





Warning!

Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the operating and installation instructions of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed in such a way that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.

- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).

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About this manual

This manual describes the installation, commissioning and programming (circuit diagram generation) of the display system.

Specialist electrical training is needed for commissioning and creating circuit diagrams. When controlling active components such as motors or pressure cylinders, parts of the system can be damaged and persons put at risk if the display system is connected or programmed incorrectly.

Device designation	<p>This manual uses the following abbreviated designations for different device models:</p> <ul style="list-style-type: none">• Display system• CL-AC2 for CL-LER.18AC2• CL-DC2 for CL-LER.18DC2, CL-LET.20DC2
Reading conventions	<p>Symbols used in this manual have the following meanings:</p> <div><div></div><div><p>Attention! Warns of the risk of material damage.</p></div></div> <div><div></div><div><p>Caution! Warns of the possibility of serious damage and slight injury.</p></div></div> <div><div></div><div><p>Warning! Indicates the risk of major damage to property, or serious or fatal injury.</p></div></div> <div><div></div><div><p>Draws your attention to interesting tips and supplementary information.</p></div></div>

For greater clarity, the name of the current chapter is shown in the header of the left-hand page and the name of the current section in the header of the right-hand page. This does not apply to pages at the start of a chapter and empty pages at the end of a chapter.

1 Display system

Intended users	<p>The display system must only be installed and connected up by trained electricians or other persons who are familiar with the installation of electrical equipment.</p> <p>Specialist electrical training is needed for commissioning and creating circuit diagrams. When active components such as motors or pressure cylinders are controlled, parts of the system can be damaged and persons put at risk if the display system is connected or programmed incorrectly.</p>
Proper use	<p>The display system is a programmable HMI, switching closed-loop and open-loop control device for replacing relay and contactor controls as well as for use as an HMI unit. The display system must be properly installed before use.</p> <p>The display module of the display system is protected to IP 65 and does not normally need any special housing protection. The rear units of the display system are designed as mounting units and must be installed in an enclosure, control cabinet or a service distribution board. Both the power feed and the signal terminals must be laid and covered so as to prevent accidental contact.</p> <p>The installation must comply with regulations for electromagnetic compatibility (EMC).</p> <p>The power up of the display system must not cause any hazards arising from activated devices, such as unexpected motor startups or power ups.</p>

Improper use

The display system should not be used as a substitute for safety-related controls such as burner or crane controls, emergency-stop or two-hand safety controls.

Overview

The display system is an electronic display and operating device as well as a logic relay with the following:

- Logic functions,
- Timing relay and counter functions,
- Time switch functions,
- Arithmetic functions,
- PID controllers,
- Operator and display functions.

The display system is a control and input device rolled into one. The display system allows you to implement many different tasks in domestic applications as well as in machine building and plant construction. The display system is a modular and flexible device.

The integrated CL-NET network allows up to eight CL-NET stations to be connected to a controller. Each CL-NET station can contain a program. In this way, high speed control systems with remote intelligence can be created.

In Terminal mode, the display system can be used to control any device in the network and display data from it. The display system makes its keypad and display available to the other device for use.

Two display systems can be connected simply via the serial interfaces.

Circuit diagrams are connected up using ladder diagrams, and each element is entered directly via the display system display. For example, you can:

- Connect N/O and N/C contacts in series and in parallel
- Connect output relays and markers,
- Define outputs as coils, impulse relays, rising or falling edge-triggered relays or as latching relays,
- Select timing relays with different functions:
 - On-delayed
 - On-delayed with random switching,
 - Off-delayed,

- Off-delayed with random switching,
 - On- and off-delayed,
 - On- and off-delayed with random switching,
 - Single pulse,
 - Synchronous flashing,
 - Asynchronous flashing.
- Use up and down counters,
- Count high-speed signals:
 - Up/down counters with upper and lower limit value,
 - Preset,
 - Frequency counters,
 - High-speed counters,
 - Count incremental encoder values.
- Compare values,
- Display graphics, texts, variables, enter setpoints, display flashing values and graphics, change and replace graphics and texts by pushbutton,
- Process analog inputs and outputs,
- Use 7-day and year time switches,
- Count operating hours (operating hours counter),
- Communicate via the integrated CL-NET network,
- Set up point-to-point communication via the serial interface,
- Implement closed-loop control with P, PI and PID controllers,
- Scale arithmetic values,
- Output manipulated variables as pulse-width modulated signals,
- Run arithmetic functions:
 - Add,
 - Subtract,
 - Multiply,
 - Divide.
- Track the flow of current in the circuit diagram
- Load, save and password-protect circuit diagrams

