cable via the SWD device plug. The wiring sets DILM12-XRL and PKZM0-XRM12 can be used for the assembly of a star-delta starter.

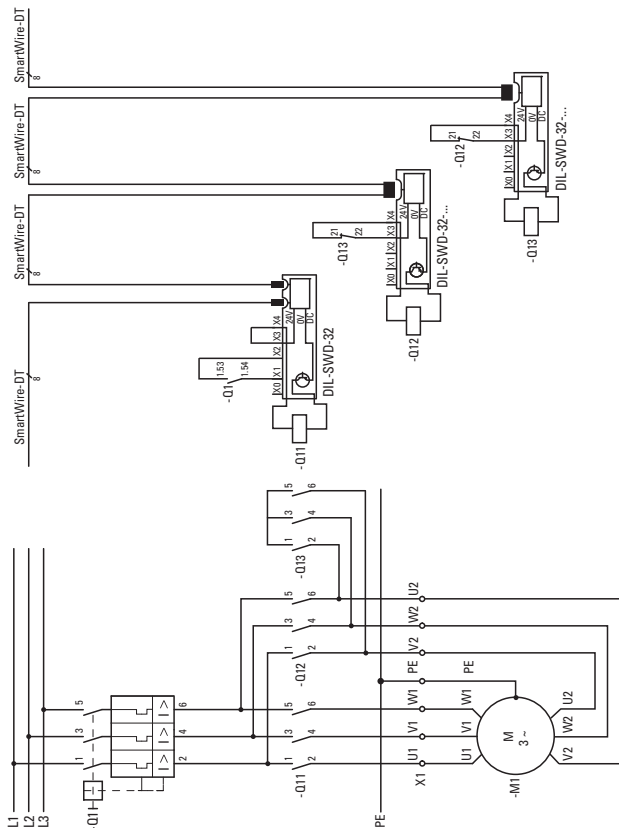
→ Figure, page 1-22

# Switching, control, visualization

## SmartWire-DT communication system

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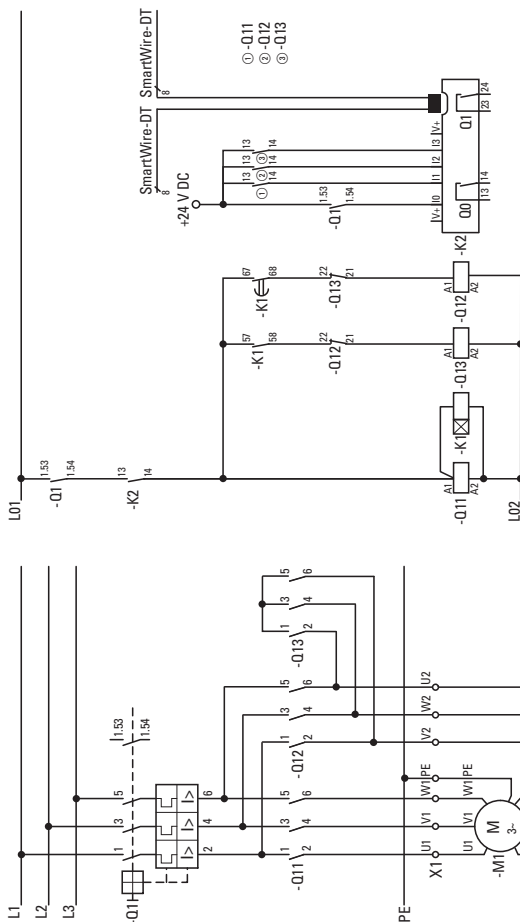
### Star delta starter with 3 SmartWire-DT contactor modules



# Switching, control, visualization

## SmartWire-DT communication system

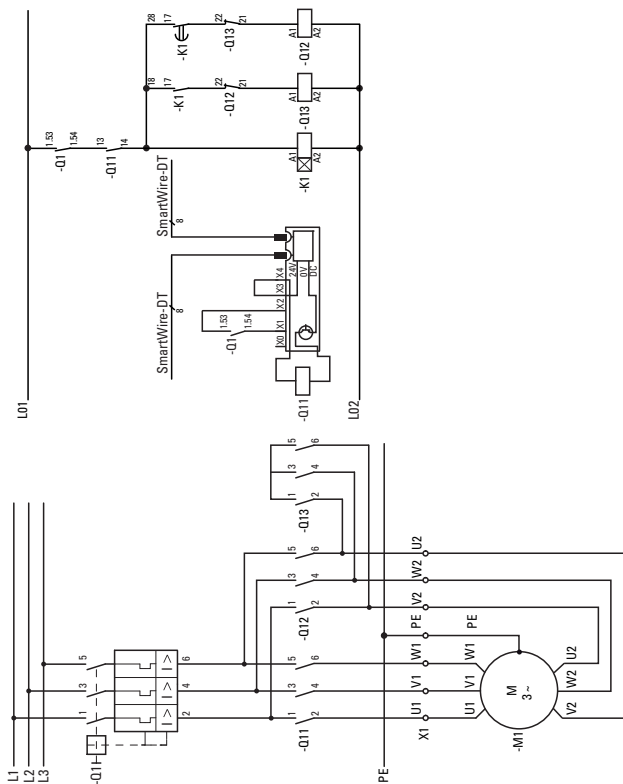
SmartWire-DT star-delta starter with EU5E-SWD-4D2R I/O module



# Switching, control, visualization

## SmartWire-DT communication system

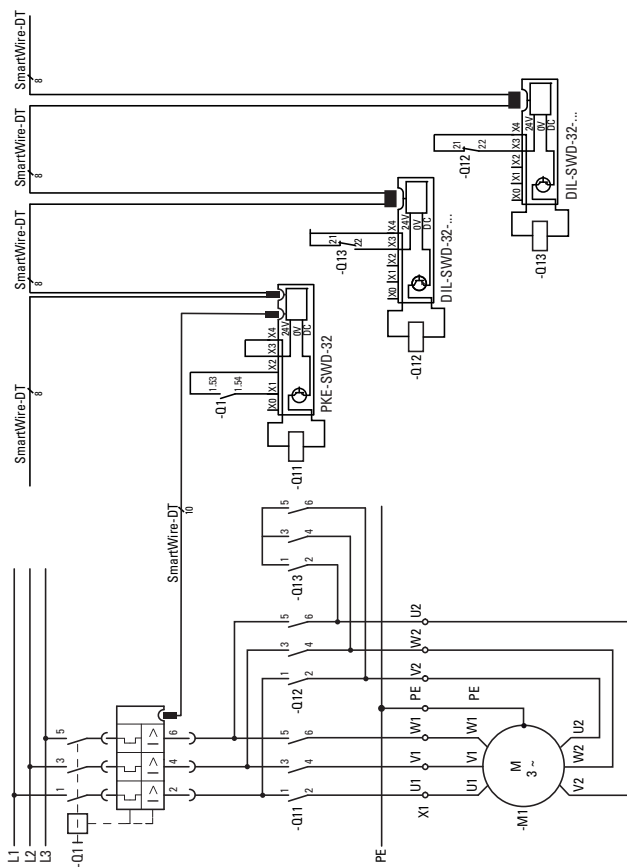
Star delta starter with SmartWire-DT contactor module and ETR4-51 timing relay



# Switching, control, visualization

## SmartWire-DT communication system

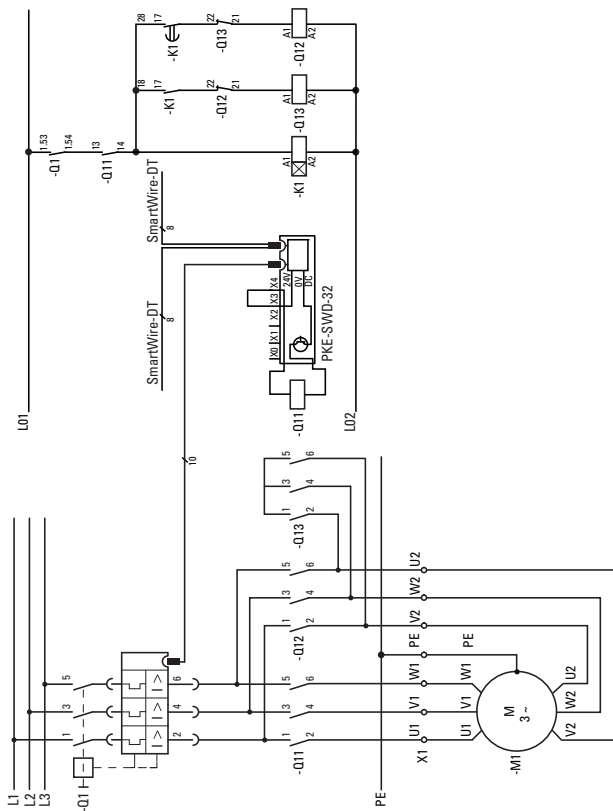
### Star delta starter with PKE and SWD modules for DILM



# Switching, control, visualization

## SmartWire-DT communication system

Star delta starter with PKE, SWD module for mains contactor DILM and ETR4-51 timing relay



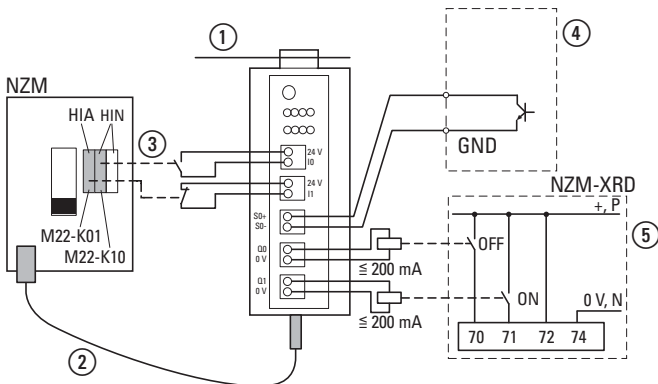
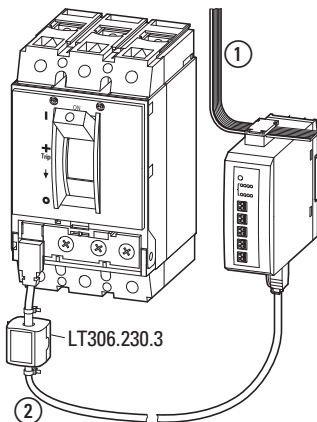
# Switching, control, visualization

## SmartWire-DT communication system

### NZM circuit-breakers

The NZM-XSWD-704 SmartWire-DT module is used for querying a circuit-breaker with an electronic release (NZM2, 3, 4) via a PLC, i.e. the On/Off/Trip position of the switch and the actual currents. An optionally installed remote operator can also be actuated via the module. The NZM-XSWD-704 is fitted on a top-hat rail and is connected to the NZM via a 2.0 m data cable. The auxiliary contacts and the remote operator are wired separately. The connection to the SmartWire-DT ribbon cable is implemented via the SWD device plug.

- ① SmartWire-DT connection
- ② Data cable NZM with NZM-XSWD-704
- ③ Auxiliary contacts in NZM
- ④ XMC energy metering device (external)
- ⑤ Remote operator



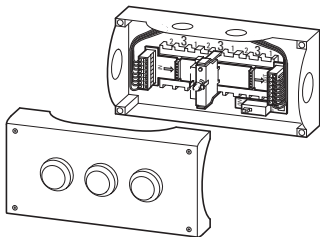
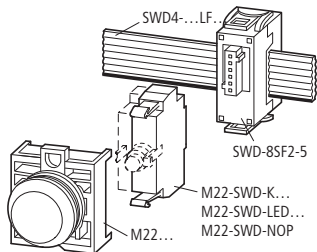
## Switching, control, visualization

### SmartWire-DT communication system

#### Pilot Devices

Simple pilot devices can be integrated directly in the SmartWire-DT communication system without any time consuming wiring. The function elements are snap fitted in the M22-A fixing adapter and then connected to the SWD communication cable via the SWD device plug.

These function elements are each available in two versions for front or base fixing. Base fixing elements can be combined to form remote operating and display devices using the M22-SWD-I cards and the M22-I.. surface mounting enclosures to IP65.



The switch position indications of the control elements and activation of the indicator are implemented with the SmartWire-DT communication system. The function elements stated in the table are available.

M22-SWD-K(C)11	Function element with one changeover contact
M22-SWD-K(C)22	Function element with two changeover contacts
M22-SWD-LED...	LED function elements in white (W), red (R), green (G) or blue (B)
M22-SWD-K11LED...	Function element with one changeover contact and one LED in white (W), red (R), green (G) or blue (B)
M22-SWD-K22LED...	Function element with two changeover contacts and one LED in white (W), red (R), green (G) or blue (B)



## Switching, control, visualization

### SmartWire-DT communication system

#### Digital and analog signal processing

The following SWD modules are available for processing digital or analog input/output signals:

EU5E-SWD-8DX	8 digital inputs
EU5E-SWD-4DX	4 digital inputs with transmitter supply
EU5E-SWD-4D4D	4 digital inputs and 4 digital outputs
EU5E-SWD-4D2R	4 digital inputs and 2 relay outputs 3 A
EU5E-SWD-X8D	8 digital outputs
EU5E-SWD-4AX	4 analog inputs 0 – 10 V, 0 – 20 mA
EU5E-SWD-2A2A	2 analog inputs and 2 analog outputs 0 – 10 V, 0 – 20 mA
EU5E-SWD-4PT	4 temperature inputs PT100, PT1000, Ni1000

The modules are fitted directly on the top-hat rail and then connected with the SWD communication cable via the SWD device plug.

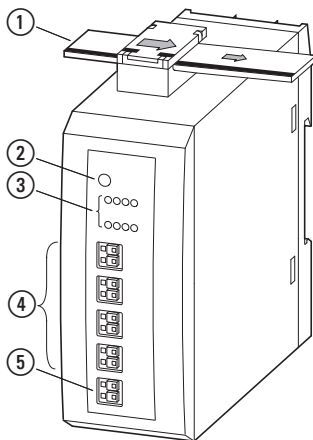
The modules can be fitted directly in the proximity of the sensors/actuators to be connected. This also reduces the remaining wiring required.

The following applications are possible:

- Connection of AC contactors or high rated contactors > DILM32 that do not have a connection option for the DIL-SWD-... module. For this use the EU5E-SWD-4D2R module.
- Connection of auxiliary contacts to modules with digital inputs

- Connection of digital actuators without integrated SWD functionality (signal lights, timing relays ..)
- Connection of any analog inputs/outputs

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- ① SmartWire-DT cable with external device plug
- ② SmartWire-DT diagnostics LED
- ③ Status display of inputs and outputs (optional)
- ④ Input/output terminals
- ⑤ External supply (optional)

## Switching, control, visualization

### SmartWire-DT communication system

#### Safety-related applications

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For most applications, disconnection in the event of an emergency or the disconnection by the opening of the protective doors is also required in addition to normal operational switching.

The SmartWire-DT system is not designed for the transfer of safety relevant signals. Using the configuration described below, the SmartWire-DT system can however be used for safety relevant switch offs.

In an emergency the control voltage for the contactor coils can be switched off via the enabling paths of the safety relay. By using additional SmartWire-DT Power modules, contactor groups are made that can be switched off together in an emergency. This type of circuit can be used to create control systems up to PL c in accordance with EN ISO 13849-1 (PL = Performance Level). The safety relay in this example must be PL c or higher (e.g. ESR5-NO-41-24VAC-DC).

→ Figure, page 1-27

#### Feedback circuit

The auxiliary contact integrated in the contactor is a mirror contact according to IEC/EC 60947-4-1. Using this contact the state of the main contacts can be reliably signalled. The mirror contact can be included into the feedback circuit of the safety relay so that the safety relay only gives a new enable signal when the contactor is open.

#### Measures for higher safety category

In many applications control systems with a performance level of PL d or PL e (PL = Performance Level) to EN ISO 13849-1 are required. Control systems with PL d can be set up using an additional group contactor which is connected in series upstream of the motor feeders. The control voltage for the motor contactors as well as for the group contactor is switched off in an emergency via the safety relay. This redundant disconnection circuit enables the implementation of PL d control systems. The safety relay used must comply with PL d or higher to achieve this safety category (e.g. ESR5-NO-31-24VAC-DC).

Further information on safety engineering for machines and plants is provided in the Eaton Safety Manual: [www.eaton.eu/shb](http://www.eaton.eu/shb)

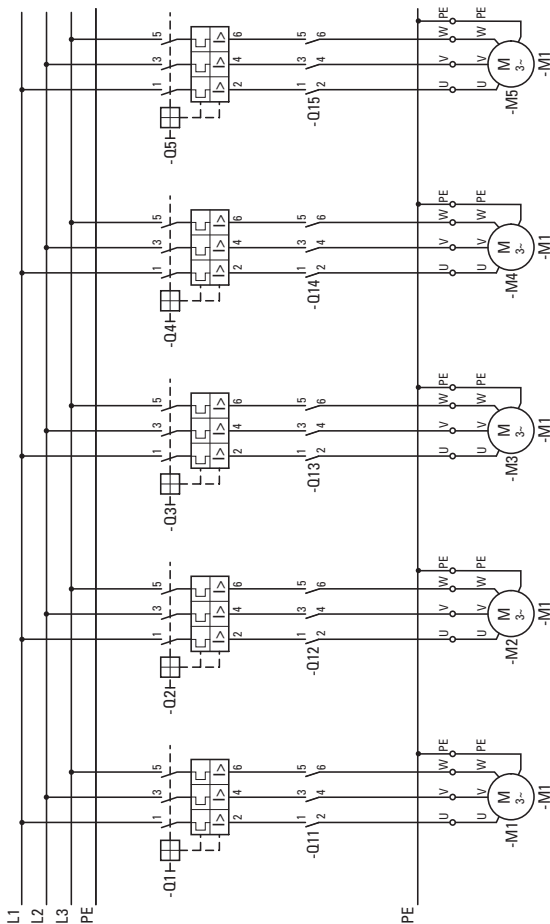
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# Switching, control, visualization

## SmartWire-DT communication system

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Mains circuit for safety relevant application



## Switching, control, visualization

The way to the safe machine



## Safety Technology

Control the unexpected

The international standard EN ISO 12100-1 "Safety of machinery - Basic concepts, general principles for design" provides the design engineer with detailed assistance in the identification of hazards and the resulting risks to be assessed.

This therefore lays down the technical measures for the reduction of hazards.

The parts of machine control systems that handle safety tasks are defined as the "safety-related parts of control systems" (SRP/CS). Safety-related control systems comprise the entire safety function consisting of the input level (sensor), the logic (safety signal processing) and the output level (actuator).

For reducing risks by means of SRP/CS, Eaton offers the right components with safety technology in accordance with the most stringent requirements stipulated in the safety standards EN 954-1, EN ISO 13849-1 and EN IEC 62061. The appropriate safety functions are used according to the application area and in compliance with the required risk reduction.

Further information on the previous and the new international safety standards as well as circuit examples for a wide range of applications are provided in the latest version of the Eaton Safety Applications Technical Guide PU05907001Z-EN.



The safety manual helps you by means of practical safety circuit examples and the associated calculations to determine safety performance in accordance with EN ISO 13849-1 and IEC 62061.

The Safety Manual is available online or in print:

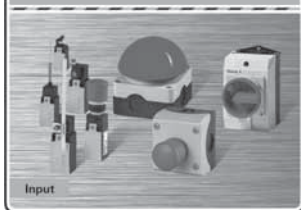
- Register at [www.eaton.eu/shb](http://www.eaton.eu/shb) and work online with the Safety Manual or download the PDF version free of charge.
- Order the current printed version from your wholesalers or your Eaton customer service: PU05907001Z-EN, Article no. 119906

# Switching, control, visualization

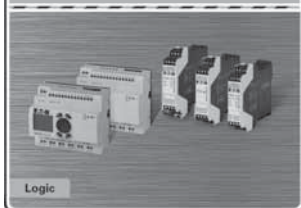
The way to the safe machine

1

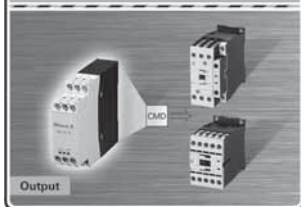
## Fast and secure detection



## Safe monitoring and processing



## Reliable shut down



Detecting hazards quickly with RMQ-Titan and FAK emergency-stop buttons. Motion safety under control with LS-Titan® position switches. Safe switching, disconnection and control with T rotary switches and P switch-disconnectors.

Safe monitoring and processing with ESR safety relays and easySafety control relay.

Reliable disconnection with DILM contactors and CMD contactor monitoring device.

Further technical information on the individual safety products is provided at [www.eaton.com/moeller](http://www.eaton.com/moeller)

## Switching, control, visualization

### The way to the safe machine

#### Logic units to ensure safety functions

Safety logic units enable the hardware required to be considerably reduced and primarily restricted to the sensor/actuator level. Eaton offers two logic series:

- ESR5 Electronic safety relays
- easySafety control relay suitable for safety circuits.

Safety relays of the ESR5 series offer the optimum solution for each application with tailored safety functions. The internal logic of the safety relay monitors the wired safety circuits and activates the enable contacts in fault-free condition.

The easySafety control relay offers a host of integrated safety relays in the form of safety function blocks in a single device, thus offering maximum flexibility in a considerable space saving design. easySafety is used for monitoring all typical safety devices and also implementing the control tasks required on the machine.

The ESR safety relays or the easySafety control relay enable applications to be implemented that meet the most stringent safety requirements in accordance with international standards:

- Category 4 to EN 954-1
- Performance level PL e acc. to EN ISO13849-1
- Safety Integrity Level SIL CL 3 according to IEC 62061
- Safety Integrity Level SIL 3 according to IEC 61508

Eaton ensures the required level of personal or process protection using the safety products approved by TÜV Rheinland – for both simple and complex machines.



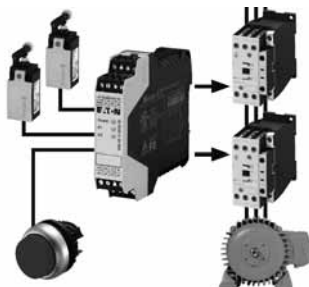
# Switching, control, visualization

## The way to the safe machine

1

### Monitoring a movable guard with ESR5

Moving guards such as safety doors, gates and flaps can be used to provide protection from accessible hazardous areas. The position of moving guards is detected with position switches or non-contacting contact sensors that are monitored and evaluated with a safety logic unit. A risk analysis supplies the necessary degree of risk reduction by the guard.



### Function

The safety logic unit provides two separate input circuits for two-channel applications, which monitor the sensor (such as the position switch of an interlock device). After the input circuits are closed, the safety relay can be started by means of a reset button. This activates the enable and signal current paths and switches on the connected actuators. Positively driven auxiliary contacts of the actuators are used by the safety relay to diagnose possible safety states.

### Safety technical assessment

Cat	B	1	2	3	4
PL	a	b	c	d	e
SIL	1	2	3		

Cat. according to EN 954-1

PL according to EN ISO 13849-1

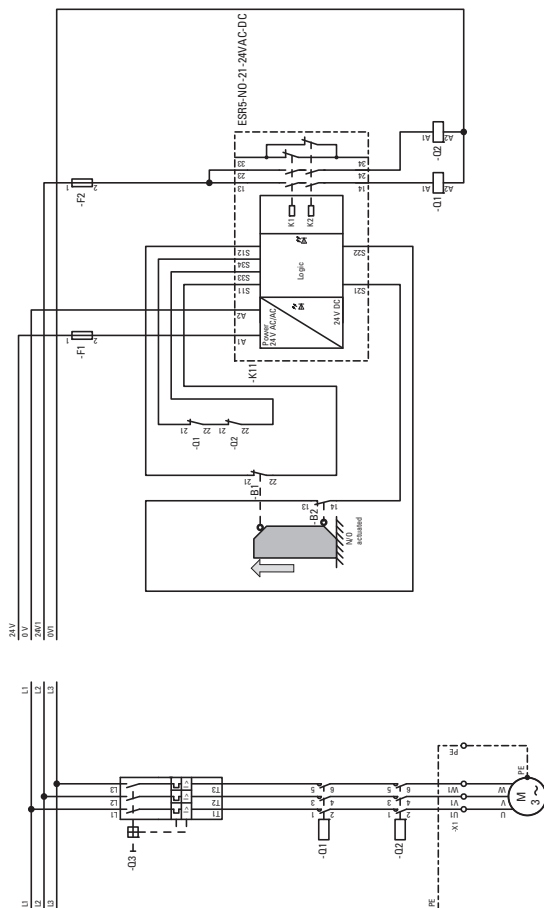
SIL according to IEC 62061



# Switching, control, visualization

The way to the safe machine

Circuit example: Two-channel guard door monitoring with ESR5



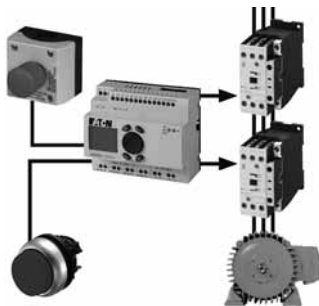
## Switching, control, visualization

### The way to the safe machine

1

#### Stopping in case of emergency with easySafety

The Emergency-stop function is an additional protective measure and is not permissible as the sole means of protection. Machinery Directive 2006/42/EC stipulates however that every machine must be provided with a device for stopping in an emergency (Emergency stop). The degree of risk reduction by the Emergency stop device must be determined by means of a risk assessment. If the immediate disconnection of the power supply does not cause hazardous states, you can use an uncontrolled Stop function in accordance with Stop category 0 to EN ISO 13850.



its interruption are implemented in the program. The two contactors drop out, and a restart is possible by pressing the START actuator. If the hazardous movement is stopped by pressing the Emergency-stop actuator S4, the enable for outputs QS1 and QS2 is removed and the contactors drop out. A restart is only possible after the Emergency-stop actuator is reset and enabled by pressing the RESET pushbutton. The drive can be braked actively by using output QS4. However, this option is not included in the safety consideration since the frequency inverter does not support the safe braking operation.

#### Safety technical assessment

Cat	B	1	2	3	4
PL	a	b	c	d	e
SIL	1	2	3		

Cat. according to EN 954-1

PL according to EN ISO 13849-1

SIL according to IEC 62061

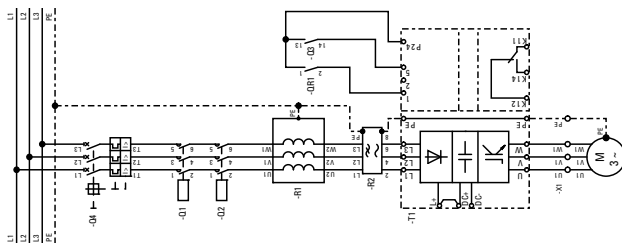
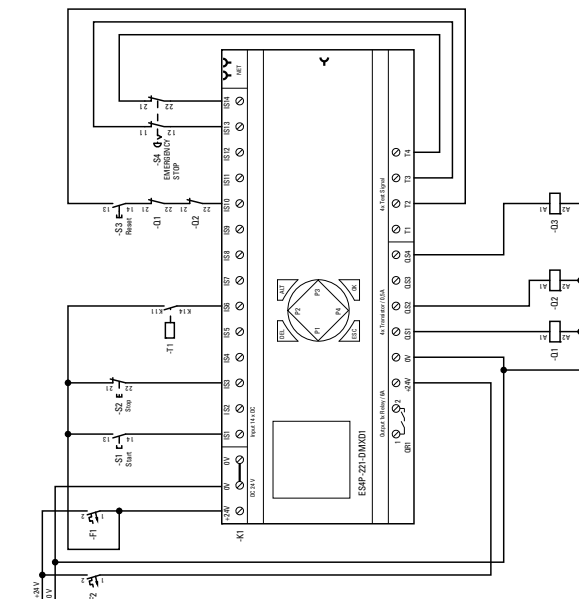
#### Function

The Emergency-stop actuator S4 must be in the enable position (NC contacts closed) so that the enable signal can be issued via the RESET pushbutton S3. Pressing the START pushbutton S1 starts the hazardous movement. The self-latching function and

# Switching, control, visualization

The way to the safe machine

Circuit example: Two-channel Emergency-stop monitoring with easySafety



## Switching, control, visualization

### Timing relays

1

Electronic timing relays are used in contactor control systems which require short reset times, high repetition accuracy, high operating frequency, and a long component lifespan. Times between 0.05 s and 100 h can be easily selected and set.

The switching capacity of electronic timing relays complies with the utilization categories AC-15 and DC-13.

In terms of the actuating voltages there are with timing relays the following differences:

- **Version A** (DILET... and ETR4)  
Universal devices:  
DC 24 to 240 V  
AC 24 to 240 V, 50/60 Hz
- **Version W** (DILET... and ETR4)  
AC devices:  
AC 346 to 440 V, 50/60 Hz
- **ETR2...** (as modular installation device to DIN 43880)  
Universal devices:  
DC 24 to 48 V  
AC 24 to 240 V, 50/60 Hz  
(ETR2-69-D: 12 to 240 V, 50/60 Hz)

The functions of each of the timing relays are as follows:

- DILET11, ETR4-11, ETR2-11  
**Function 11** (on-delayed)
- ETR2-12  
**Function 12** (off-delayed)
- ETR2-21  
**Function 21** (fleeting contact on energization)
- ETR2-42  
**Function 42** (flashing, pulse initiating)
- ETR2-44  
**Function 44** (flashing, two speeds; can be set to either pulse initiating or pause initiating)

- Multifunction relays DILET70, ETR 4-69/70  
**Function 11** (on-delayed)  
**Function 12** (off-delayed)  
**Function 16** (on- and off-delayed)  
**Function 21** (fleeting contact on energization)  
**Function 22** (fleeting contact on de-energization)  
**Function 42** (flashing, pulse initiating)
- **Function 81** (pulse generating)  
**Function 82** (pulse shaping)  
**ON, OFF**
- Multifunction relay ETR2-69(-D)  
**Function 11** (on-delayed)  
**Function 12** (off-delayed)  
**Function 21** (fleeting contact on energization)  
**Function 22** (fleeting contact on de-energization)  
**Function 42** (flashing, pulse initiating)  
**Function 43** (flashing, pause initiating)  
**Function 82** (pulse initiating)
- Star-delta timing relays ETR4-51  
**Function 51** (on-delayed)

With both DILET70 and ETR4-70 an external potentiometer can be connected. Upon connection, both timing relays automatically recognize that a potentiometer is fitted.

The ETR4-70 has a special feature. Equipped with two changeover contacts which can be converted to two timing contacts 15-18 and 25-28 (A2-X1 linked) or one timing contact 15-18 and a non-delayed contact 21-24 (A2-X1 not linked). If the link A2-X1 is removed, only the timed contact 15-18 carries out the functions described below.

# Switching, control, visualization

## Timing relays

### Function 11

On-delayed

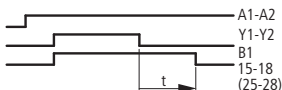


The actuating voltage  $U_s$  is applied via an actuating contact to the terminals A1 and A2.

After the set delay time the changeover contact of the output relay goes to the position 15-18 (25-28).

### Function 12

Off-delayed



After the supply voltage has been applied to the terminals A1 and A2, the changeover contact of the output relay remains in the original position 15-16 (25-26). If the terminals Y1 and Y2 in the DILET70 are linked by a potential-free N/O contact or, in the case of the ETR4-69/70 or ETR2-69, a potential is applied to B1, the changeover contact changes without delay to the position 15-18 (25-28).

If the connection between the terminals Y1–Y2 is now interrupted, or B1 is separated from the potential, once the set time has elapsed, the changeover contact returns to its original position 15-16 (25-26).

### Function 16

On- and Off-delayed

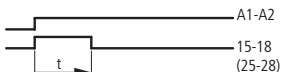


The supply voltage  $U_s$  is applied directly to the terminals A1 and A2. If the terminals Y1 and Y2 in the DILET70 are linked by a potential-free N/O contact, or in the case of the ETR4-69/70 a potential is applied to B1, after a set time  $t$  the changeover contact goes to the position 15-18 (25-28).

If the connection Y1-Y2 is now interrupted, or B1 is separated from the potential, the changeover contact goes back to its original position 15-16 (25-26) after the same time  $t$ .

### Function 21

Fleeting contact on energization



After the voltage  $U_s$  has been applied to A1 and A2, the changeover contact of the output relay goes to position 15-18 (25-28) and remains actuated for as long as the set fleeting contact time.

A fleeting pulse (terminals 1-2, 15-18) of defined duration is therefore produced from a two-wire control process (voltage on A25/A28) by this function.

# Switching, control, visualization

## Timing relays

### Function 82

Pulse shaping

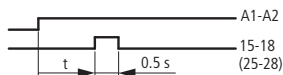


After the supply voltage has been applied to A1 and A2, the changeover contact of the output relay remains in the rest position 15-16 (25-26). If the terminals Y1 and Y2 in the DILET70 are linked by a potential-free N/O contact, or in the case of the ETR4-69/70 or ETR2-69, a potential is applied to B1, the changeover contact changes without delay to the position 15-18 (25-28).

If Y1–Y2 is now opened again, or B1 is kept with the potential, the changeover contact remains actuated until the set time has elapsed. If, instead, Y1–Y2 remain closed or B1 is separated from the potential for longer, the output relay likewise changes back to its rest position after the set time. An output pulse of precisely defined duration is thus produced in the pulse shaping function, irrespective of whether the input pulse via Y1–Y2 or B1 is shorter or longer than the set time.

### Function 81

Pulse generating with fixed pulse

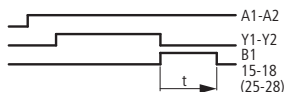


The actuating voltage is applied to the terminals A1 and A2 via an actuating

contact. After the set delay time has elapsed the changeover contact of the output relay goes to position 15-18 (25-28) and returns to its original position 15-16 (25-26) after 0.5 s. This function is therefore a fleeting pulse with a time delay.

### Function 22

Fleeting contact on de-energization



The supply voltage  $U_s$  is present directly at A1 and A2. If the terminals Y1 and Y2 of the DILET70 that have been shorted (DILET-70 potential-free) at any time beforehand are opened again, or with ETR4-69/70 or ETR2-69 the contact B1 becomes potential-free again, the contact 15-18 (25-28) closes for the duration of the set time.

### Function 42

Flashing, pulse initiating



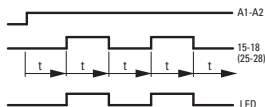
After the voltage  $U_s$  has been applied to A1 and A2, the changeover contact of the output relay changes to position 15-18 (25-28) and remains actuated for as long as the set flashing time. The subsequent pause duration corresponds to the flashing time.

# Switching, control, visualization

## Timing relays

### Function 43

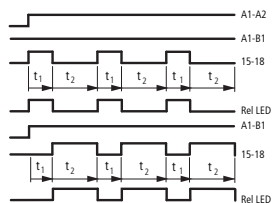
Flashing, pause initiated



After the voltage  $U_s$  has been applied to A1 and A2 the changeover contact of the output relay stays in position 15-16 for the set flashing time and after the duration of this time goes to position 15-18 (the cycle begins with a pause phase).

### Function 44

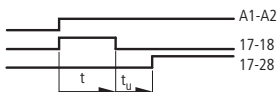
Flashing, two speeds



After the voltage  $U_s$  has been applied to A1 and A2 the changeover contact of the output relay goes to position 15-18 (pulse initiating). By bridging the contacts A1 and Y1 the relay can be switched to pause initiating. The times  $t_1$  and  $t_2$  can be set to different times.

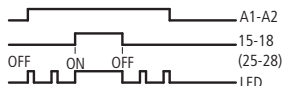
### Function 51 Star-delta

On-delayed



If the actuating voltage  $U_s$  is applied to A1 and A2, the instantaneous contact switches to position 17-18. After the set time duration the instantaneous contact opens; the timing contact 17-28 closes after a changeover time  $t_u$  of 50 ms.

### On-Off Function



The On-Off function allows the operation of a control system to be tested and is an aid for example for commissioning. The Off function allows the output relay to be de-energized and it no longer reacts to the function sequence. The On function energizes the output relay. This function is dependent on the supply voltage being applied to the terminals A1/A2. The LED indicates the operating state.

### Further information sources

- Instructional leaflets  
→ [www.eaton.com/moeller/support](http://www.eaton.com/moeller/support)  
(AWA / IL Installation Instructions)  
Search terms: DILET, ETR4, ETR2
- Main Catalogue Industrial Control Systems (HPL) Section "Timing relays"

## Switching, control, visualization

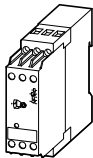
### EMR measuring and monitoring relays

1

Measurement and monitoring relays are required for a wide range of applications. With the new EMR range Eaton covers a large number of requirements:

- general use, EMR...-I current monitoring relay
- space saving monitoring of the rotation field, EMR...-F phase sequence relay
- Protection against destruction or damage of single system parts, EMR...-(A)W(N) phase monitoring relay
- safe recognition of phase failure, EMR...-A phase imbalance monitoring relay
- enhanced safety by open-circuit principle, EMR...-N liquid level monitoring relay
- increase of the operational safety, EMR...-R insulation monitoring relay

#### EMR...-I Current monitoring relay



The EMR-I current monitoring relay is suitable for the monitoring of AC as well as DC current. Pumps and drill machines can be monitored for underload or overload. This is possible due to the selectable lower or upper threshold limit.

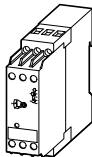
There are two versions each with three measuring ranges (30/100/1000 mA, 1.5/5/15 A). The multi-voltage coil allows universal use of the relay. The two auxiliary

changeover contacts allow for a direct feedback.

#### Selected bridging of short current peaks

By using the selectable response delay of between 0.05 and 30 s short current peaks can be bridged.

#### Phase monitoring relay EMR...-W



The EMR...-W phase monitoring relay monitors the voltage as well as the rotation field rotation. This provides protection from the destruction or damage of individual system parts. The minimum undervoltage and also the maximum overvoltage can be set here easily, within a defined range to the required voltage.

An on-delayed or off-delayed function can also be set. In the on-delayed position short voltage drops can be bridged. The off-delayed position allows for a fault storage for the set time.

The delay time can be set between 0.1 and 10 s.

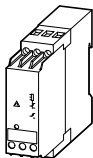
The relay activates with the correct rotation field and voltage. After a drop-out the device does not reactive until the voltage exceeds a 5 % hysteresis.



## Switching, control, visualization

### EMR measuring and monitoring relays

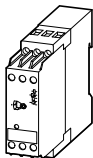
#### EMR...-F phase sequence relay



With the only 22.5 mm wide phase sequence relay, portable motors, with which the rotation direction is important (e. g. pumps, saws, drills), can be monitored for correct rotation. This provides space in the switchboard thanks to the narrow width and protection against damage due to the monitoring of the rotating field.

With correct rotating field the changeover contact releases the control voltage of the motor switching device. The EMR...-F500-2 covers the total voltage range from 200 to 500 V AC.

#### EMR...-A phase imbalance relay

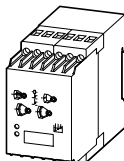


The 22.5 mm wide EMR...-A phase imbalance relay is the correct protection device against phase failure. The motor is then protected against destruction.

As the phase failure is monitored on the basis of phase displacement, this can be

detected even with a higher motor feedback and an overload of the motor can be prevented.

#### EMR...-N liquid level monitoring relay



The EMR...-N liquid level monitoring relay is used mostly as dry running protection for pumps or for the level regulation of liquids. It operates with sensors that measure conductivity. One sensor is required for the maximum level and one sensor for the minimum level. A third sensor is used for earth potential.

The 22.5 mm wide EMR...-N100 device is suitable for conductive liquids. It can be switched from level regulation to dry running protection. Safety is increased as in both cases the open-circuit principle is used.

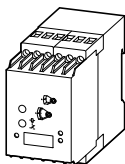
The EMR...-N500 liquid level monitoring relay has an increased sensitivity and is suitable for less conductive liquids. Due to an integrated pickup and drop-out delay of between 0.1 and 10 s moving liquids can also be monitored.

## Switching, control, visualization

### EMR measuring and monitoring relays

1

#### EMR...-R Insulation monitoring relay



EN 60204 "Safety of machines" provides increased operational safety by the monitoring of the auxiliary circuit for earth-fault using an insulation monitoring relay. This is the main application for the EMR...-R. There are similar requirements in medically used areas.

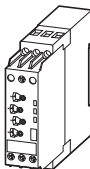
An earth-fault is signalled via a changeover contact so that a fault can be cleared without expensive down time.

The device has a selectable fault memory so that the fault must be acknowledged after it's removal. The use of a Test button enables the device to be checked for correct operation at any time.

#### AC or DC control voltage

There is a device for AC and also DC. Therefore the total control voltage range is covered. Both devices have a multi-voltage source. This means that both AC and DC supplies are possible.

#### EMR...-AW(N) multifunctional three-phase monitors



The multifunctional three-phase monitors provide the space saving monitoring of the rotation field with different functions.. These measure the phase parameters of phase sequence, phase failure, phase imbalance as well as undervoltage and overvoltage.

Depending on device type, the threshold value for phase imbalance can be set between 2 to 15 %. The threshold values for undervoltage and overvoltage are adjustable or permanently set.

The different options and set values are explained in the relevant instructional leaflet.