If you prefer to wire up the display system from a PC, then use the CL-SOFT programming tool. This software is used to create and test your circuit diagram on the PC. All display and operator functions on the display system device are created exclusively using CL-SOFT. CL-SOFT enables you to print out your circuit diagram in DIN, ANSI or CL format.

Device overview

Display system devices at a glance

Display module

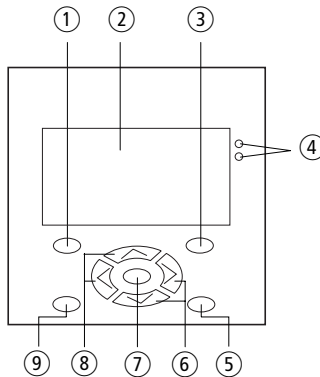


Figure: 1: Display module device overview

- ① DEL button
- ② Graphic display
- ③ ALT button
- ④ LEDs for signalling
- ⑤ Mode button
- ⑥ Right, down cursor buttons
- ⑦ OK button
- ⑧ Left, up cursor buttons
- ⑨ ESC button

Display base module

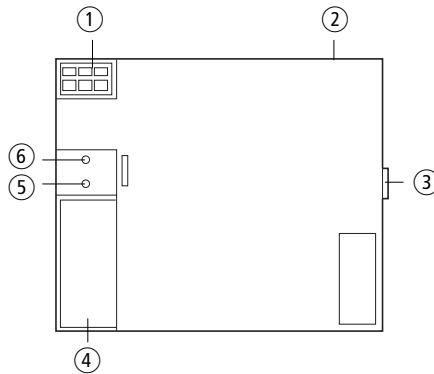


Figure 2: Device overview of display base module

- ① Supply voltage
- ② CL-NET terminals
- ③ CL-LINK terminal
- ④ Interface for memory module, PC and point-to-point connection
- ⑤ Power supply/operating mode LED
- ⑥ CL-NET LED

Display I/O module

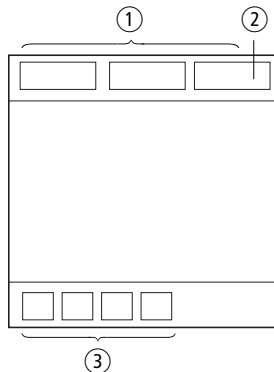


Figure 3: Device overview of display I/O module

- ① Inputs
- ② Analog output (optional)
- ③ Outputs

Operating the display system



Keypad

- DEL:** Delete object in circuit diagram
- ALT:** Special functions in circuit diagram, status display
- Cursor buttons** < > ^ v:
 - Move cursor
 - Select menu items
 - Set numbers and values
- OK:** Next menu level, Save your entry
- ESC:** Previous menu level, Cancel
- *:**
 - Toggle between visualization display and status display
 - Close Terminal mode



In visualization applications, the keypad of the operating unit can be used for other functions than the ones stated above. In this case the buttons are assigned the function selected in the application. The standard button functions are only restored when you leave the application.

Selecting menus and entering values

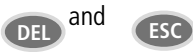
- DEL** and **ALT**: Show system menu
- OK**:
 - Move to next menu level
 - Call menu item
 - Activate, change, store entries
- ESC**:
 - Move to previous menu level
 - Cancel entries since last **OK**



- ^ v Change menu item
- < > Change value
- Change digit

P button function:

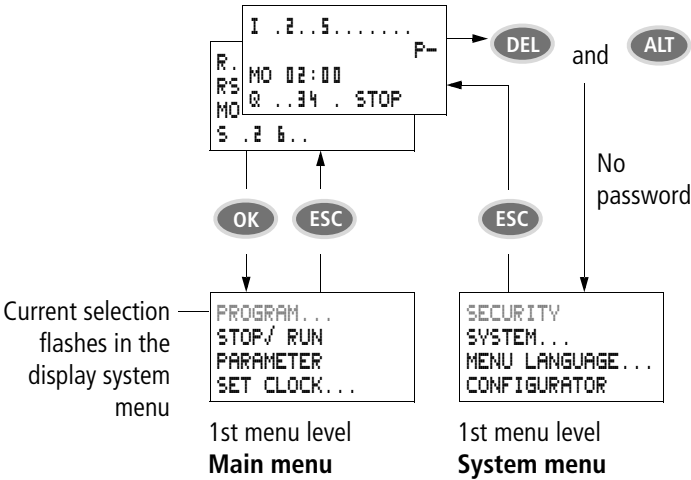
- | | | | |
|---|----------|---|----------|
| < | Input P1 | ^ | Input P2 |
| > | Input P3 | v | Input P4 |



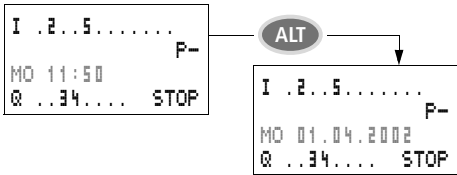
Reset the display system display

Selecting main and system menu

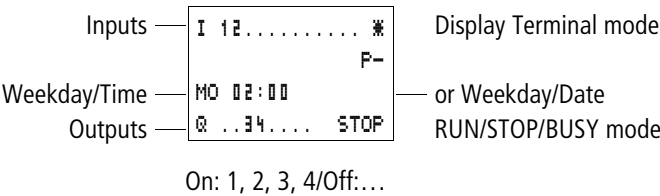
Status display



Date display



Status display display system



Status display for local expansion

Inputs	—	R 1 12	—	AC expansion ok/P buttons
Expansion device	—	RS AC P-	—	or Weekday/Date
Weekday/Time	—	MO 10:42		
Outputs	—	S 1 0 STOP		

On: 1, 2, 3, 4/Off:...

RS = Expansion functioning correctly

Advanced status display

Retention/debounce	—	I 12 . . . 6 . 09 . . 12	—	AC expansion ok/P buttons
CL-NET station	—	RE I NT1 AC P-	—	Startup behaviour
		MO 14:42 T		
		@ 12345678 RUN		

RE : Retention switched on

I : Debounce switched on

NT1 : CL-NET station with station address

COM COM connection active

AC : AC expansion functioning correctly

DC : DC expansion functioning correctly

GW : Bus coupling module detected

GW flashing: Only CL-LEC.CI000 detected. I/O expansion not detected.

ST : When the power supply is switched on, the display system switches to STOP mode

Display system LED display

The display system is provided with two LEDs on the rear of the CL-LDC.L... display base module. These indicate the status of the power supply (POW) and the RUN or STOP operating mode (→ fig. 1, page 14).

Table 1: Power supply/RUN-STOP mode LED

LED off	No power supply
LED continuously lit	Power supply present, STOP mode
LED flashing	Power supply present, RUN mode

Table 2: LED CL-NET (CL-NET)

LED off	CL-NET not operational, fault, in configuration
LED continuously lit	CL-NET is initialized and no station has been detected.
LED flashing	CL-NET in fault-free operation

One green and one red LED are located on the front of the CL-LDD... display module. These LEDs can be used in your visualization application as indicator lights.

The following applies to Terminal mode:

Green LED

Table 3: Power supply/RUN-STOP mode LED

LED off	No power supply
LED continuously lit	Power supply present, STOP mode
LED flashing	Power supply present, RUN mode

Red LED

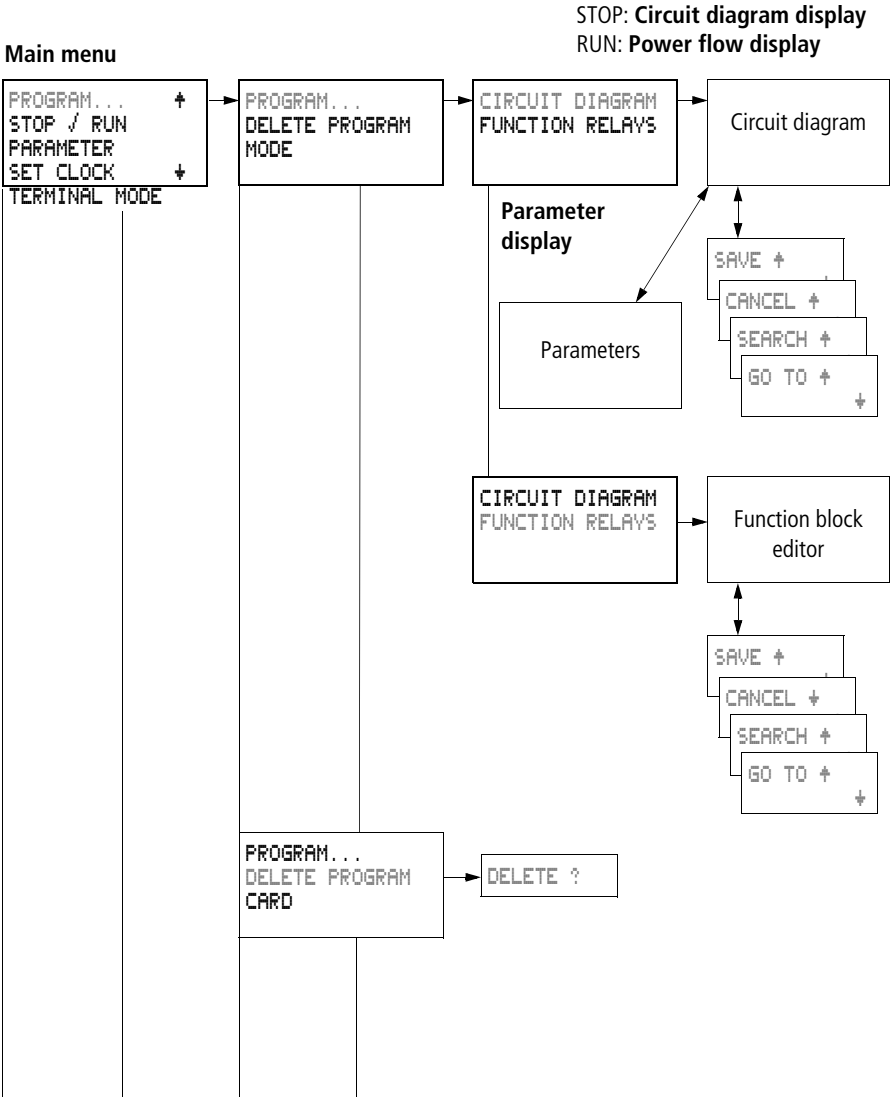
Table 4: Fault in CL-NET

LED off	Operation correct
LED continuously lit	CL-NET remote device faulty

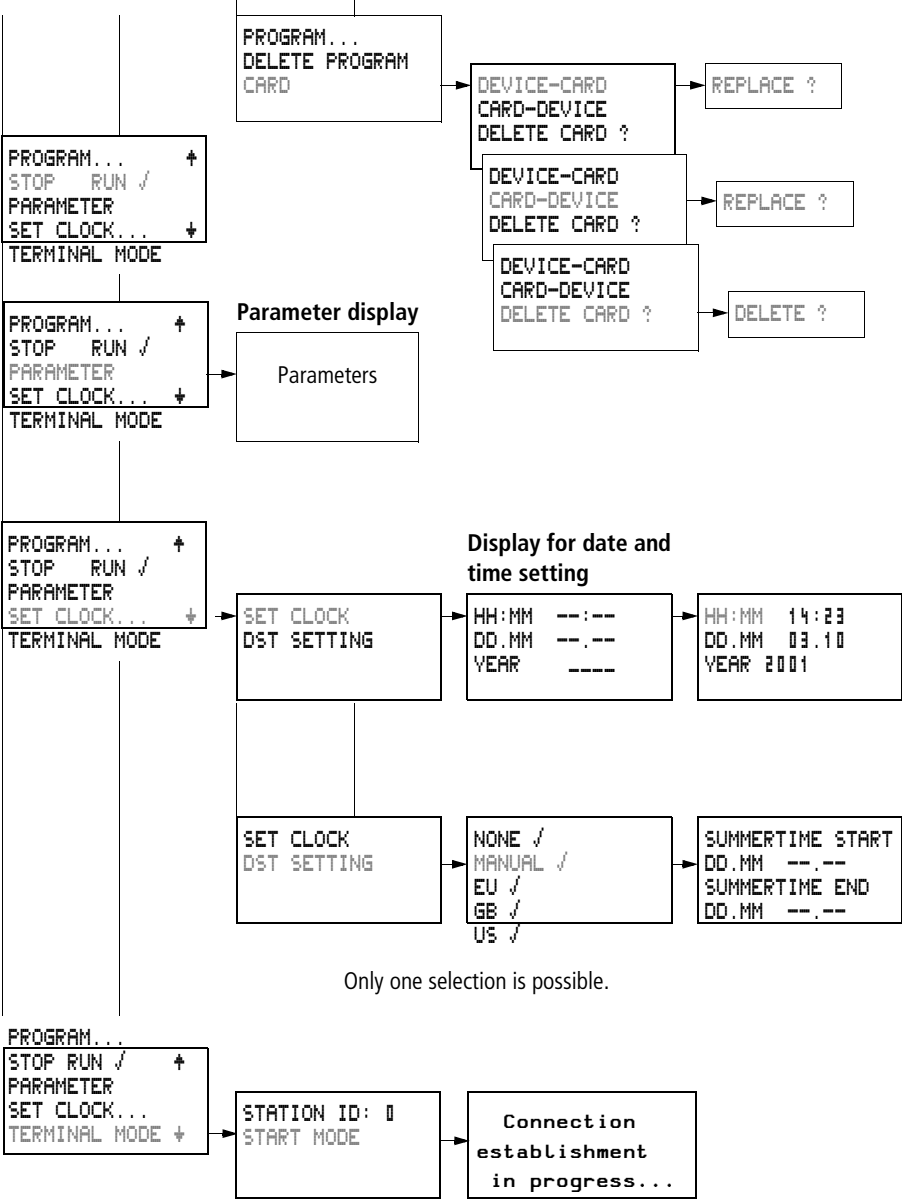
Menu structure