#### Further information sources

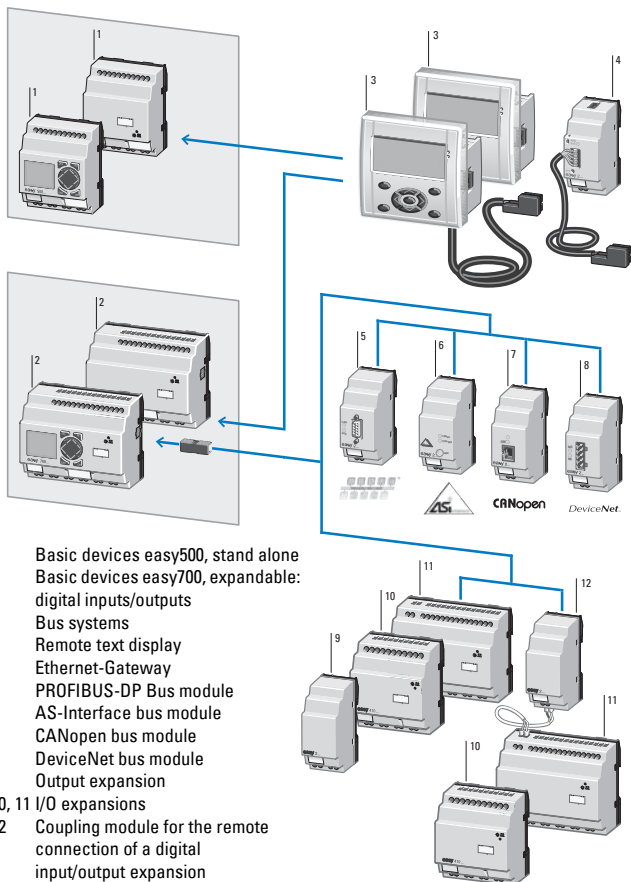
- Instructional leaflets  
→ [www.eaton.com/moeller/support](http://www.eaton.com/moeller/support)  
(AWA / IL Installation Instructions)  
Search terms: EMR4, EMR5
- Main catalog industrial switchgear (HPL),  
→ chapter "EMR measuring relays, EMR monitoring relays"

# Switching, control, visualization

## System overview easyRelay, MFD-Titan

### 500/700 control relays easy

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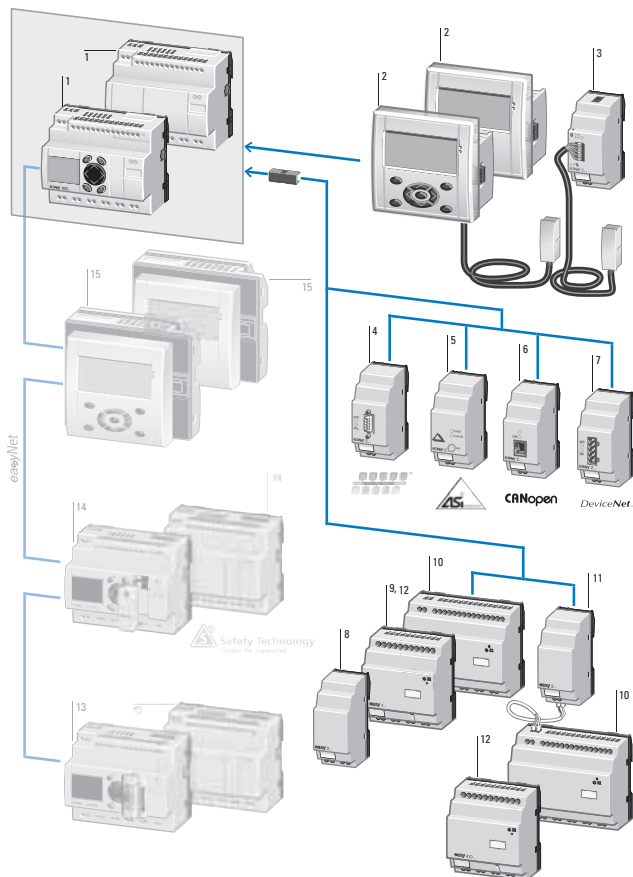


# Switching, control, visualization

## System overview easyRelay, MFD-Titan

### 800 control relay

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## Switching, control, visualization

### System overview easyRelay, MFD-Titan

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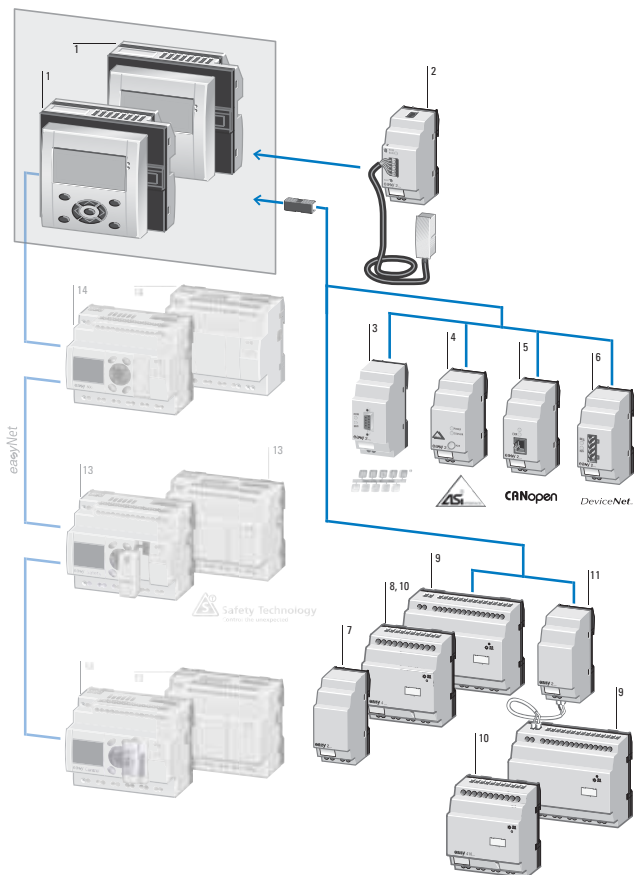
- 1 easy800 basic devices, expandable:  
Digital inputs/outputs and  
Bus systems, easyNet onboard
- 2 Remote text display
- 3 Ethernet gateway
- 4 PROFIBUS-DP bus module
- 5 AS-Interface bus module
- 6 CANopen bus module
- 7 DeviceNet bus module
- 8 Output expansion
- 9, 10 I/O expansions
- 11 Coupling module for the remote  
connection of a digital  
input/output expansion
- 12 I/O expansion
- 13 easyControl compact PLC
- 14 easySafety control relay
- 15 MFD-Titan multi-function display

# Switching, control, visualization

## System overview easyRelay, MFD-Titan

### MFD-Titan multi-function display

1



## Switching, control, visualization

### System overview easyRelay, MFD-Titan

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- 1 MFD-Titan, consisting of:
  - Display/operating unit
  - Power supply unit/CPU module,
  - I/O module
- 2 Ethernet gateway
- 3 PROFIBUS-DP bus module
- 4 AS-Interface bus module
- 5 CANopen bus module
- 6 DeviceNet bus module
- 7 Output expansion
- 8, 9, 10 I/O expansions
- 11 Coupling module for the remote connection of a digital input/output expansion
- 12 Compact PLC easyControl
- 13 easySafety
- easycontrol relays
- 14 easy 800 control relays

# Switching, control, visualization

## System overview easyRelay, MFD-Titan

### Functions

#### easy500 and easy700



easy500 and easy700 have the same functions. easy700 offers more inputs and outputs, is expandable and can be connected to a standard bus system. The contacts and coils are connected in series and in parallel in up to 128 current paths: max. three contacts and a coil in series. The display of 16 operating and message texts is implemented via an internal or external display.

The main functions are:

- Multi-function timing relays
- Current impulse relays,
- Counters
  - up and down,
  - high-speed counter,
  - frequency counters,
  - operating hours counter,
- Analog value comparators
- Week and year time switches,
- Automatic DST switch
- Retentive actual values of markers, counters and timing relays.

Customized inscription of easy500 and easy700 is possible.

#### MFD(-AC)-CP8... and 800



MFD(-AC)-CP8... and easy800 have the same functions. With IP65 MFD-80 can be used in harsh environments. Eight easy800 or MFD-Titan devices can also be networked via easyNet for expansions or connection to standard bus systems. Contacts and coils are linked in series or in parallel up to 256 rungs consisting of four contacts and a coil in series. The display of 32 operating and report message is implemented via an internal or external display.

The easy800 and MFD-Titan offer the following functions in addition to those of the easy700:

- PID controllers,
- Arithmetic modules,
- Value scaling,
- and much more.

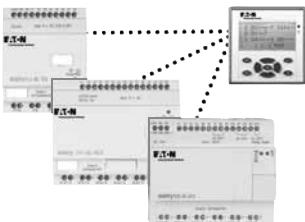
Customized inscription on the MFD-80 and the easy800 is possible.



## Switching, control, visualization

### System overview easyRelay, MFD-Titan

#### Remote display, text display for easy relay



1

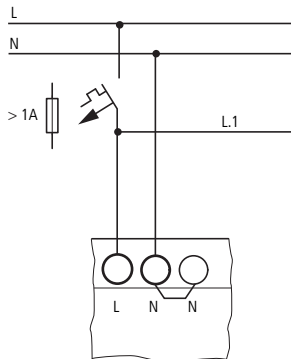
The plug & work functionality allows you to connect the MFD-80.. display to the easyRelays via the MFD-CP4.. power supply and communication module. The MFD-CP4... comes with a 5 m connection cable that can be cut to the required length. Another advantage is that no software or drivers are required for connection. The MFD-CP4.. offers genuine plug & work capabilities. The input and output wiring is connected to the easyRelay. The processing of the circuit diagram is also run in the easyRelay. The MFD-80.. is mounted using two 22.5 mm fixing holes. The IP65 display is backlit and offers an easy to read display. The display can be labeled to individual requirements.

# Switching, control, visualization

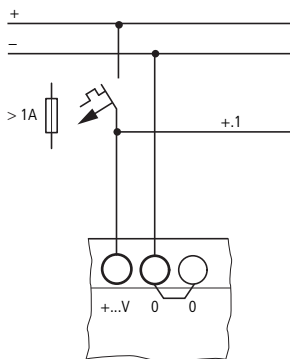
## Engineering easyRelay, MFD-Titan

### Power supply connection

#### for AC devices



#### for DC devices



#### Basic devices

EASY512-AB-...	24 V AC
EASY719-AB-...	24 V AC
EASY512-AC-...	100 – 240 V AC
EASY719-AC-...	100 – 240 V AC
EASY819-AC-...	100 – 240 V AC

MFD-AC-CP8-...	100 – 240 V AC
----------------	----------------

#### Expansion units

EASY618-AC...	100 – 240 V AC
---------------	----------------

#### Basic devices

EASY512-DA-...	12 V DC
EASY719-DA-...	12 V DC
EASY512-DC-...	24 V DC
EASY7...-DC-...	24 V DC
EASY819-DC-...	24 V DC
EASY82...-DC-...	24 V DC

MFD-CP8-...	24 V DC
MFD-CP10...	24 V DC

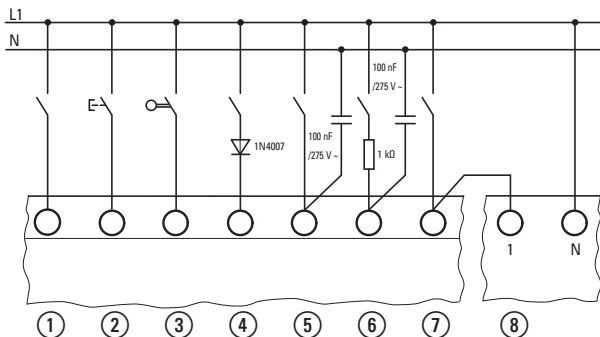
#### Expansion units

EASY410-DC...	24 V DC
EASY618-DC...	24 V DC
EASY620-DC...	24 V DC
EASY406-DC-ME	24 V DC
EASY411-DC-ME	24 V DC

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Digital input connection of the AC devices



- ① Input signal via relay contact e.g. DILER
- ② Input signal via RMQ-Titan pushbutton
- ③ Input signal via position switch e.g. LS-Titan
- ④ Additional circuit with diode (→ Notes)
- ⑤ Increased input current
- ⑥ Limiting the input current
- ⑦ Increasing the input current with EASY256-HCI
- ⑧ EASY256-HCI upstream device with internal additional circuit (→ Notes)

#### Notes

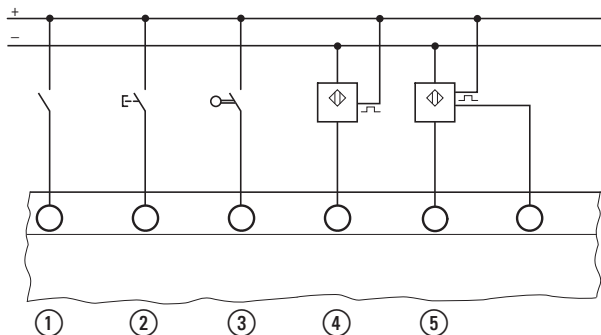
- Due to the additional circuit the drop out delay of the input is increased.
- Length of input conductor without additional circuit  $\leq 40$  m, with additional circuit  $\leq 100$  m.
- Inputs I7, I8 already have an internal additional circuit.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Digital input connection of the DC devices

1



- ① Input signal via relay contact e.g. DILER
- ② Input signal via RMQ-Titan pushbutton
- ③ Input signal via position switch e.g. LS-Titan
- ④ Proximity switch, three wire
- ⑤ Proximity switch, four wire

#### Notes

- With conductor length consider also the voltage drop.
- Due to the high residual current do not use two-wire proximity switches.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Analog inputs

Depending upon the device two or four 0 to 10 V analog inputs are available.

The resolution is 10-bit = 0 to 1023.

The following applies:

I7 = IA01	}	EASY512-AB/DA/DC...
I8 = IA02		
		EASY719-AB/DA/DC...
		EASY721-DC...
I11 = IA03	}	EASY819/820/821/822-DC...
		MFD-R16, MFD-R17,
I12 = IA04		MFD-T16, MFD-TA17

- Supplying loads such as motors, solenoid valves or contactors and easy from the same supply voltage may cause interference of the analog input signals when switching. Connect therefore inductive loads to be switched via the easy outputs to a separate supply voltage, or use a suppressor circuit for motors and valves.

1

### Warning!

Incorrect connection may lead to unwanted switching states. Analog signals are more sensitive to interference than digital signals, therefore the signal cables should be carefully routed and connected.

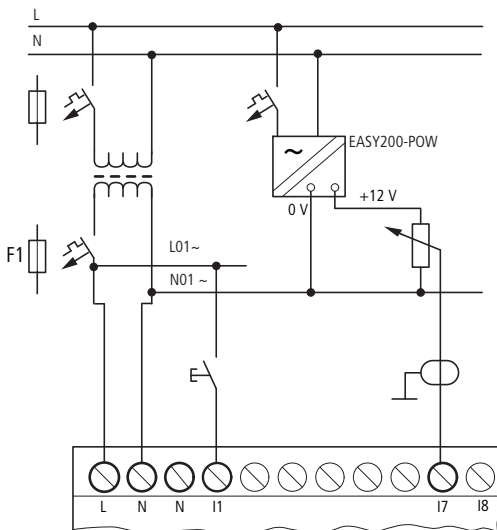
- Use shielded twisted pair cables to prevent interference with the analog signals.
- For short cable lengths, ground the shielding at both ends using a large contact area. If the cable length is more than around 30 m, grounding at both ends can result in equalization currents between the two grounding points and thus in the interference of analog signals. In this case, only ground the cable at one end.
- Do not lay signal lines parallel to power cables.

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### Connecting power supply and analog inputs for easy...AB device

1



#### Notes

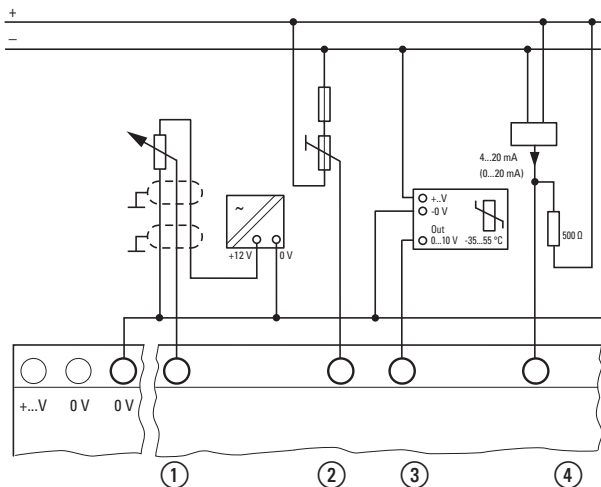
With easy.... AB devices that process analog signals, the device must be fed via a transformer so that the device is galvanically isolated from the mains supply. The neutral conductor and the reference potential of the DC power feed for analog sensors must be electrically connected.

Ensure that the common reference potential is earthed or monitored by a ground fault monitoring device. Observe the applicable standards.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Analog input connections to easy...DA/DC ... or MFD-R.../T...



- ① Setpoint potentiometer via separate power supply and potentiometer  $\leq 1 \text{ k}\Omega$ , e.g.  $1 \text{ k}\Omega$ ,  $0.25 \text{ W}$
- ② Setpoint potentiometer with upstream resistor  $1.3 \text{ k}\Omega$ ,  $0.25 \text{ W}$ , potentiometer  $1 \text{ k}\Omega$ ,  $0.25 \text{ W}$  (values for  $24 \text{ V DC}$ )
- ③ Temperature monitoring via temperature sensor and transducer
- ④ Sensor 4 to  $20 \text{ mA}$  with resistor  $500 \Omega$

### Notes

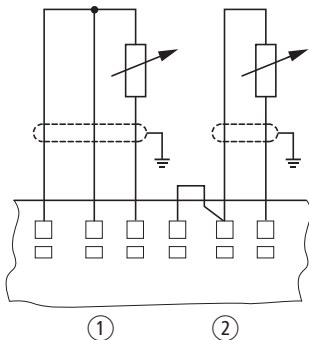
- Pay attention to the differing number and designation of the analog inputs of each device type.
- Connect the  $0 \text{ V}$  of the or the MFD-Titan with the  $0 \text{ V}$  of the power supply of the analog transmitter.
- A  $4(0)$  to  $20 \text{ mA}$  sensor and a resistor of  $500 \Omega$  give the following approx. values:
  - $4 \text{ mA} \approx 1.9 \text{ V}$ ,
  - $10 \text{ mA} \approx 4.8 \text{ V}$ ,
  - $20 \text{ mA} \approx 9.5 \text{ V}$ .
- Analog input  $0$  to  $10 \text{ V}$ , resolution  $10 \text{ bit}$ ,  $0$  to  $1023$ .

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### Connecting Pt100/Ni1000 with MFD-T(A)P...

1



- ① Three wire connection    ② Two wire connection

MFD-TAP13-PT-A MFD-TP12-PT-A	-40 °C ... +90 °C
	0 °C ... +250 °C
	0 °C ... +400 °C
MFD-TAP13-NI-A MFD-TP12-NI-A	0 °C ... +250 °C
	-40 °C ... +90 °C
MFD-TAP13-PT-B MFD-TP12-PT-B	0 °C ... +850 °C
	-200 °C ... +200 °C

#### Notes

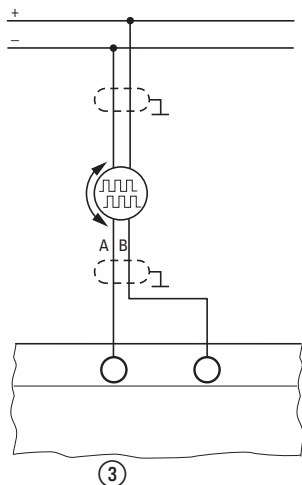
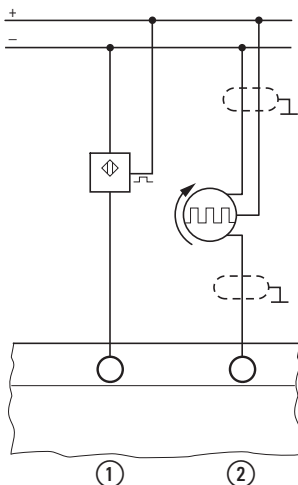
Cable length, shielded < 10 m.



## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

Connection options for the "High-speed counter" inputs on easy...DA/DC devices or MFD-R.../T...