Main menu without password protection

► You access the main menu by pressing OK.

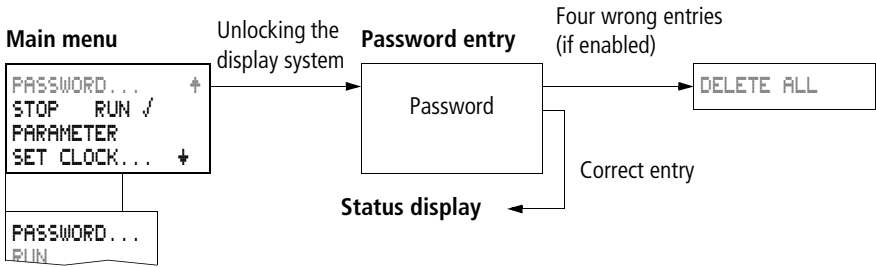


Main menu



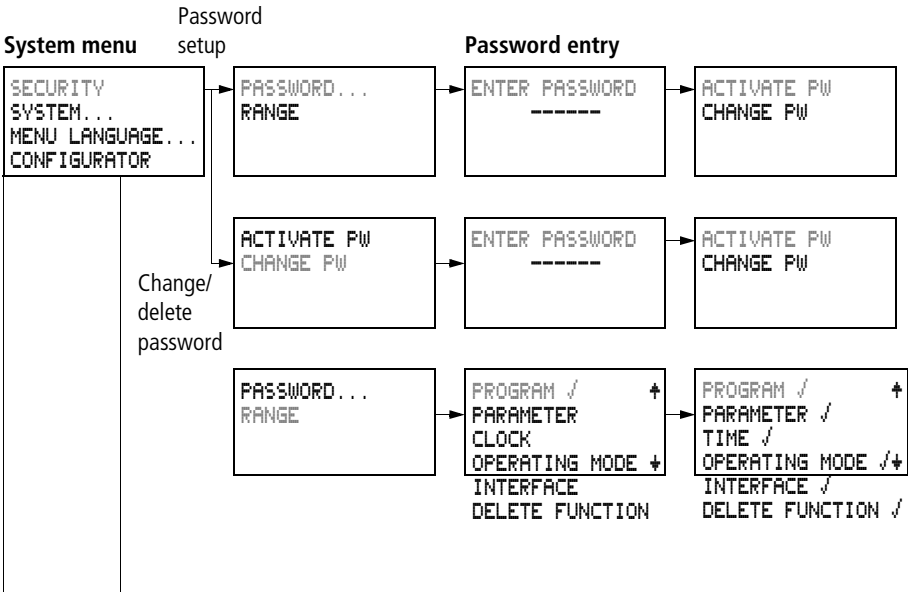
Only one selection is possible.

Main menu with password protection

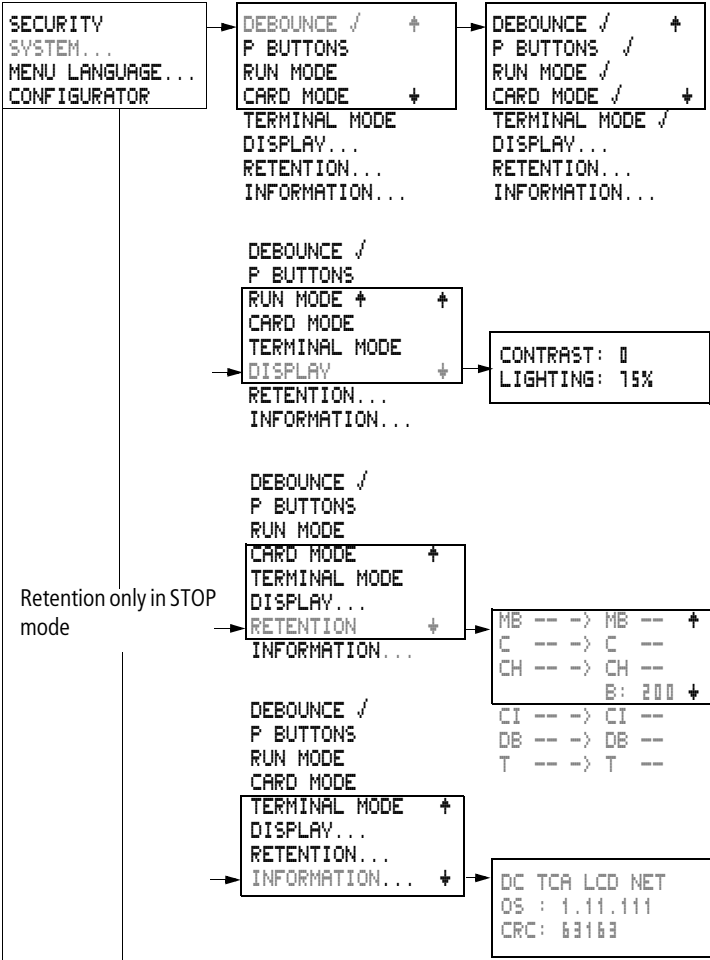


System menu display system

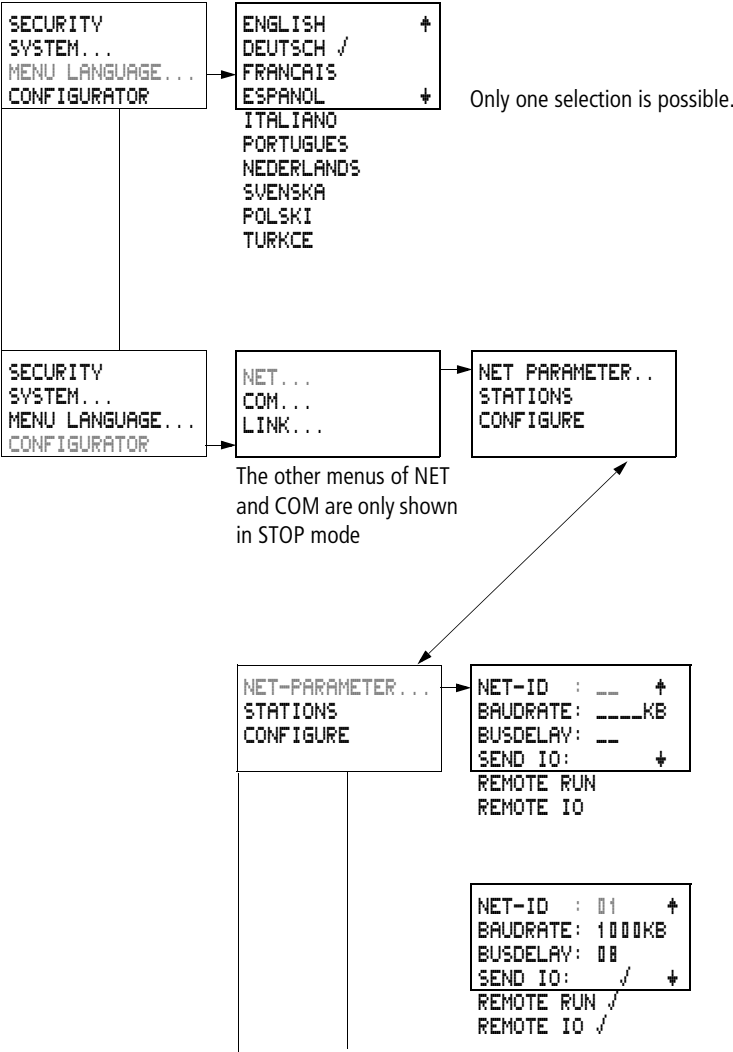
► The system menu is accessed by simultaneously pressing **DEL** and **ALT**.