- ① High-speed counter, square wave signal via proximity switch, mark-to-space ratio should be 1:1  
easy500/700 max. 1 kHz  
easy800 max. 5 kHz  
MFD-R/T... max. 3 kHz
- ② Square wave signal via frequency generator, pulse pause relationship should be 1:1  
easy500/700 max. 1 kHz  
easy800 max. 5 kHz  
MFD-R/T... max. 3 kHz

- ③ Square wave signals via 24 V DC incremental encoder  
easy800-DC... max. 5 kHz and  
MFD-R/T... max. 3 kHz

#### Notes

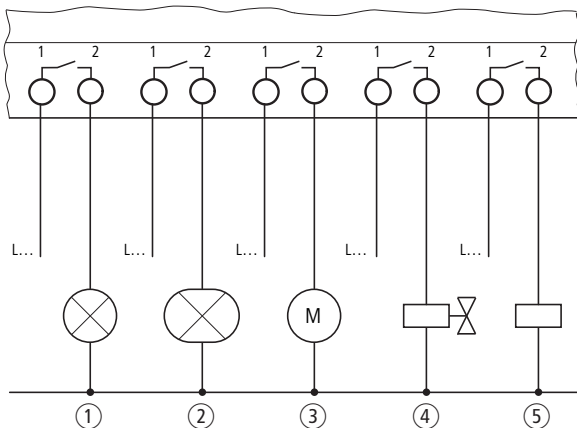
Pay attention to the different number and designation of the inputs of the "high-speed counter", "frequency generator" and "incremental encoder" for each device type.

# Switching, control, visualization

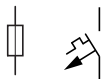
## Engineering easyRelay, MFD-Titan

### Connection of relay outputs for EASY...R MFD...R.

1



#### Protective element main pole L..



≤ 8 A/B16

#### Possible AC voltage range:

24 to 250 V, 50/60 Hz

e.g. L1, L2, L3 phase to zero conductor

#### Possible DC voltage range:

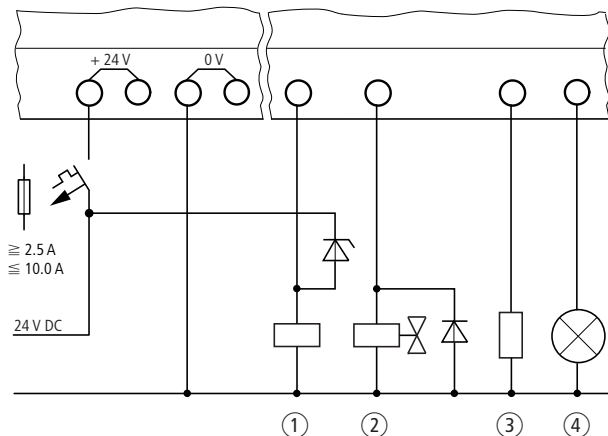
12 to 300 V DC





- ① Filament lamp, max. 1000 W at 230/240 V AC
- ② Fluorescent tube, max. 10 x 28 W with electronic upstream device, 1 x 58 W with conventional upstream device at 230/240 V AC
- ③ AC motor
- ④ Valve
- ⑤ Coil

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Connection of transistor outputs for EASY...T MFD T...



- ①  Contactor coil with zener diode as suppressor circuit, 0.5 A at 24 V DC
- ②  Valve with diode as suppressor circuit, 0.5 A at 24 V DC
- ③  Resistor, 0.5 A at 24 V DC
- ④  Indicator light 3 or 5 W at 24 V DC, Output dependent on device types and outputs

#### Notes

Please note the following when switching off inductive loads: Suppressed inductances cause less interference in the entire electrical system. It is generally recommended that the suppressor is

connected as close as possible to the inductance.

If inductances are not suppressed, the following applies:

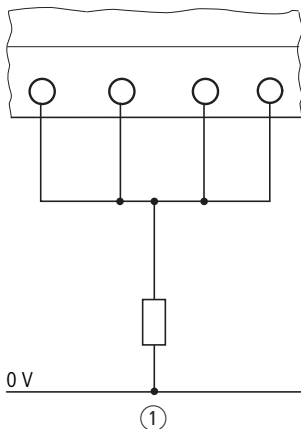
Several inductances should not be switched off simultaneously to avoid overheating the driver blocks in the worst possible case. If in the event of an emergency stop the +24 V DC power supply is to be switched off by means of a contact, and if this would mean switching off more than one controlled output with an inductance, these inductances must be provided with a suppressor circuit.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Parallel connection

1



① Resistor

### Notes

The outputs may only be connected in parallel within a group (Q1 to Q4 or Q5 to Q8, S1 to S4 or S5 to S8); Q1 and Q3 or Q5, Q7 and Q8. Parallel outputs must be activated simultaneously.



if 4 outputs in parallel,  
max. 2 A at 24 V DC



if 4 outputs in parallel,  
max. 2 A at 24 V DC  
Inductances without suppression  
circuit max. 16 mH



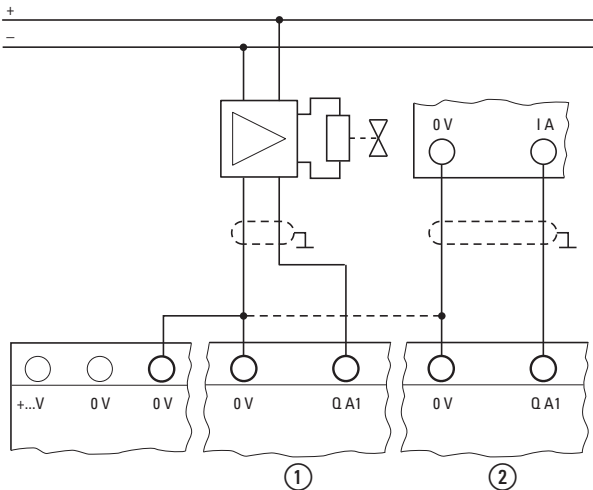
12 or 20 W at 24 V DC  
Output dependent on device types  
and outputs

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### Connection of analog outputs for EASY820-DC-RC..., EASY822-DC-TC..., MFD-RA..., MFD-TA...

1



- ① Solenoid valve control
- ② Set value selection for drive control

#### Notes

- Analog signals are more sensitive to interference than digital signals, therefore the signal conductors should be carefully routed. Incorrect connection may lead to unwanted switching states.
- Analog output 0 to 10 V, resolution 10 bit, 0-1023.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### I/O expansion

1

#### Central expansion, up to 40 I/O

easy700, easy800, MFD(-AC)-CP8... can be expanded via easy202, easy410, easy618 or easy620. Up to 24 inputs and 16 outputs are provided. An expansion is possible with each basic unit, → Section "easy central and remote expansion module", page 1-63.

#### Remote expansion, up to 40 I/O

easy700, easy800 and MFD-Titan can be expanded via the coupling module easy200-EASY with easy410, easy618 or easy620. The expansion unit can be operated up to 30 m from the basic device. There are a maximum of 24 inputs and 16 outputs available. One expansion unit per basic device is possible, → Section "easy central and remote expansion module", page 1-63.

#### Networking via easyNet, up to 320 I/O

Up to eight stations can be interconnected by expanding the inputs and outputs via easyNet. An expansion device can be added to each easy800 or MFD(-AC)-CP8... A network length of up to 1000 m is possible. There are two types of operation:

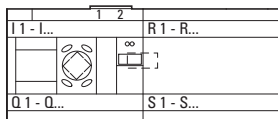
- A master (position 1, user address 1) and up to 7 other modules. The program is contained in the master.
- A master (position 1, user address 1) and up to 7 other "intelligent" or "dumb" modules. Each "intelligent" module has a program.

→ Section "easyNet, "loop through the device" network connection", page 1-64

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### easy central and remote expansion module

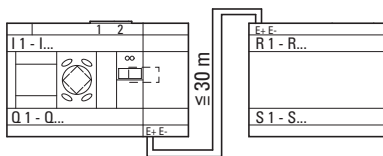


easy700  
easy800

easy202...  
easy410...  
easy618..., easy620...

#### Central expansion

1



easy700  
easy800

easy200

easy410...  
easy618..., easy620...

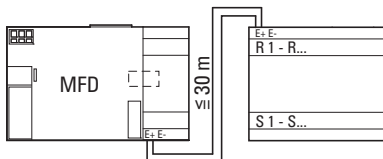
#### Remote expansion



MFD-AC-CP8...  
MFD-CP8...  
MFD-CP10...

easy202...  
easy410...  
easy618..., easy620...

#### Central expansion



MFD-AC-CP8...  
MFD-CP8...  
MFD-CP10...

easy200

easy410...  
easy618...  
easy620...

#### Remote expansion

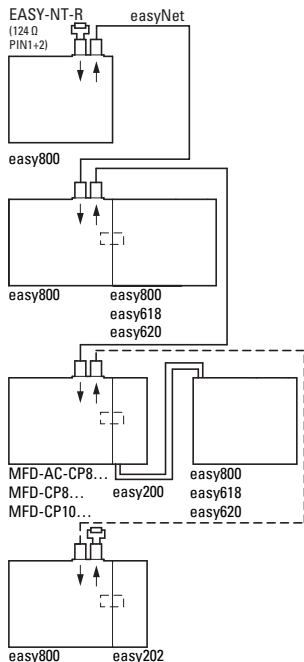
[ ] EASY-LINK-DS

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### easyNet, "loop through the device" network connection

1



□ □ □ EASY-LINK-DS

- Addressing the stations:
  - Automatic addressing from station 1 or via easySoft... from the PC, **physical location = station**,
  - Single addressing on the corresponding station or via easySoft... on each station, **geographic location and station can be different**.

Geographic location, position <sup>1)</sup>	Stations Example 1	Example 2
1	1	1
2	2	3
3	3	8
8	8	2

<sup>1)</sup> The geographic location/position 1 **always** has the station address 1.

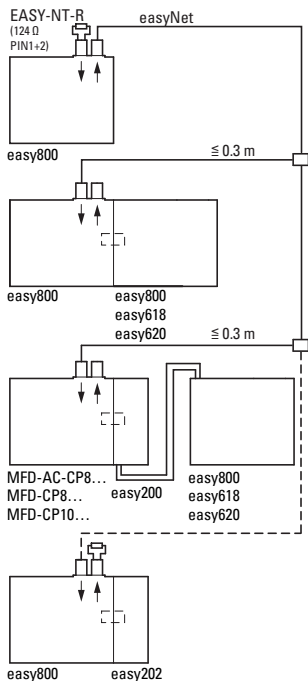
- The maximum length of easyNet is 1000 m.
- Should easyNet be interrupted or a station is not operational, the network is no longer active from the interrupted point.
- 4 core cable unshielded, each two cores twisted. Characteristic impedance of the cable must be 120 Ω.



# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### easyNet, network connection "T connector with stub line"



[ ] EASY-LINK-DS

- Addressing the stations:
  - Single addressing on corresponding station or via easySoft... on every station.
- The max. total length, including stub lines, with easyNet is 1000 m.
- The max. stub line's length of the T connector to easy800 or to MFD-Titan is 0.30 m.

Geographic location, position <sup>1)</sup>	Stations Example 1	Example 2
1	1	1
2	2	3
3	3	8
[ 8 ]	( 8 )	( 2 )

<sup>1)</sup> The geographic location/position 1 **always** has the station address 1.

- If easyNet is interrupted between the T connector and the station, or a station is not operational, the network is still active for the remaining stations.
- 4 core cable unshielded, each two cores twisted. Three cores are required. Characteristic impedance of the cable must be 120 Ω.

# Switching, control, visualization

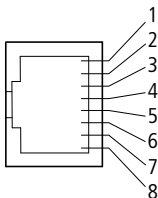
## Engineering easyRelay, MFD-Titan

### easyNet network connection

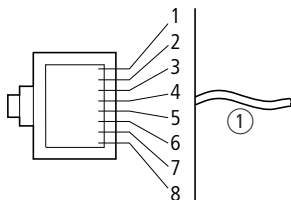
1

#### RJ45 sockets and plugs

Pin assignment of RJ45 socket on easy and MFD.



Pin assignment of the RJ45 plug on the easy, MFD(-AC)-CP8/CP10....



① Cable entry side  
8-pole RJ45, EASY-NT-RJ45

#### Assignment with easyNET

- PIN 1: ECAN\_H; Data cable;  
conductor pair A
- PIN 2: ECAN\_L; Data cable;  
conductor pair A
- PIN 3: GND; ground conductor;  
conductor pair B
- PIN 4: SEL\_IN; Select conductor;  
conductor pair B

#### Creating the network cable for easyNet

The characteristic impedance of the cable must be 120  $\Omega$ .

The network cable does not require any shielding braid.

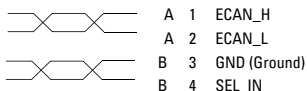
However, if a shielding braid is used, it should be connected to PE.

#### Notes

Cable lengths and cross-sections

→ Table, page 1-68.

The minimum operation with easyNet functions with cables ECAN\_H, ECAN\_L, GND. The SEL\_IN cable is only used for automatic addressing.



#### Bus terminating resistor

A bus terminal resisting must be connected to the geographical first and last station in the network:

- Value of the bus terminal resisting 124  $\Omega$ ,
- Connect to PIN 1 and PIN 2 of the RJ45 plug,
- Terminating connector : EASY-NT-R.

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### Prefabricated cables, RJ45 plug at both ends

Cable length [cm]	Part no.
30	EASY-NT-30
80	EASY-NT-80
150	EASY-NT-150

#### User prepared cables

100 m, 4 x 0.14 mm<sup>2</sup>; twisted pair:  
EASY-NT-CAB

RJ45 plug:

EASY-NT-RJ45

Crimping tool for RJ45 plug:

EASY-RJ45-TOOL

#### Calculating cross-section with known cable lengths

The minimum cross-section is determined for the known maximum expansion of the network.

$l$  = Length of cable in m

$S_{\min}$  = Minimum cross-section in mm<sup>2</sup>

$\rho_{\text{cu}}$  = Resistivity of copper, if not  
otherwise stated 0.018 Ωmm<sup>2</sup>/m

$$S_{\min} = \frac{l \times \rho_{\text{cu}}}{12.4}$$

#### Calculating length with known cable cross-section

For a known conductor cross section the maximum conductor length is calculated.

$l_{\max}$  = Length of cable in m

$S$  = Cable cross-section in mm<sup>2</sup>

$\rho_{\text{cu}}$  = Resistivity of copper, if not  
otherwise stated 0.018 Ωmm<sup>2</sup>/m

$$l_{\max} = \frac{S \times 12.4}{\rho_{\text{cu}}}$$

1

#### Notes

If the result of the calculation does not yield a standard cross-section, the next larger cross-section is used.

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### Permissible network lengths with easyNet

1

Total length of easyNet cable	Transmission speed	Cable cross-section, standardized		Bus cable, minimum cable cross-section
		EN mm <sup>2</sup>	AWG	
m	Kbit/s			mm <sup>2</sup>
≤ 6	≤ 1000	0.14	26	0.10
≤ 25	≤ 500	0.14	26	0.10
≤ 40	≤ 250	0.14	26	0.10
≤ 125	≤ 125 <sup>1)</sup>	0.25	24	0.18
≤ 175	≤ 50	0.25	23	0.25
≤ 250	≤ 50	0.38	21	0.36
≤ 300	≤ 50	0.50	20	0.44
≤ 400	≤ 20	0.75	19	0.58
≤ 600	≤ 20	1.0	17	0.87
≤ 700	≤ 20	1.5	17	1.02
≤ 1 000	= 10	1.5	15	1.45

1) Default setting

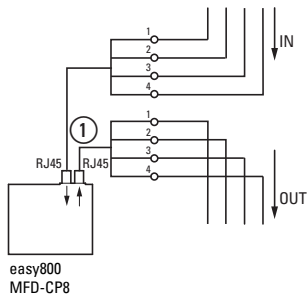
# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

**Network connection on cable**  
cross-sections > 0.14 mm<sup>2</sup>, AWG26

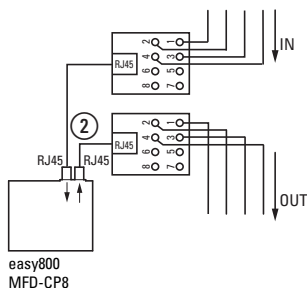
**Network connect "through the device"**

Example A, with terminals



① Recommendation  $\leq 0.3$  m

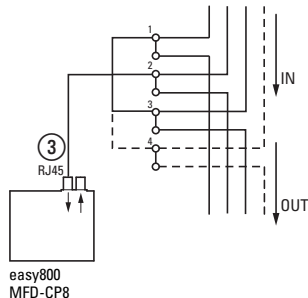
Example B, with interface element



② Recommendation  $\leq 0.3$  m (EASY-NT-30)

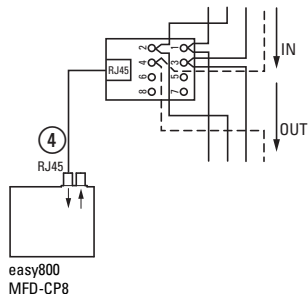
**Network connection "T connector with stub line"**

Example A, with terminals



③  $\leq 0.3$  m (3-core)

Example B, with interface element



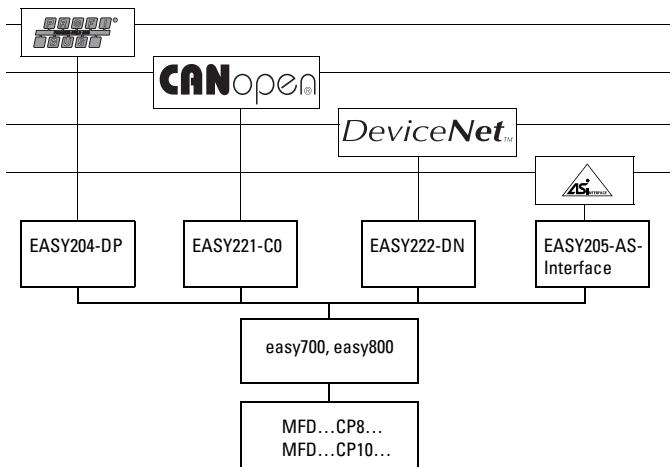
④  $\leq 0.3$  m (EASY-NT-30)

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Expansion units for networking

1



An expansion unit for networking can be connected with easy700, easy800 or MFD(-AC)-CP8-... The expansion unit for networking is integrated as slave in the configuration.

The inputs and output points can be expanded via easyNet (→ Section "easyNet, network connection "T connector with stub line"", page 1-65 and → Section "easyNet, network connection "T connector with stub line"", page 1-65).

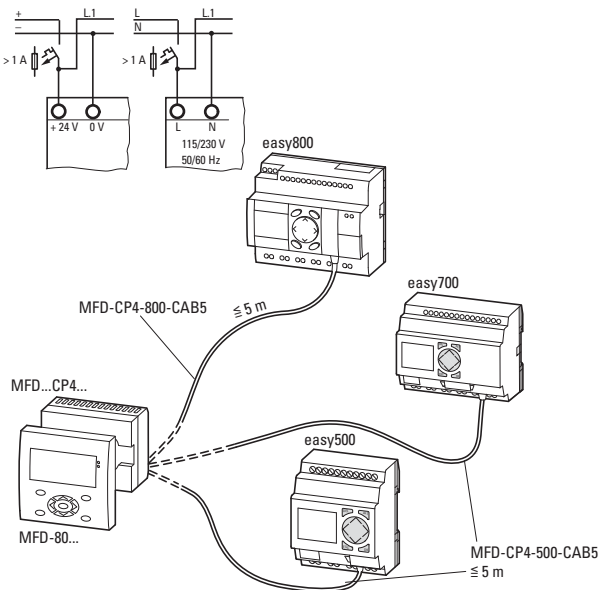
Further information can be found in the manuals:

- MN05013003Z-EN  
easy500, easy700, control relays
- MN04902001Z-EN  
easy800, control relays
- MN05002001Z-EN  
MFD-Titan multi-function display
- MN05013005Z-EN  
EASY204-DP
- MN05013008Z-EN  
EASY221-C0
- MN05013007Z-EN  
EASY222-DN

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Remote display in IP65



The display of the easyRelay is shown on the MFD-80... "remote display".

The easyRelay can also be operated with the MFD-80-B.

No extra software or programming is necessary to operate the "remote display".

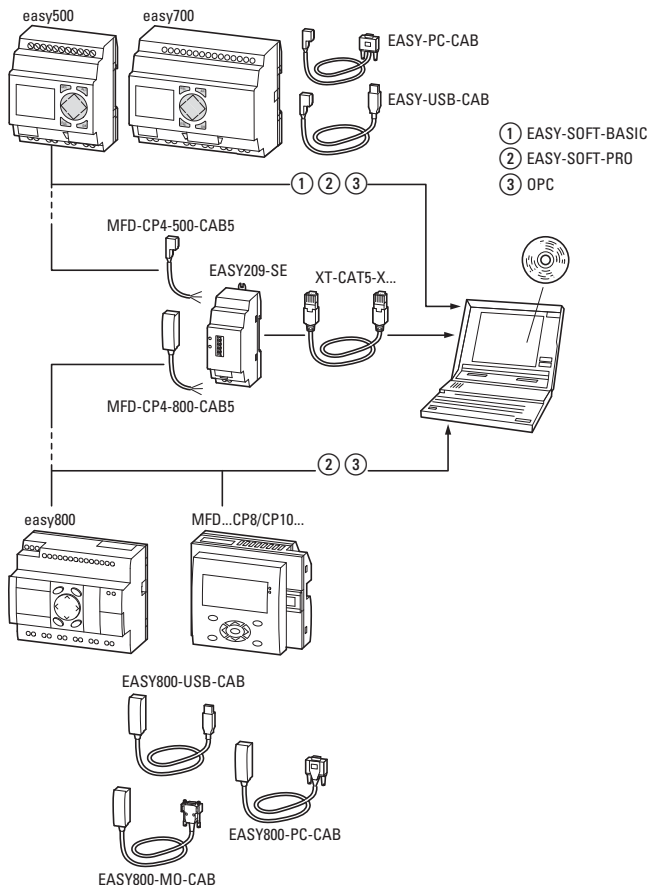
The connection cable MFD-CP4-...-CAB5 can be shortened.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### easy communication connections

1

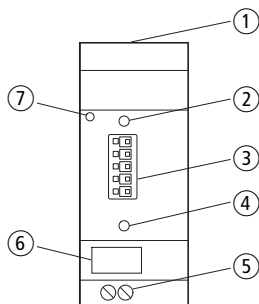




# Switching, control, visualization

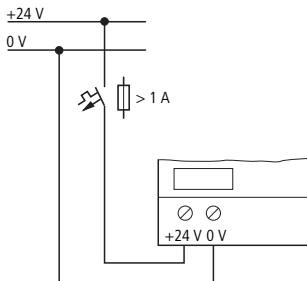
## Engineering easyRelay, MFD-Titan

### EASY209-SE standard connection

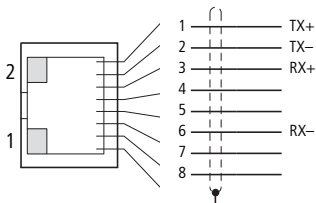


- ① Ethernet connection (RJ45 socket)
- ② Status LED (POW/RUN)
- ③ COM connection, spring-cage terminal 5-pole
- ④ RESET pushbutton
- ⑤ Power supply device 24 V DC V
- ⑥ Device label
- ⑦ Strain relief

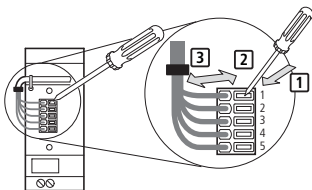
### 24 V connection



### Ethernet connection



### COM connection



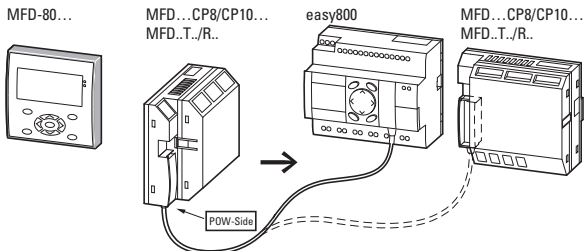
- ① press – ② insert – ③ remove
- 1 = grey
- 2 = brown
- 3 = yellow
- 4 = white
- 5 = green

## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

#### COM-LINK connection

1



The COM-LINK is a point-to-point connection using the serial interface. Via this interface the status of the inputs and outputs are read as well as marker ranges read and written. Twenty marker double words read or written are possible. Read and write operations can be defined as required. This data can be used for setpoint entry or for display functions.

The stations of the COM-LINK have different functions. The active station is always a MFD...CP8/CP10... and controls the complete interface.

Remote stations can be an easy800 or an MFD...CP8/CP10.... The remote station responds to the requests of the active station. It does not recognize the difference whether COM-LINK is active or a PC with easySoft-PRO is using the interface.

The stations of the COM-LINK can be expanded locally or remotely with easy expansion units.

The remote station can also be a station in the easyNet.

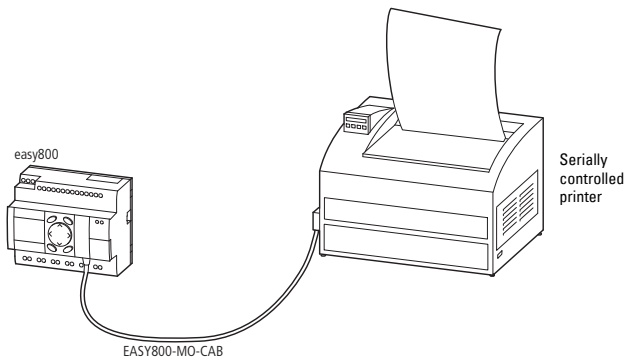
## Switching, control, visualization

### Engineering easyRelay, MFD-Titan

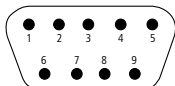
#### Connecting and operating the 800 on the serial log printer

An SP (SP = serial protocol) module can be used to directly send data to the log printer via the serial PC interface on the front of the device. More information on this is provided in the easySoft-PRO help.

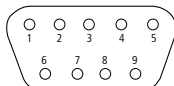
1



Pin assignment of EASY800-MO-CAB:



2 white T x D  
3 brown R x D  
5 green GND



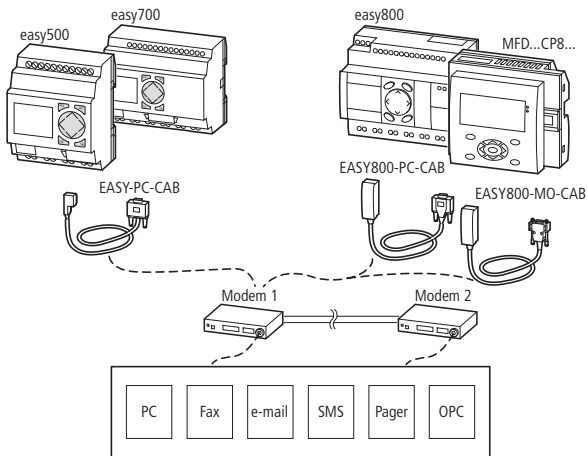
Information on EASY800-MO-CAB, see also IL05013021Z instructional leaflet.

# Switching, control, visualization

## Engineering easyRelay, MFD-Titan

### Connection and modem operation with easy or MFD

1



Information on EASY800-MO-CAB, see also  
IL05013021Z instructional leaflet.

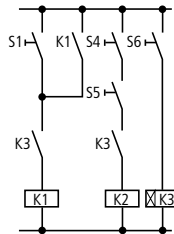
# Switching, control, visualization

## Programming easyRelay, MFD-Titan

1

### Programming instead of wiring

Circuit diagrams are the basis of all electrotechnical applications. In practice this involves the wiring together of electrical switchgear. With the easy control relay this can be carried out simply at the push of a button or by using the convenient easySoft programming software on a PC. Simple menu navigation in many languages simplify the input. This saves time and therefore costs. easy and MFD-Titan are the professionals for the world market.



### Contacts, coils, function blocks, operands

Operand	Description	easy500, easy700	easy800	MFD(-AC)-CP8... MFD(-AC)-CP10...
I	Bit input, basic device	x	x	x
nI	Bit input, basic device via easyNet	—	x	x
IA	Analog input	x	x	x
R	Bit input, expansion device <sup>1)</sup>	x	x	x
nR	Bit input, expansion unit via easyNet	—	x	x
Q	Bit output, basic device	x	x	x
nQ	Bit output, basic device via easyNet	—	x	x
QA	Analog output	—	x	x
S	Bit output, expansion unit	x	x	x
nS	Bit output, expansion unit via easyNet	—	x	x
ID	Diagnostic alarm	—	x	x
ID 1	COM-Link diagnostic alarm	—	—	x
LE	Bit output display backlight + Front plate LEDs	—	—	x
M	Marker	x	x	x
1M	Marker COM-Link	—	—	x
MB	Marker byte	—	x	x
MD	Marker double word	—	x	x
MW	Marker word	—	x	x
1MB/1MW /1MD	Marker operand COM-Link	—	—	x
N	Marker	x	—	—
P	P pushbuttons	x	x	x

# Switching, control, visualization

## Programming easyRelay, MFD-Titan

1

Operand	Description	easy500, easy700	easy800	MFD(-AC)-CP8... MFD(-AC)-CP10...
:	Jump	x	x	x
nRN	Bit input via easyNet	—	x	x
nSN	Bit output via easyNET easyNet	—	x	x
A	Analog value comparator	x	x	x
AR	Arithmetic functions	—	x	x
BC	Block comparison	—	x	x
BT	Block transfer	—	x	x
BV	Boolean sequence	—	x	x
C	Counter relay	x	x	x
CF	Frequency counter	x <sup>2)</sup>	x	x
CH	High-speed counter	x <sup>2)</sup>	x	x
CI	Incremental counter	—	x	x
CP	Comparator	—	x	x
D	Text display	x	x	—
DB	Data function block	—	x	x
DC	PID controller	—	x	x
FT	PT1 signal smoothing filter	—	x	x
GT	Get value from easyNet	—	x	x
ⓐ H/HW	(Hour)/7-day time switch	x	x	x
Y/HY	Year time switch	x	x	x
JC	Conditional jump	—	x	x
LB	Jump label	—	x	x
LS	Value scaling	—	x	x
Z/MR	Master reset	x	x	x
MX	Data multiplexer	—	x	—
NC	Numerical converter	—	x	x
O/OT	Operating hours counter	x	x	x
PO	Pulse output	—	x	—
PW	Pulse width modulation	—	x	x
SC	Synchronize clock via network	—	x	x
ST	Set cycle time	—	x	x
SP	Serial protocol	—	x	—
SR	Shift register	—	x	x
T	Timing relays	x	x	x
TB	Table function	—	x	x
UC	Value limitation	—	x	x

1) With easy700, easy800 and MFD...CP8/CP10...

n = NET station 1...8

2) With easy500 and easy700 parameterizable as operating mode

# Switching, control, visualization





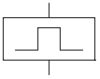

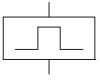

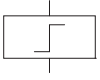

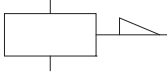
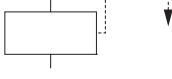
## Programming easyRelay, MFD-Titan

### Coil functions

The switching behaviour of the relay coil is determined by the selected coil function. The specified function should for each relay coil only be used once in the wiring diagram.

Unused outputs Q and S can also be used as markers like M and N.

1

Circuit diagram symbol	easy display	Coil function	Example
		Contactor function	{Q1,{D2, {S4,{1:1, {M7
		Contactor function with negated result	}Q1,}D2, }S4
		Cycle pulse on falling edge	lQ3,lM4, lD8,lS7
		Cycle pulse with rising edge	!Q4,!M5, !D7,!S3
		Surge function	!Q3,!M4, !D8,!S7
	S	Latch (set)	SQ8,SM2, SD3,SS4
	R	Reset (unlatching)	RQ4,RM5, RD7,RS3

# Switching, control, visualization

## Programming easyRelay, MFD-Titan

### Parameter sets for times

1

Parameters	Switch function
X	On-delayed switching
?X	On-delayed switching with random time range
■	Off-delayed switching
?■	Off-delayed switching with random time range
X■	Switching with on- and off-delayed
?X■	Switching with on- and off-delayed with random time
Л	Pulse shaping switching
И	Switching with flashing

Possible coil functions:

- Trigger = TT..
- Reset = RT..
- Halt = HT..

### Example based on EASY512

Depending up on the program the following parameters can be set:

- Switch function,
- Time range,
- Parameter display,
- Time 1 and
- Time 2.

```
T1  Л  S  +
I1   30,000
I2   I7
□   T:00.00
```

T1 Relay no.

I1 Time setpoint 1

I2 Time setpoint 2

□ Output switch status:

□ N/O contact open,

■ N/C contact closed

Л Switch function

S Time range

+ Parameter display

30,000 constant as value, e.g. 30 s

I7 Variable, e.g. analog value I7

T:00.00 actual time



## Switching, control, visualization

### Programming easyRelay, MFD-Titan

1

Parameter	Time range and setpoint time	Resolution
S 00.00	Seconds: 0.000 to 99,999	easy500, easy700 10 ms easy800, MFD...CP8/CP10... 5 ms
M:S 00:00	Minutes:Seconds 00:00 to 99:59	1 s
H:M 00:00	Hours:Minutes 00:00 to 99:59	1 min

Parameter set	Displaying the parameter set via menu item "Parameter"
+	Call enabled
-	Access disabled

#### Basic circuits

The easy circuit diagram is entered in ladder diagram. This chapter includes a few circuit examples which are intended to demonstrate the possibilities for your own circuit diagrams.

The values in the logic table have the following meanings for switching contacts

0 = N/O contact open,  
N/C contact closed

1 = N/O contact closed,  
N/C contact open

For relay coils Qx

0 = Coil not energized

1 = Coil energized

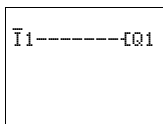
#### Note

The examples shown are based on easy500 and easy700. easy800 and MFD...CP8/CP10... provide four contacts and one coil per rung.

#### Negation

Negation means that the contact opens rather than closes when it is actuated (NOT connection).

In the easy circuit diagram, press the **ALT** button to toggle between N/C and N/O contact.



#### Logic table

I1	Q1
1	0
0	1

## Switching, control, visualization

### Programming easyRelay, MFD-Titan

1

#### Series connection

Q1 is controlled by a series connection consisting of three N/O contacts (AND connection).

$$I1-I2-I3-Q1$$

$$\bar{I1}-\bar{I2}-\bar{I3}-Q2$$

Q2 is actuated via three N/C contacts connected in series (NAND connection).

In the easy circuit diagram, you can connect up to three N/O or N/C contacts for easy500 and easy700 in series within a rung. Use M marker relays if you need to connect more than three N/O contacts in series.

Logic table

I1	I2	I3	Q1	Q2
0	0	0	0	1
1	0	0	0	0
0	1	0	0	0
1	1	0	0	0
0	0	1	0	0
1	0	1	0	0
0	1	1	0	0
1	1	1	1	0

#### Parallel switching

Q1 is actuated via a parallel connection of several N/O contacts (OR connection).

$$I1 \text{ } \overline{\text{---}} \text{ } Q1$$

$$I2 \text{ } |$$

$$I3 \text{ } |$$

A parallel connection of closed N/Cs Q2 (NOR circuit).

$$\bar{I1} \text{ } \overline{\text{---}} \text{ } Q2$$

$$\bar{I2} \text{ } |$$

$$\bar{I3} \text{ } |$$

Logic table

I1	I2	I3	Q1	Q2
0	0	0	0	1
1	0	0	1	1
0	1	0	1	1
1	1	0	1	1
0	0	1	1	1
1	0	1	1	1
0	1	1	1	1
1	1	1	1	0

## Switching, control, visualization

### Programming easyRelay, MFD-Titan

#### Two way switch

A two way switch is made in easy using two series connections that are combined to form a parallel circuit (XOR).

XOR is the abbreviation of **exclusive Or** circuit. The coil is energized if only one contact is activated.

$I1 - \bar{I2} \text{ --- } Q1$   
 $\bar{I1} - I2 \text{ --- } Q1$

#### Logic table

I1	I2	Q1
0	0	0
1	0	1
0	1	1
1	1	0

#### Self-latching

A combination of a series and parallel connection is used to wire a latching circuit.

Latching is established by contact Q1 which is connected in parallel to I1. When I1 is actuated and reopened, the current flows via contact Q1 until I2 is actuated.

S1 N/O contact on I1  
 S2 N/C contact on I2

$I1 \text{ --- } (Q1 \text{ --- } \bar{I2}) \text{ --- } Q1$

#### Logic table

I1	I2	Contact Q1	Coil Q1
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	1
1	0	1	0
0	1	1	1
1	1	1	1

The latching (self-maintaining) circuit is used to switch machines on and off. The machine is switched on at the input terminals via N/O contact S1 and is switched off via N/C contact S2.

S2 breaks the connection to the control voltage in order to switch off the machine. This ensures that the machine can be switched off, even in the event of a wire breakage. I2 is always closed when not actuated.

A self-maintaining circuit with open-circuit monitoring can alternatively be wired using the Set and Reset coil functions.

S1 N/O contact on I1  
 S2 N/C contact on I2

$I1 \text{ --- } SQ1$   
 $\bar{I2} \text{ --- } RQ1$

## Switching, control, visualization

### Programming easyRelay, MFD-Titan

1

Coil Q1 latches if I1 is activated. I2 inverts the break contact signal of S2 and only switches if S2 is activated in order to disconnect the machine or in the event of a wire breakage.

Make sure that both coils are wired up in the correct order in the easy circuit diagram: first wire the S coil and then the R coil. This will ensure that the machine will be switched off when I2 is actuated, even if I1 is switched on.

#### Impulse relays

An impulse relay is often used for controlling lighting such as for stairwell lighting.

S1 N/O contact at I1

I 1-----┐Q1

#### Logic table

I1	Status Q1	Q1
0	0	0
1	0	1
0	1	1
1	1	0

#### On-delayed timing relay

The on-delay can be used to override short pulses or with a machine, to start a further operation after a time delay.

S1 N/O contact at I1

I 1-----TT1  
T1-----┐M1

#### Permanent contact

To energize a relay coil continuously, make a connection of all contact fields from the coil to the leftmost position.

-----┐Q1

#### Logic table

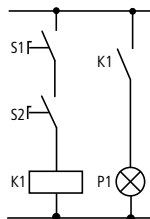
---	Q1
1	1

## Switching, control, visualization

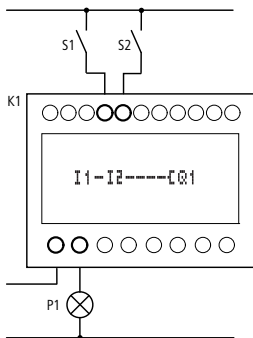
### Programming easyRelay, MFD-Titan

#### Wiring of contacts and relays

Hardwired



Wiring with easy

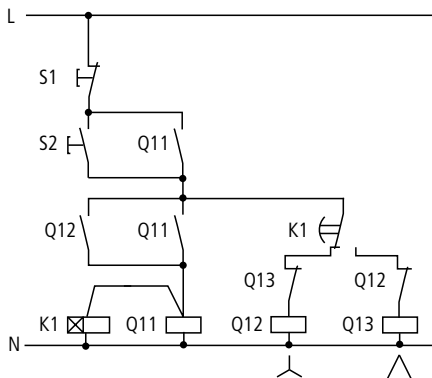


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#### Star-delta starting

You can implement two star-delta circuits with easy. The advantage of easy is that it is possible to select the changeover time between star and delta contactors, and

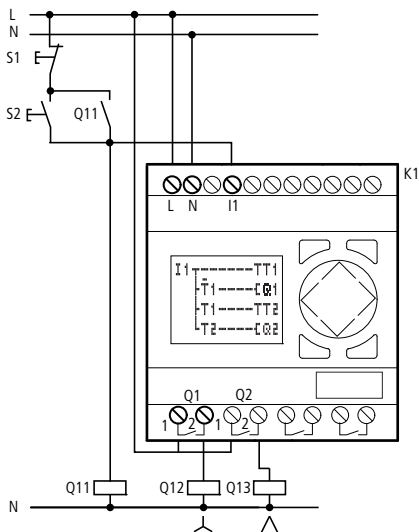
also the time delay between switching off the star contactor and switching on the delta contactor.



## Switching, control, visualization

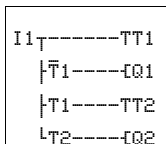
### Programming easyRelay, MFD-Titan

1



#### Function of the easycircuit diagram:

Start/Stop the connection with the external pushbuttons S1 and S2. The mains contactor starts the timing relay in easy.



I1: Mains contactor switched on

Q1: Star contactor ON

Q2: Delta contactor ON

T1: Changeover time star-delta (10 to 30 s)

T2: Wait time between star off, delta on  
(30, 40, 50, 60 ms)

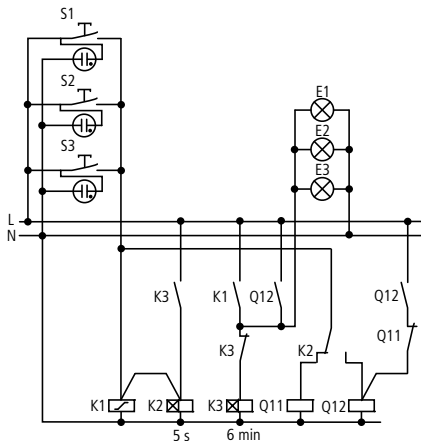
If your easy has an integral time switch, you can combine star-delta starting with the time switch function. In this case, use easy to also switch the mains contactor.

**Switching, control, visualization**  
Programming easyRelay, MFD-Titan

## Stairway lighting

For a conventional connection a minimum of five space units are required in the distribution board, i.e. one impulse relay, two timing relays, two auxiliary relays.

easy requires only four space units. With five connections and the easy circuit the stairway lighting is operational.



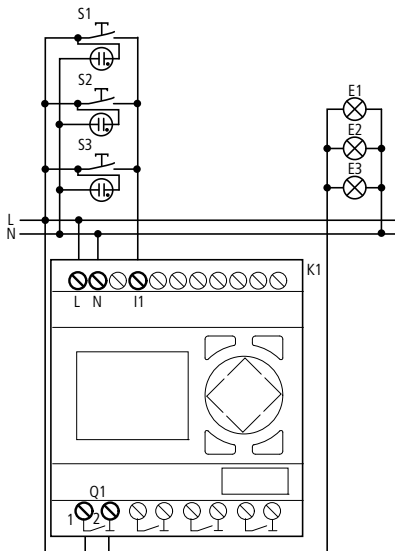
### Important Note

Four such stairway circuits can be implemented with one easy device.

# Switching, control, visualization

## Programming easyRelay, MFD-Titan

1



Pushbutton pressed briefly

Light ON or OFF. The impulse relay function will even switch off with continuous lighting.

Light off after 6 min

Switched off automatically. With continuous light this function is not active.

Pushbutton pressed for more than 5 s

Continuous light



## Switching, control, visualization

### Programming easyRelay, MFD-Titan

The easy circuit configuration for the described function below looks like this:

```

I1-----TT2
T2-----SM1
I1┐-----JQ1
T3┘
Q1-̄M1----TT3
Q1-----RM1
  
```

The expanded easy circuit diagram: after four hours, the continuous lighting is also switched off.

```

I1-----┐TT1
          └TT2
T2-----SM1
T1┐-----JQ1
T3┘
T4┘
Q1┐M1----TT3
   └-----TT4
Q1-----RM1
  
```

#### Meaning of the contacts and relays used

I1: ON/OFF pushbutton

Q1: Output relay for light ON/OFF

M1: Marker relay. This is used to block the "switch off automatically after 6 minutes" function for continuous lighting.

T1: Cyclical impulse for switching Q1 ON/OFF, (I, pulse shaping with value 00.00 s)

T2: Scan to determine how long the pushbutton was pressed. When pressed for longer than 5 s, it changes to continuous light. (X, on-delayed, value 5 s)

T3: Switch off after the light has been on for von 6 min. (X, on-delayed, value 6:00 min.)

T4: Switch off after 4 hours continuously on. (X, on-delayed, value 4:00 h)

# Switching, control, visualization

## Programming easyRelay, MFD-Titan

### 4-way shift register

1

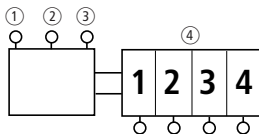
A shift register can be used for storing an item of information – e.g. sorting of items into “good” or “bad” – two, three or four transport steps further on.

A shift pulse and the value (0 or 1) to be shifted are required for the shift register.

Values which are no longer required are deleted via the reset input of the shift register. The values in the shift register pass through the register in the following order:

1st, 2nd, 3rd, 4th storage position.

Block diagram of the 4-way shift register



- ① Pulse
- ② Value
- ③ RESET
- ④ Storage position

### Function

Pulse	Value	Storage position			
		1	2	3	4
1	1	1	0	0	0
2	0	0	1	0	0
3	0	0	0	1	0
4	1	1	0	0	1
5	0	0	1	0	0
Reset = 1		0	0	0	0

Allocate the value 0 with the information content bad. Should the shift register be accidentally deleted, no bad parts will be reused.

I1: Shift pulse (PULSE)

I2: Information (good/bad) to be shifted (VALUE)

I3: Delete contents of the shift register (RESET)

M1: 1st storage location

M2: 2nd storage location

M3: 3rd storage location

M4: 4th storage location

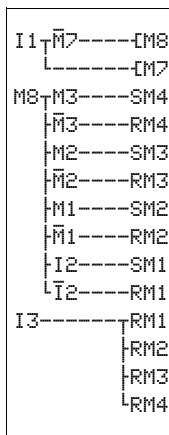
M7: Marker relay for cycle pulse

M8: Cyclical pulse for shift pulse

## Switching, control, visualization

### Programming easyRelay, MFD-Titan

1



Generate shift pulse

4th storage location, set

4th storage location, delete

3rd storage location, set

3rd storage location, delete

2nd storage location, set

2nd storage location, delete

1st storage location, set

1st storage location, delete

Delete all storage locations

## Switching, control, visualization

### Programming easyRelay, MFD-Titan

#### Display text and actual values , display and edit setpoint values

1

easy500 and easy700 can display 16 freely editable texts, easy800 can display 32.

These texts can be triggered by the actual values of function relays such as timing relays, counters, operating hours counters, analog value comparators, date, time or scaled analog values. Setpoint values of timing relays, counters, operating hours counters and analog value comparators can be altered on the device during the display of the texts.

Example of a text display:

```
SWITCHING;
CONTROL;
DISPLAY;
ALL EASY!
```

The text display can display the following:

```
RUNTIME M:S
T1 :012:46
C1 :0355 ST
PRODUCED
```

— Line 1, 12 characters

— Line 2, 12 characters, a setpoint value or an actual value

— Line 3, 12 characters, a setpoint value or actual value

— Line 4, 12 characters

The setpoint values can be edited:

- easy500 and easy700, two values
- easy800, four values

The text output function block D (D = Display, text display) functions in the circuit diagram like a normal marker M. Should a text be attached to a marker this would be shown at condition in the easy display when the coil is set to 1. For this easy must be in RUN mode and before the texts are displayed the Status display must be active.

D1 is defined as an alarm text and has therefore priority over text displays.

D2 to D16/D32 are displayed when activated. When several displays are activated they are shown in succession every 4 secs. When a setpoint value is edited the corresponding display stays active until the value is transferred.

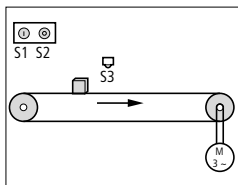
# Switching, control, visualization

## Programming easyRelay, MFD-Titan

### Visualization with MFD-Titan

The visualization with MFD-Titan is implemented with screen, on which the display is shown.

Example of a screen:



The following screen elements can be combined.

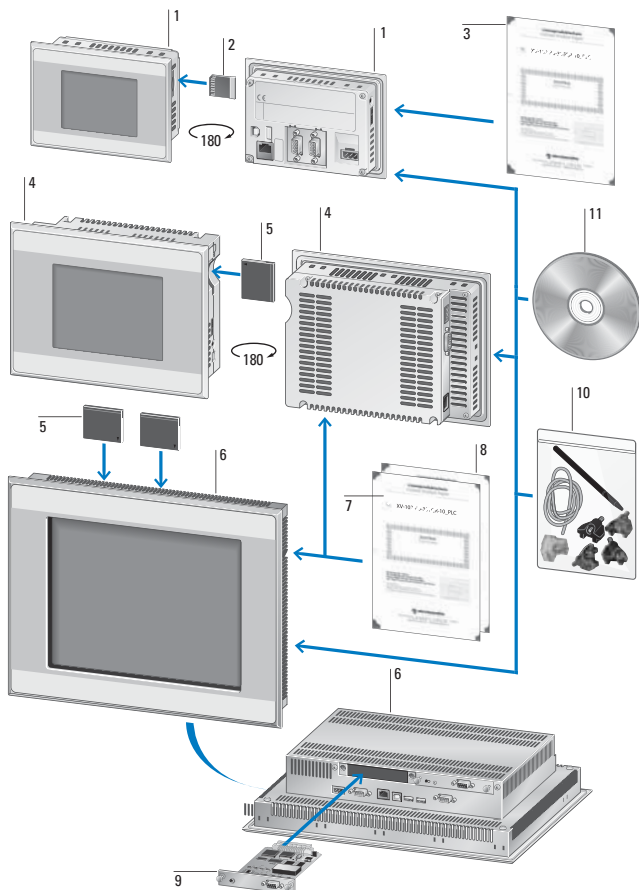
- Graphic elements
  - Bit display
  - Bitmap
  - Bargraph
  - Message bitmap
- Button elements
  - Latching pushbutton
  - Button field
- Text elements
  - Static text
  - Message text
  - Screen menu
  - Running text
  - Rolling text
- Value display elements
  - Date and time display
  - Numerical value
  - Timing relay value display
- Value entry elements
  - Value entry
  - Timing relay value entry
  - Date and time entry
  - 7-day time switch entry
  - Year time switch entry

# Switching, control, visualization

## HMI-PLC - Systematic visualization and control

### System overview

1



## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

---

- 1 XV100 HMI/PLC with touch display:  
Fully graphical 3.5", 5.7" or 7" wide  
screen devices
- 2 SD memory card
- 3 XV license product certificates:  
Expansion of device functionality  
through assignment of license points.
- 4 XV200 HMI/PLC with touch display;  
Fully graphical 5.7" devices
- 5 CompactFlash memory card
- 6 XV400 HMI/PLC with touch display:  
5.7", 8.4", 10.4", 12.1", 15" devices with  
infra-red or resistive touch
- 7 XV license product certificates:  
Expansion of device functionality  
through assignment of license points
- 8 OS Upgrade license
- 9 Communication module for XV400
- 10 Fixing kit
- 11 Software

## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

#### General information

1



Each transmitter is assigned a receiver on the other side. The beams are directed slightly over the front panel. The simultaneous interruption of several infra-red channels on the X and Y axis is used to indicate where the panel was touched in order to trigger the appropriate switch function.

Whether in machine or system building or in individual applications, an HMI (Human Machine Interface) or HMI-PLC (HMI with PLC functionality) simplifies operation and reduces the workload for the operator.

Touch panels provide a clear, flexible menu navigation in any required language and enables the manufacturer to sell machinery worldwide with only one hardware and software solution.

Touch panels with resistive and infra-red technology are primarily used. Eaton offers devices with both technologies.

On the resistive touch panel, a conductive foil is stretched over the conductive screen surface. The foil is separated from the screen using several insulating pads. Only when a slight pressure is applied, does the foil touch the screen surface at this point and a current flows. A different current or resistance value is produced, based on the voltage divider principle according to where on the screen contact with the foil was made. The contact point is thus located unambiguously.

The infra-red touch panels uses a light matrix in the infra-red range.



## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

Touch-technology	Infra-red	Resistive
Light permeability	100 %	70 – 85 %
Operable with	Fingers, gloves	Fingers, gloves, touch pen
Triggering of the function	Without pressure (interruption of the light matrix)	With slight pressure
Display front	Glass	Plastic film
Device front	Level determined by the infra-red frame	Fully flat
Sensitivity to scratches	No	Yes
Resistance to cleaning agent and chemicals	High	Average
Use in humid atmospheres	Yes	Yes

1

Devices with display sizes from 3.5" to 19" are used in automation applications. Eaton offers device versions in plastic and metal. The front on the metal devices is either in aluminium or stainless steel.

Front degree of protection: IP65

Most touch panels can also be used in portrait format (upright).

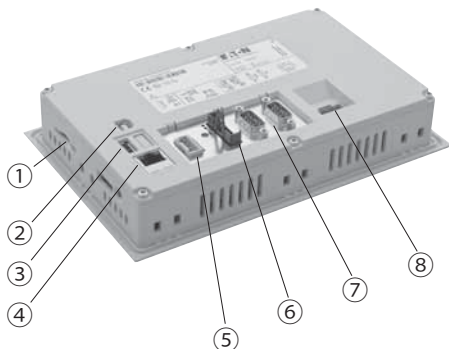


# Switching, control, visualization

## HMI-PLC - Systematic visualization and control

### Engineering

1



Rear view of a 7" resistive panel of the XV102 series with plastic housing

- ① SD memory card (Secure Digital memory card)
- ② USB device, page 1-98
- ③ USB host, page 1-98
- ④ Ethernet interface, page 1-99
- ⑤ 24 V DC power supply POW and AUX (for SmartWire-DT slaves, page 1-99)
- ⑥ SmartWire-DT interface (only specific devices) page 1-100
- ⑦ Onboard interfaces, depending upon the device:
  - RS232, page 1-100
  - RS485, page 1-101
  - CAN, page 1-102
  - PROFIBUS-DP, page 1-104
- ⑧ 24 V DC device supply, page 1-106

#### ② USB device

The USB device interface supports USB 2.0.



#### • Cable

- Only use standard USB cables with a shield.
- Maximum cable length: 5 m

#### ③ USB-Host

The USB Host interface supports USB 2.0.



#### • Cable

- Only use standard USB cables with a shield.
- Maximum cable length: 5 m

## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

#### ④ Ethernet interface

LINK ACT



LED	Signal	Meaning
ACT (yellow)	flashes	Ethernet is active (data traffic)
LINK (green)	On	Active network is connected and detected

#### • Cable

- Use shielded twisted pair (STP) cable for networking
- For device to device connection: cross over cable
- For connection to hub/switch: 1:1 patch cord
- Maximal cable length: 100 m

Ethernet interface according to EIA/TIA 568 TSB-36.

#### ⑤ POW and AUX 24 V DC power supply (for SmartWire-DT slaves)

The POW/AUX interface is not galvanically isolated. The following power supplies are required for a SmartWire-DT network:

Supply voltage POW:

The device supply voltage for the electronics of all SWD slaves (15 V DC) is generated from the 24 V DC supply voltage that you apply to the POW terminal connection.

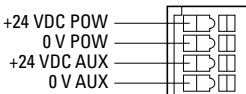
Supply voltage AUX:

If there are any contactors or motor starters in the SWD topology, a 24 V DC voltage AUX must be additionally supplied as a control voltage for the contactor coils.



#### • Wiring

WAGO plug connector, Art no. 734-104 is supplied with the device.



Connection	Assignment
+24 V DC POW	$U_{POW}$ +24 V DC
0 V POW	$U_{POW}$ 0 V
+24 V DC AUX	$U_{AUX}$ +24 V DC
0 V AUX	$U_{AUX}$ 0 V

Observe the following when preparing the wiring of the plug connector:

Terminal type:	Spring-loaded terminals
Connectable conductor, solid:	0.2 - 1.5 mm <sup>2</sup> (AWG24 - 16)
Stripping length:	6 - 7 mm

## Switching, control, visualization

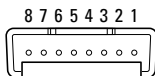
### HMI-PLC - Systematic visualization and control

1

External protection using a 24 V DC miniature circuit-breaker is required for  $U_{Aux}$ .

#### ⑥ SmartWire-DT interface (only specific device types)

The SWD interface is not galvanically isolated.



#### • Cabling

Only use the following cables to connect the SmartWire-DT network:

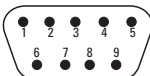
- SWD-4-100LF8-24 with the SWD-4-8MF2 blade terminals or
- SWD-4-(3/5/10)F8-24-25 (prefabricated cable)

Detailed instructions for fitting the SWD-4-8MF2 blade terminal is provided in the manual MN05006002Z-EN, chapter “Fitting the SWD4-8MF2 blade terminal”.

The project configuration (SmartWire-DT configuration in XSoft-CoDeSys-2 project) is described in the manual MN04802091Z-EN, XSoft-CoDeSys-2: PLC programming XV100, chapter “SmartWire-DT Configuration”.

#### ⑦ RS232

The RS232 interface is not galvanically isolated. The device may be damaged by potential differences. The GND terminals of all bus stations must therefore be connected.



Pin	Signal	Assignment
1	DCD	Data Carrier Detected
2	RxD	Receive Data
3	TxD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request to Send
8	CTS	Clear To Send
9	RI	Ring Indicator

#### • Wiring

- Shielded cables must be used.
- The maximum baud rate depends on the cable length:

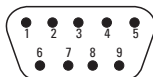
Cable length	Max. baud rate
2.5 m	115200 bit/s
5 m	57600 bit/s
10 m	38400 bit/s
15 m	19200 bit/s
30 m	9600 bit/s

## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

#### ⑦ RS485

The RS485 interface is not galvanically isolated. The device may be damaged by potential differences. The GND terminals of all bus stations must therefore be connected.



Pin	Signal	Assignment
1	-	nc
2	-	nc
3	B	Line B
4	-	nc
5	GND	Ground
6	-	nc
7	A	Line A
8	-	nc
9	-	nc

nc: Pin 1, 2, 4, 6, 8 and 9 must not be connected.

#### • Wiring

Screened twisted-pair cables must be used.

#### Cable specification

Rated cable impedance	120 $\Omega$
Permissible impedance	108-132 $\Omega$

#### Cable specification

Max. cable length	1200 m
Possible baud rates	9600 bit/s 19200 bit/s 38400 bit/s 57600 bit/s 115200 bit/s

When preparing connections, ensure that the cable shield has a low impedance connection with the connector housing.

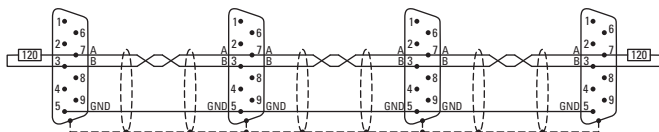
#### • RS485-topology

- A bus segment can interconnect up to 32 slaves.
- Several bus segments can be connected via repeaters (bidirectional amplifiers). Refer to the documentation of the repeater manufacturer for more specific details.
- The use of repeaters enables the maximum cable length to be increased. Refer to the documentation of the repeater manufacturer for more specific details.
- A bus segment must be provided with cable termination (120  $\Omega$ ) at both ends. These terminals must be connected in the connector directly between pin 3 and 7.
- The bus segment must be terminated at both ends.
- No more than two terminations must be provided for each bus segment.
- Operation without correct cable termination can cause transfer errors.

## Switching, control, visualization

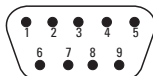
### HMI-PLC - Systematic visualization and control

1



#### ⑦ CAN

The CAN interface is not galvanically isolated. The device may be damaged by potential differences. The GND terminals of all bus stations must therefore be connected.



Pin	Signal	Assignment
1	-	nc
2	CAN-L	Bus line (dominant low)
3	CAN-GND	CAN ground
4	-	nc
5	-	nc
6	GND	Optional CAN ground
7	CAN-H	Bus line (dominant high)
8	-	nc
9	-	nc

Pin 3 (CAN-GND) and 6 (GND) are internally interconnected  
 nc: Pin 1, 4, 5, 8 and 9 must not be connected.

The power supply of the CAN bus drivers is implemented internally.

A power supply for third party devices is not provided on the CAN connector.

#### • Wiring

Shielded twisted pair cables must be used.

#### Cable specification

Rated cable impedance	120 $\Omega$
Permissible impedance	108-132 $\Omega$
Capacitance per unit length	< 60 pF/m
Conductor cross-section	$\geq 0.25 \text{ mm}^2/100 \text{ m}$
Max. cable length	$\geq 0.34 \text{ mm}^2/250 \text{ m}$ $\geq 0.75 \text{ mm}^2/500 \text{ m}$

## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

The maximal baud rate depends on the cable length

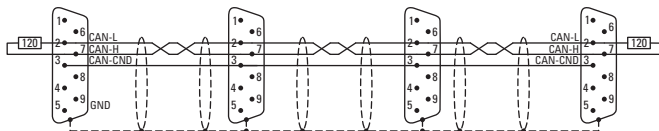
Cable length	Max. baud rate
25 m	1000 kbit/s
50 m	800 kbit/s
100 m	500 kbit/s
250 m	250 kbit/s
500 m	125 kbit/s
500 m	100 kbit/s
1000 m	50 kbit/s
2500 m	20 kbit/s
5000 m	10 kbit/s

- The use of repeaters is recommended for cable lengths over 1000 m. Repeaters can also be used for galvanic isolation. Refer to the documentation of the repeater manufacturer for more specific details.

- Observe the recommendations of CiA (CAN in Automation).
- When preparing connections, ensure that the cable shield has a low impedance connection with the connector housing.

#### • CAN-Bus-topology

- A bus segment can interconnect up to 32 slaves.
- Several bus segments can be connected via repeaters (bidirectional amplifiers). Refer to the documentation of the repeater manufacturer for more specific details.
- A bus segment must be provided with cable termination (120  $\Omega$ ) at both ends. These terminals must be connected in the connector directly between pin 2 and 7.
- The bus segment must be terminated at both ends.
- No more than two terminations must be provided for each bus segment.
- Operation without correct cable termination can cause transfer errors.



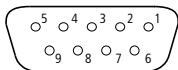
## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

1

#### ⑦ PROFIBUS-DP

The PROFIBUS interface is not galvanically isolated. The device may be damaged by potential differences. The GND terminals of all bus stations must therefore be connected.



Pin	Signal	Assignment
1	-	nc
2	-	nc
3	B	EIA RS485 cable B
4	RTSAS	Output for controlling a repeater
5	M5EXT	Output 0 V for external termination
6	P5EXT	Output 5 V for external termination
7	-	nc
8	A	EIA RS485 cable A
9	-	nc

Pin 6 (5 V) must not be used as a power supply for external devices.

#### • Wiring

Screened twisted-pair cables, cable type A (acc. to the PROFIBUS standard EN 50170) must be used.

#### Cable specification

Rated cable impedance	150 Ω
Permissible impedance	135-165 Ω
Capacitance per unit length	< 30 pF/m
Loop resistance	< 110 Ω/km
Core cross section	≥ 0.34 mm <sup>2</sup> (AWG22)

The maximal baud rate depends on the cable length

Cable length	Max. baud rate
200 m	1500 kbit/s
400 m	500 kbit/s
1000 m	187.5 kbit/s
1200 m	≤ 93.75 kbit/s

When preparing connections, ensure that the cable shield has a low impedance connection with the connector housing.



## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

#### • PROFIBUS-topology

Shielded twisted-pair cables must be used.

- A bus segment can interconnect up to 32 slaves.
- Several bus segments can be connected via repeaters (bidirectional amplifiers). Refer to the documentation of the repeater manufacturer for more specific details.

#### Notes:

The use of repeaters enables the maximum cable length to be increased. Refer to the documentation of the repeater manufacturer for more specific details.

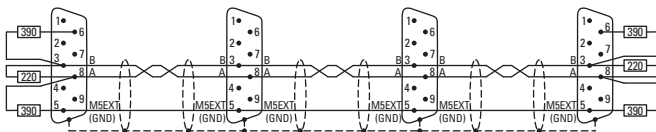
- Only use bus connector plugs that are specified for use in the PROFIBUS network. These combine both bus cables on a bus station and ensure that the cable shield is a low impedance connection and fed through to the shield reference potential of the bus station. The bus connector plug

contains the PROFIBUS-specific cable termination that can be activated if required.

- A bus segment must be provided with cable termination at both ends. The termination is passive but is fed from the bus station. It ensures a defined quiescent signal on the bus if no bus station is sending. These bus terminals are primarily implemented externally in the connector housing in accordance with the PROFIBUS standard.

#### Notes:

- The bus segment must be terminated at both ends.
- No more than two terminations must be provided for each bus segment.
- At least one of the two terminations must be fed by the bus station.
- Operation without correct termination of the PROFIBUS network can cause transfer errors.



## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

1

#### ⑧ 24 V DC device supply

The device has an internal fuse and protection against polarity reversal. The functional earth must only be connected with the connector panel not the 0 V. The housing is plastic and is potential free. The power supply of the device is not galvanically isolated.

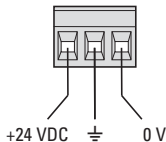
The device requires a power supply of 24 V DC from an AC/DC transformer with safe isolation (SELV).

- SELV (safety extra low voltage); circuit in which no dangerous voltage occurs even in the event of a single fault.



#### • Wiring

Plug connector Phoenix Contact MSTB 2.5/3-ST-5.08, Phoenix Art no. 1757022 is supplied with the device.



Connection	Assignment
+24 V DC	Supply voltage +24 V DC
E	Functional earth with connector panel. Does not have to be connected.
0 V	Supply voltage 0 V

Observe the following when preparing the wiring of the plug connector:

Terminal type:	Screw terminal plug-in
Cross-section:	min. 0.75 mm <sup>2</sup> / max. 2.5 mm <sup>2</sup> (lead or wire) min. AWG18 / max. AWG12
Stripping length:	7 mm
Max. tightening torque:	0.6-0.8 Nm / 5-7 lb in

## Switching, control, visualization

### HMI-PLC - Systematic visualization and control

#### Preparing the cables with the SUB-D connector

The design of the bus cabling is an essential factor for reliable operation and electromagnetic compatibility (EMC).

#### Wiring requirements

- The cables must be shielded.
- The cable shield must consist of a copper braid.
- The cable shield must have a large area and low-impedance connection to the connector housing. This is achieved by:
  - Using metal or metallized connector housings with a strap for strain relief.
  - The strap must be screw fastened with the connector.

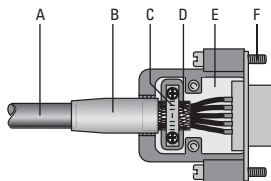
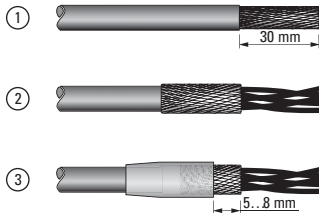
– 5 - 8 mm shield braid must be exposed at the cable end.

– The folded shield braid end must be covered by the heat-shrink tubing or rubber grommet.

④ Fit the SUB-D connector to the cable end:

– The exposed screen braid must be connected to the connector housing with the cable clip.

#### Connecting the cable shield



- A Cable with cable sheath  
 B Heat-shrink tubing or rubber grommet  
 C Gland plate  
 D Shield braid  
 E SUB-D plug  
 F Fixing screw UNC

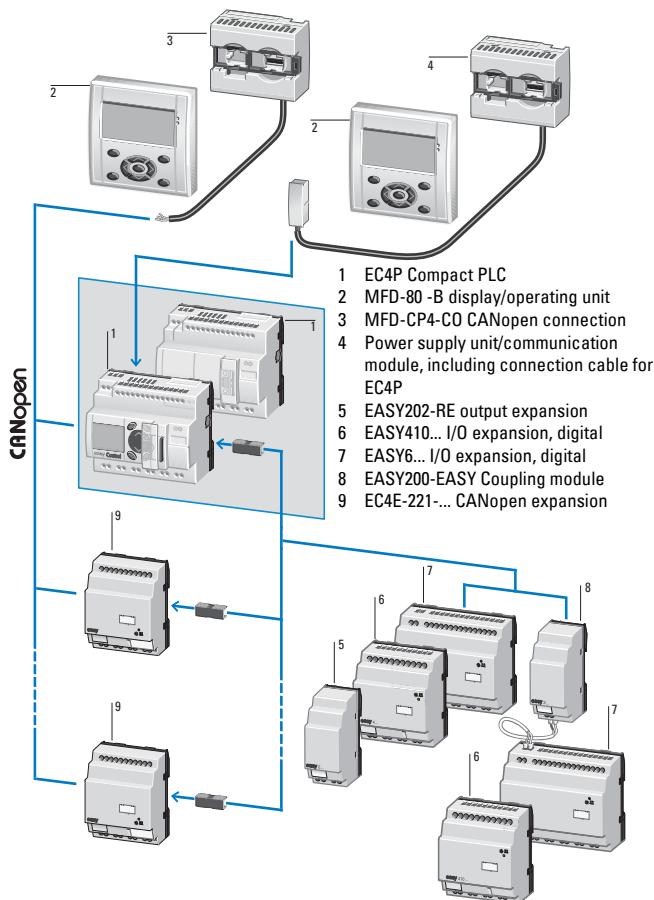
- ① Insulate the cable end so that approx. 3 cm of shield braid is exposed.
- ② Fold back the shield braid over the cable sheath.
- ③ Attach heat-shrink tubing approx. 3 cm in length over the folded shield braid or use a rubber grommet.

# Switching, control, visualization

## Compact PLC – universal compact controllers

### System overview

1



## Switching, control, visualization

### Compact PLC – universal compact controllers

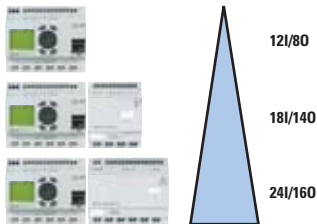
#### General information

Compact controllers offer in a single device several functions that cover the automation of small and medium-sized applications.

For this sector Eaton offers the EC4P series. The controllers provide the functionality of a PLC in the housing of an easy800 control relay. Programming is carried out using CoDeSys software.

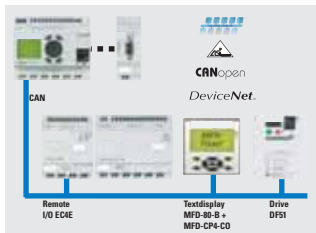
The controllers vary according to the number and type of inputs/outputs. Moreover, there are variants with and without display, as well as with and without an Ethernet interface. Ethernet allows remote programming via the network and communication via UDP and MODBUS.

All EC4P controllers are provided with a CAN/easyNet interface.



Flexible networking options:

- Remotely expandable via CANopen or easyNet
- Locally expandable via easyLink interface
- Remote programming via network
- Connection of one or several MFD-80-B via CANopen
- Connection of an MFD-80-B via RS232
- Pluggable memory modules for data archiving




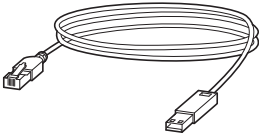

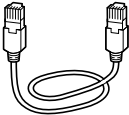

# Switching, control, visualization

## Compact PLC – universal compact controllers


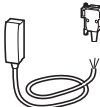
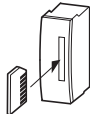
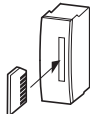
### Engineering

#### Cable connections

1

Cable type/ Memory card	Device	Function
EU4A-RJ45-CAB1 	PC, terminal/ printer	Programming via serial interface COM1, transparent mode
EU4A-RJ45-USB-CAB1 	PC	Programming via USB interface
EU4A-RJ45-CAB2 	MFD-CP4-C0 + MFD-80-B EC4E	CAN connection
XT-CAT5-X-2 	PC	Programming via Ethernet
MFD-CP4-800-CAB5 	MFD-CP4	Display extension, serial

**Switching, control, visualization****Compact PLC – universal compact controllers**

Cable type/ Memory card	Device	Function
easy800-USB-CAB 	PC	For programming via the USB interface
easy800-MO-CAB 	PC, terminal/ printer	Programming via serial interface COM1, transparent mode
EU4A-MEM-CARD1 	EC4P	Memory card
EU4A-MEM-CARD2 	EC4P	Memory card with battery for backing up the time

## Switching, control, visualization

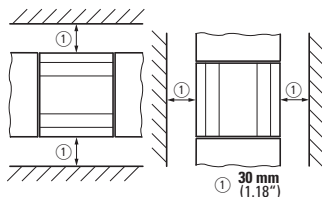
### Compact PLC – universal compact controllers

1

#### Device arrangement

Install the PLC in a control cabinet, a service distribution board or in an enclosure so that the supply voltage terminals and the terminal capacities are protected against direct contact during operation.

The PLC can be installed vertically or horizontally on a top-hat rail in compliance with IEC/EN 60715 or on a mounting plate using fixing brackets. Ensure that the terminal side has a clearance of at least 3 cm from the wall and from neighbouring devices in order to simplify wiring.



#### Connection examples

The connection examples listed here from the chapter "Engineering easyRelay, MFD-Titan" are also relevant for the EC4P compact controller.

- Connecting the power supply, → page 1-50
- Connecting the digital inputs, → page 1-51
- Connecting analog inputs, → page 1-55
- Connecting the incremental encoder, → page 1-57
- Connecting relay outputs, → page 1-58
- Connecting transistor outputs, → page 1-59
- Connecting analog outputs, → page 1-61

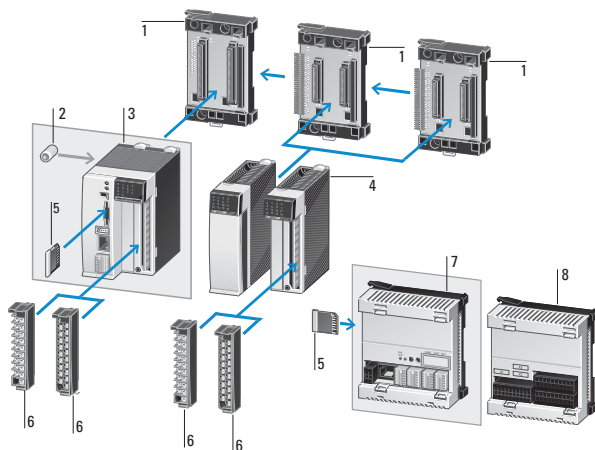
Further information → Manual  
MN05003003Z-EN



# Switching, control, visualization

## Modular PLC

### System overview



- 1 Racks
- 2 Battery
- 3 XC100/XC200 controllers
- 4 XI/OC I/O-modules, Communication modules
- 5 Memory card
- 6 XI/OC terminal block (screw or spring-cage terminal)
- 7 XC121 controller
- 8 XIO-EXT121-1 I/O-expansion for XC121 controller

# Switching, control, visualization

## Modular PLC

1

### General information

Modular PLCs offer an outstanding level of scalability. This ensures a high level of flexibility for designing individual automation systems. Different CPU performance classes and a wide range of expansion modules are available.

The data exchange via an Ethernet interface to OPC clients or integrated WEB servers enables the creation of innovative solutions.



In this class Eaton offers the two XC100 and XC200 series.

### XC100 modular PLCs

The controllers of the XC100 series are universal automation devices for small and medium-sized applications. They differ according to the size of the available program memory. One variant is provided with an optical CAN interface.

- Expandable by up to 15 XI/OC modules
- Data storage on SD card
- CAN interface for communication
- RS232 interface

Further information → Manual  
MN05003004Z-EN

### XC200 modular PLCs

The controllers of the XC200 series offer a high CPU performance and a wide range of communication options. These devices differ according to the size of the program memory, the cycle time and the integrated WEB server.

- Expandable by up to 15 XIOC modules
- Data storage on SD card or USB stick
- Ethernet interface for programming and communication
- CAN interface for communication
- RS232 interface
- Integrated web server

Further information → Manual  
MN05003001Z-EN

### XIOC signal modules

The XIOC signal modules can be connected to XC100 as well as to XC200 controllers (exception: XIOC-TC1 telecontrol module only to XC200). A wide range of different modules are available:

- Digital input/output modules
- Analog input/output modules
- Temperature measuring modules
- Counter modules
- Serial interface module (RS232, RS485, RS422; operating modes: Transparent mode, Modbus master/slave, Sucom-A, Suconet K slave)
- Telecontrol module
- Communication modules PROFIBUS-DP master, PROFIBUS-DP slave, Suconet-K master)

Further information → Manual  
MN05002002Z-EN

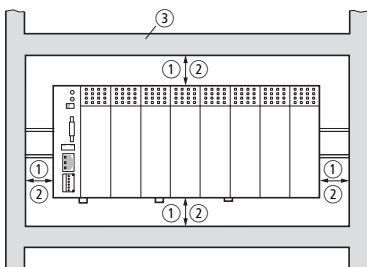
# Switching, control, visualization

## Modular PLC

### Engineering

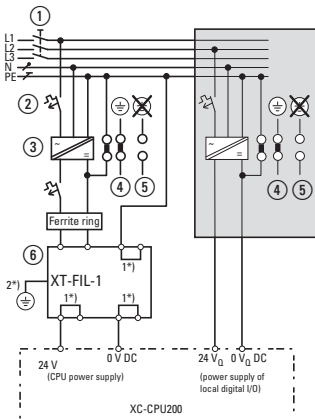
#### Device arrangement

Build the module racks and the controls into the switchgear cabinet in a horizontal position.



- ① Clearance > 50 mm
- ② Clearance > 75 mm to active elements
- ③ Cable duct

#### Power supply



- ① Main switches
- ② Circuit protection device
- ③ 24 V DC supply voltage
- ④ Earthed operation
- ⑤ In floating (i.e. unearthed) operation, an isolation monitor must be used (IEC 204-1, EN 60204-1, DIN EN 60204-1)
- ⑥ 24 V DC line filter; ensures that a current of up to 2.2 A (maximum) is available at a rated operating voltage of 24 V DC. Use of the filter ensures that the EMC stipulations for devices.

1\*) Internally bridged

2\*) Additional PE connection via contact spring on rear

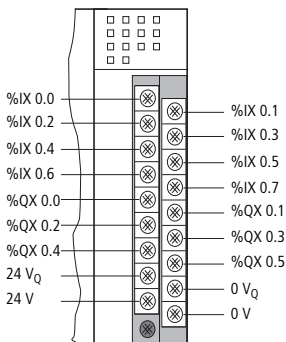
# Switching, control, visualization

## Modular PLC

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### Terminal assignment on the CPU

The connections for the power supply and the local inputs/outputs have the following assignment:



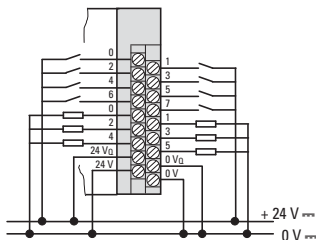
### Connecting inputs/outputs to the central processing unit

The 0V<sub>Q</sub>/24V<sub>Q</sub> voltage terminal is intended exclusively for the power supply to the local inputs (8) and outputs (6), and is electrically isolated from the bus.

At a duty factor (DF) of 100 % and a utilization factor of 1, outputs 0 to 3 can each carry a load of 500 mA, and outputs 4 and 5 a load of 1 A.

The example shows the wiring with a separate power supply for controller and I/O terminals. If only one power supply is used, the following terminals must be connected:

24 V to 24V<sub>Q</sub> and 0 V to 0V<sub>Q</sub>.



# Switching, control, visualization

## Modular PLC

### Ethernet/RS2232

(XC-CPU101, XC-CPU201)	(XC-CPU202)		RS232	ETH (XC-CPU201, XC-CPU202)
		8	RxD	–
		7	GND	–
		6	–	Rx–
		5	TxD	–
		4	GND	–
		3	–	Rx+
		2	–	Tx–
		1	–	Tx+

1

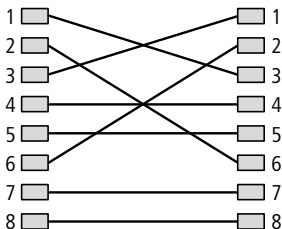
From a purely physical/mechanical point of view the programming devices interface is an RJ45 interface (socket). This means that normal commercial RJ45 connectors or Ethernet patch cables can be used.

- Direct connection PC – XC200:

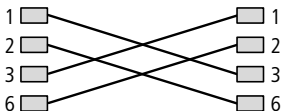
The XC200 can be connected directly to the (programming) PC via a crossover Ethernet cable.

Crossover cables have the following design features:

- Connection set-up of 8-pole crossover cable



- Connection set-up of a 4-pole crossover cable



The following cross-over cables are available:

XT-CAT5-X-2 (2 m long)

XT-CAT5-X-5 (5 m long)

- PC – XC200 via Hub/Switch connection:

If you use a Hub or a Switch between the PC – XC200 connection, you must use a standard Ethernet cable which is connected 1:1 for the connection between PC – Hub/Switch and Hub/Switch – XC200.

The cable EU4A-RJ45-USB-CAB1 is provided for programming via the USB interface of a PC.

## Switching, control, visualization

### Modular PLC

#### Note!

Please note that when there is a double assignment of the RJ45 interface with the RS232 and Ethernet, the connections 4 and 7 are connected to "GND potential" because of the RS232 interface. For this reason, we recommend the use of 4-core cables for the connection of the XC200 to the Ethernet.

#### CANopen interface

Configuration of the 6-pole Combicon plug:

	Terminal	Signal
6	6	GND
5	5	CAN_L
4	4	CAN_H
3	3	GND
2	2	CAN_L
1	1	CAN_H

Connector type: 6-pole, pluggable spring-loaded terminal block

Connector terminals: up to 0.5 mm<sup>2</sup>

Terminals 1 and 4, 2 and 5 as well as 3 and 6 are internally connected.

The CAN interface is electrically isolated.

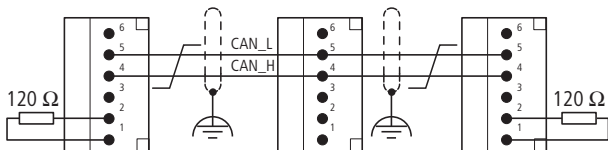
Bus termination resistors must be installed at the first or last station on the line (->Fig. below).

The bus terminating resistor on the XC-CPU202 can be switched. The switch is located above the battery.

Only use a cable that is permissible for CANopen with the following properties:

- Characteristic impedance 100 to 120  $\Omega$
- Capacitance per unit length < 60 pF/m

Baud rate [Kbit/s]	Length [m]	Core cross-section [mm <sup>2</sup> ]	Loop resistance [ $\Omega$ /km]
20	1000	0.75 – 0.80	16
125	500	0.50 – 0.60	40
250	250	0.50 – 0.60	40
500	100	0.34 – 0.60	60
1000	40	0.25 – 0.34	70



## Switching, control, visualization

### Modular PLC

#### Connection examples

Terminal blocks with either screw terminals or spring-loaded terminals can be optionally used for the wiring.

1

Conductor	Screw connection	Spring clamp connection
Solid	0.5-2.5 mm <sup>2</sup>	0.14-1.0 mm <sup>2</sup>
Flexible with ferrule	0.5-1.5 mm <sup>2</sup>	The cables are to be inserted into the terminals with out the use of ferrules or cable lugs.
Flexible	—	0.34-1.0 mm <sup>2</sup>

#### Notes:

- Cable lugs must not exceed 6 mm in diameter.
- Do not attach more than 2 cable lugs to one terminal.
- Use a cable with a maximum conductor cross-section of 0.75 mm<sup>2</sup>, or 0.5 mm<sup>2</sup> if two cable lugs are going to be fixed to the same terminal.

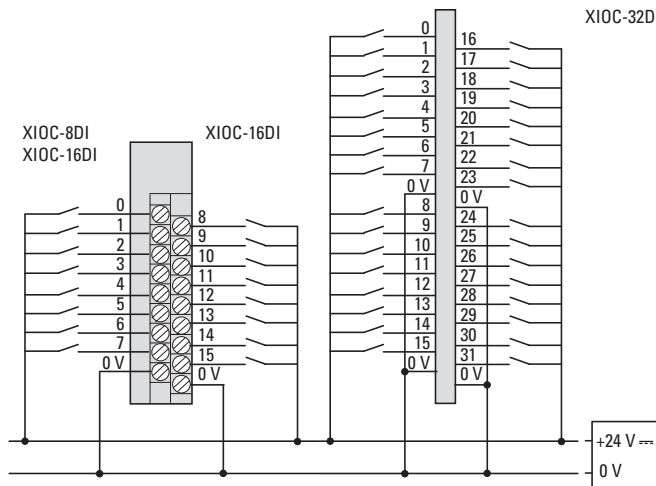
# Switching, control, visualization

## Modular PLC

### Wiring: digital input modules

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XIOC-32DI

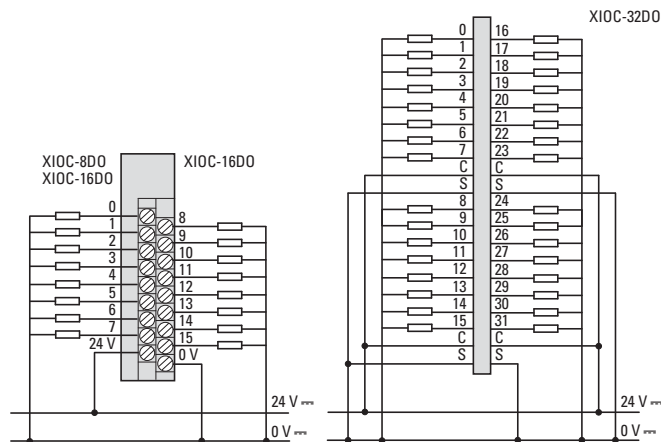




# Switching, control, visualization

## Modular PLC

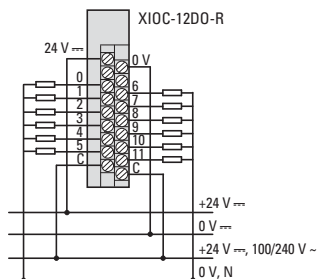
### Wiring digital output modules



1

When using inductive loads, connect a free-wheel diode in parallel.

### Wiring digital output modules (relays)



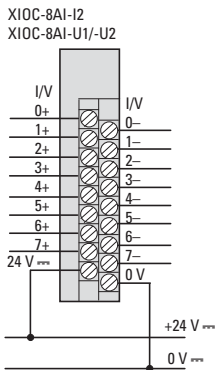
# Switching, control, visualization

## Modular PLC

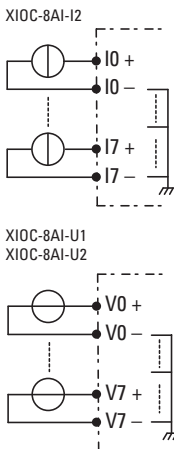
### Wiring analog input modules

1

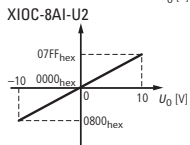
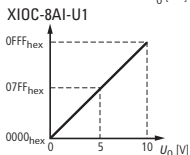
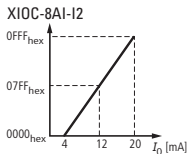
#### Terminal assignment



#### Module wiring



#### U/I diagram for the modules



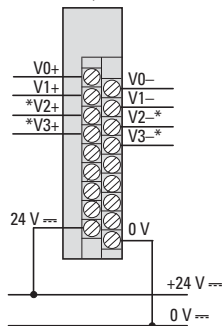
# Switching, control, visualization

## Modular PLC

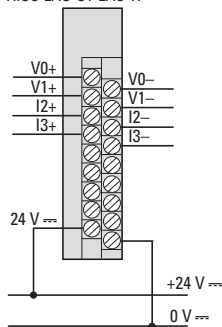
### Wiring analog output modules

#### Terminal assignment

XIOC-2AO-U2  
XIOC-4AO-U1/U2

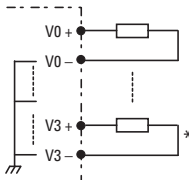


XIOC-2AO-U1-2AO-I1

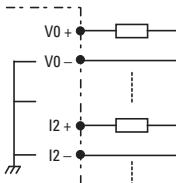


#### Module wiring

XIOC-2AO-U2  
XIOC-4AO-U1/U2

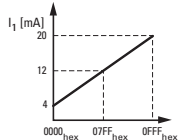


XIOC-2AO-U1-2AO-I1

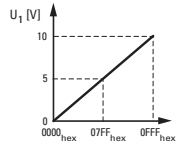


#### U/I diagram for the modules

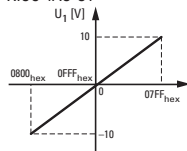
XIOC-2AO-U2  
XIOC-4AO-U1/U2



XIOC-2AO-U1-2AO-I1



XIOC-2AO-U2  
XIOC-4AO-U1

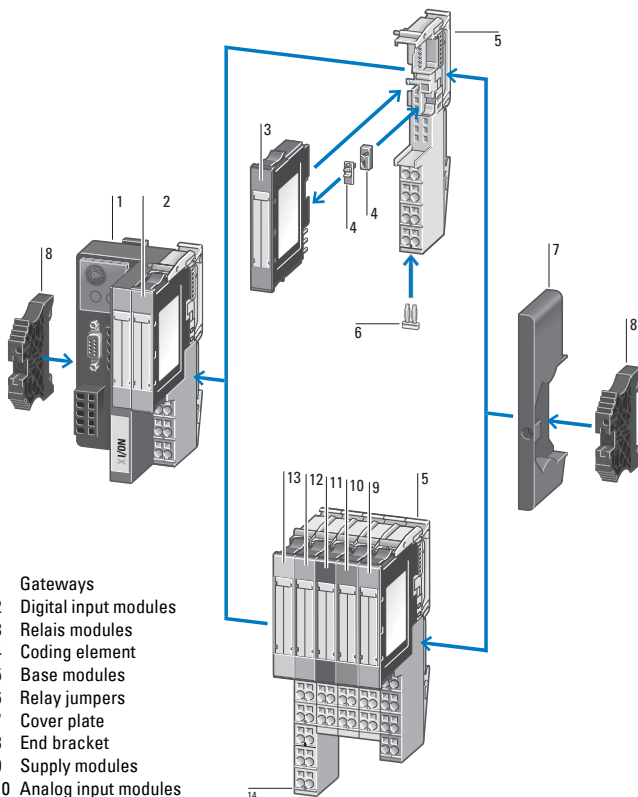


# Switching, control, visualization

## Modular I/O system

### System overview

1



- 1 Gateways
- 2 Digital input modules
- 3 Relais modules
- 4 Coding element
- 5 Base modules
- 6 Relay jumpers
- 7 Cover plate
- 8 End bracket
- 9 Supply modules
- 10 Analog input modules
- 11 Digital output modules
- 12 Analog output modules
- 13 Technology modules
- 14 Marker

# Switching, control, visualization

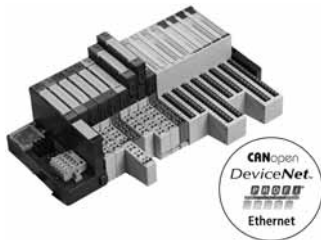
## Modular I/O system

### General information

Whether controlling movements, measuring temperature or speeds, logging currents and voltages – the application ranges for remote I/Os are varied. Remote I/Os can be found wherever remote signal processing is the key element of the automation concept.

The XI/ON I/O system has the following essential features:

- High modularity
- Field busses: CANopen, PROFIBUS-DP, DeviceNet and Ethernet
- Bus-independent, plug-in modules
- Low wiring requirement
- Effective diagnostics
- Space and cost savings with ECO modules
- Programmable CANopen coupling unit
- Standard and ECO modules can be mixed



The XI/ON I/O system provides an extensive range of digital and analog I/Os as well as technology modules:

- XI/ON ECO gateways and ECO modules
- XI/ON ECO adds cost and space-optimized I/O modules and gateways to the XI/ON I/O system. The ECO gateways support the

CANopen, PROFIBUS-DP and Ethernet bus systems.

- ECO gateways with built-in bus termination resistors
- Full compatibility with the standard XI/ON system
- No base modules required
- High channel density: (up to 16 DI/DO over 12.5 mm width)
- Push-in spring-cage terminals
- Multi-functional slices
- Mini USB diagnostics interface
- XI/ON Default gateways and standard modules

The standard gateways support the CANopen, PROFIBUS-DP, DeviceNet and Ethernet bus systems.

- Use of the pluggable I/O modules is possible regardless of the fieldbus used
  - Wiring implemented on base modules, fixed wiring
  - Hot-swapping of modules
  - Generation of diagnostics information for the higher-level controller
  - Up to 74 slice modules can be connected per gateway
  - Modules mechanical coding
  - Programmable CANopen coupling unit
- With the programmable CANopen gateway, PLC performance is now brought directly to the fieldbus terminal. The device is ideal for managing remote automation tasks and thus relieving the work load of a higher-level PLC. The serial onboard interface is used for programming onsite and as an interface for the I/Oassistant configuration and diagnostics tool. Alternatively this interface can also be

## Switching, control, visualization Modular I/O system

1

used as a free user interface. The gateway is programmed with XSOFT-CODESYS-2.

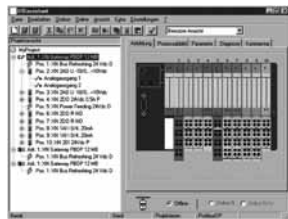
- Base modules for every requirement
- The base modules are used for connecting the fieldbus wiring for the standard XI/ON

modules. They are available for 2-, 3- and 4-cable connections, as block or slice modules, either with spring-cage or screw terminals.

### Engineering

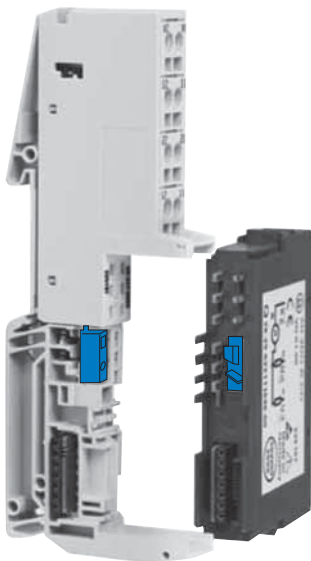
#### I/Oassistant configuration and diagnostics tool

The I/Oassistant is integrated in the XSOFT-CODESYS-2 software and offers interactive support in the entire planning and implementation of an XI/ON system. You choose the gateways, electronics and basic modules, as well as the appropriate accessories. The individual stations are then either configured online or offline. When everything is set to your requirements, you put the system into operation. I/Oassistant automatically generates a full parts list for your order. The I/Oassistant checks the station, reads process data, outputs values and visualizes the diagnostics data of the channels. In this way, you can also commission your station without the need for a higher-level controller and ensure that one section of the installation is functioning correctly.



#### Safety due to coding

The pluggable modules also allow hot swapping for the fast and toolless exchange of modules. The mechanical coding of the modules prevents incorrect fitting.



# Switching, control, visualization

## Modular I/O system

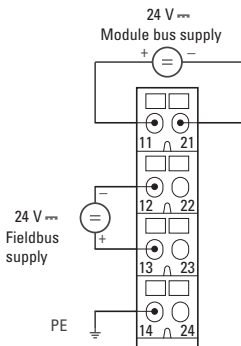
### Connection examples

#### Power supply module (Bus Refreshing Module)

- Module for feeding the 24 V DC system power supply and the 24 V DC field voltage supply

*XN-P4...-SBBC with gateway supply*

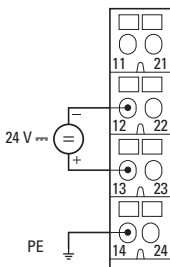
*XN-P4...-SBBC-B without gateway supply*



#### Feeder module (Power Feeding modules)

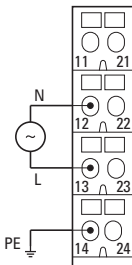
- Field power supply module 24 V

*XN-P4...-SBBC for XN-PF-24VDC-D*



- Field power supply module 120/230 V AC

*XN-P4...-SBB for XN-PF-120/230VAC-D*

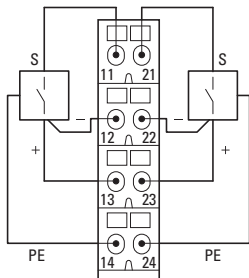


# Switching, control, visualization

## Modular I/O system

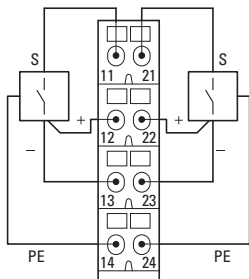
### Digital input modules

- Positive switching  
*XN-S4...-SBBC for XN-2DI-24VDC-P*



- Negative switching

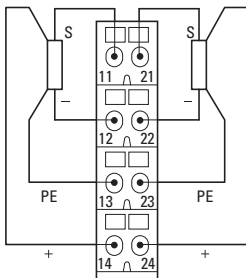
*XN-S4...-SBBC for XN-2DI-24VDC-N*



### Digital output module

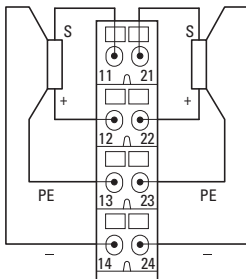
- Positive switching

*XN-S4...-SBCS for  
XN-2DO-24VDC-0.5A-P  
XN-2DO-24VDC-2A-P*



- Negative switching

*XN-S4...-SBCS for  
XN-2DO-24VDC-0.5A-N*





# Switching, control, visualization

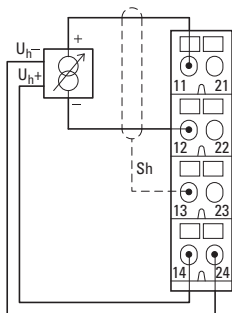
## Modular I/O system

### Analog input modules

*XN-S4...-SBBS for XN-1AI-I(0/4...20MA)*

*XN-S4...-SBBS for  
XN-1AI-U(-10/0...+10VDC)*

Analog transmitter with non-isolated  
transmitter supply



Further connection examples can be found  
in the manuals:

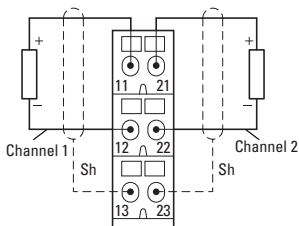
XI/ON digital I/O modules, power supply  
modules, MN05002010Z-EN  
(previously: M001735-02)

XI/ON analog I/O modules,  
MN05002011Z-EN (previously: M001756-04)

These manuals can be downloaded as PDF  
files at [www.eaton.com/moellerproducts](http://www.eaton.com/moellerproducts)  
in the "Products & Solutions" area.

### Analog output module

*XN-S3...-SBB for XN-2AO-I(0/4...20MA)*



## Switching, control, visualization Software

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Users of automation components such as machine and system builders are increasingly no longer satisfied with single solutions. This is why standards such as IEC 61131-3 have become established as manufacturer-independent standards for PLC programming. CoDeSys supports all programming languages described in the IEC-61131 standard.

CoDeSys is based on a standard of 3S. Proven technical features, simple handling and a wide distribution of this software for programming automation components of different manufacturers guarantee its success.

All Eaton controllers are programmed with the CoDeSys software. Programming can be carried out in different programming languages. These are divided into text-based or graphic-based languages.

### Text-oriented languages

#### Instruction List (IL)

An instruction list (IL) consists of a sequence of instructions. Each instruction starts on a new line and contains an operator and one or several comma separated operands – depending on the type of operation.

An identifier label followed by a colon (:) may be placed in front of an instruction. This is used for labelling the instruction which can then be used as a jump target.

A comment must always be the last element of a line.

Example:

```
LD 17
ST lint (* comment *)
GE 5
JMPC next
LD idword
EQ istruct.sdword
STN test
next:
```

#### Structured Text (ST)

Structured Text (ST) consists of a series of instructions that are arranged as in high level languages (IF...THEN...ELSE) or in loops (WHILE...DO).

Example:

```
IF value < 7 THEN
WHILE value < 8 DO
value := value + 1;
END_WHILE;
END_IF
```

# Switching, control, visualization

## Software

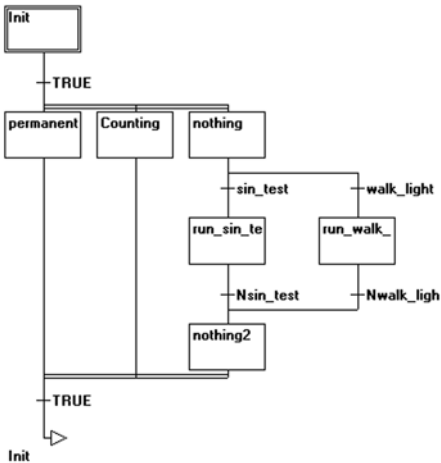
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### Graphic-oriented languages

#### Sequential Function Chart (SFC)

Sequential function chart (SFC) is a graphical language. It enables the timing of different actions within a program to be defined. Different step elements are used for this which are assigned to specific actions and which are controlled by so-called transition elements.

Example of a network in a sequential function chart:



# Switching, control, visualization Software

## Ladder Diagram (LD)

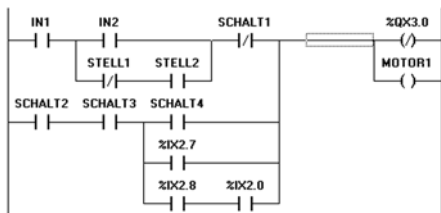
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Ladder diagram is a graphical programming language which closely follows the principle of an electrical circuit.

On the one hand, ladder diagram is suitable for designing logical switch systems, on the other hand, it is also possible to create networks as in FBD. LD is therefore very good for controlling the calling of other blocks. Ladder diagram consists of a

sequence of networks. A network is bordered on the left and right by a left and right vertical current path. A circuit diagram consisting of contacts, coils and connection lines is located in between.

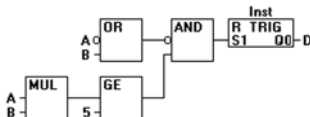
Example of a network in ladder diagram consisting of contacts and coils:



## Function Block Diagram (FBD)

Function block diagram is a graphical programming language. It operates with a list of networks, in which each network contains a structure that may represent a logic and arithmetic expression, the calling of a function block, a jump or a return instruction.

Example of a network in a function block diagram:



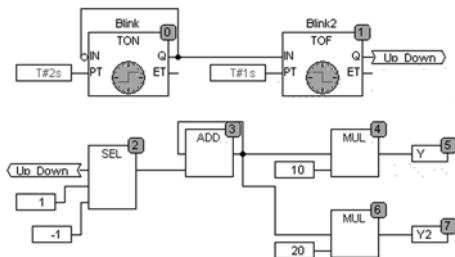
## Switching, control, visualization Software

### Continuous function chart (CFC)

The freely graphical function chart is based on function block diagram (FBD) but does not work like this with networks but with freely placable elements. This enables

for example the implementation of feedback paths.

Implementation example in freely graphical function block diagram editor:



### Integrated visualization

The CoDeSys programming system also contains a visualization editor as well as the programming tool. This offers a clear advantage:

Only one additional software package is required to visualize (i.e. for monitoring and operation) the data of a controller programmed in CoDeSys. Whilst the application is being developed, the user can already create visualization screens in the same user interface. The visualization integrated in CoDeSys can access the variables from the controller directly.

If the controller has a display (HMI-PLC), this visualization can be displayed directly on the panel (target visualization).

Many controllers are now equipped with a web server. If required CoDeSys generates from the visualization data an XML description which is stored on the controller together with a Java applet and

which can be shown on a browser using TCP/IP (WEB visualization).

### GALILEO interactive visualization tool

For its HMI and HMI-PLCs Eaton offers an easy to learn project design environment that is nevertheless powerful and comprehensive – ideal for use in all machine and process-relevant applications in system and machine building. Galileo has a sector neutral design and offers seamless project design for all of Eaton's graphical HMI devices.

## Notes

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**1**