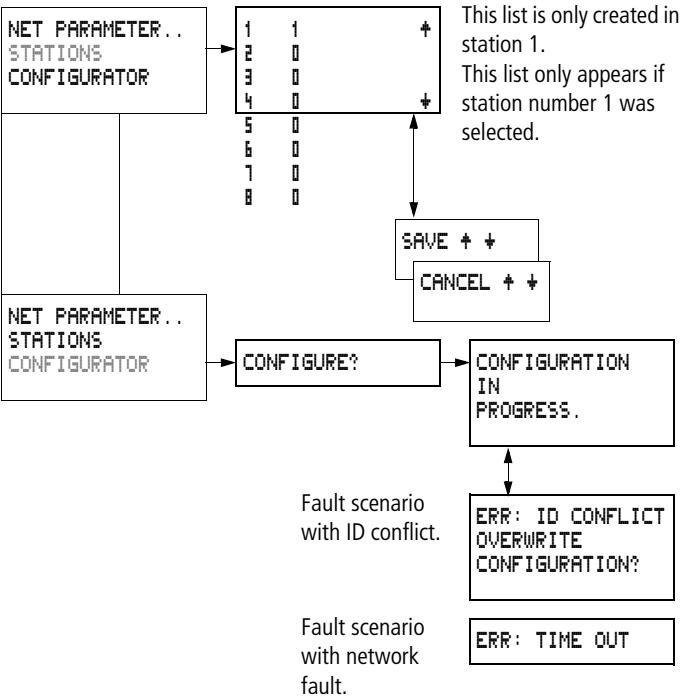
System menu



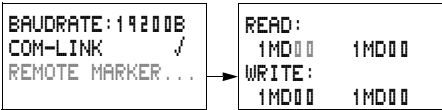
System menu



System menu

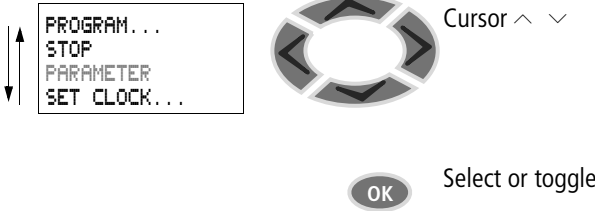


System menu

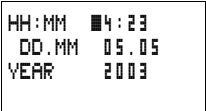


This menu only appears if COM-LINK was selected.

Selecting or toggling between menu items



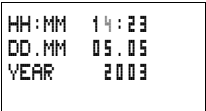
Cursor display



The cursor flashes.

Full cursor /:

- Move cursor with < > ,
- In circuit diagram also with ^ v

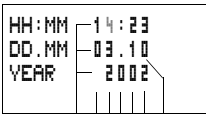


Value M/M

- Change position with < >
- Change values with ^ v

Flashing values/menus are shown in grey in this manual.

Setting values



Values

Digits

Value at digit



Select value ^ v

Select digit < >

Change value at digit ^ v



Store entries



Retain previous value

2 Installation

The display system must only be installed and connected up by trained electricians or other persons who are familiar with the installation of electrical equipment.



Danger of electric shock!

Never carry out electrical work on the device while the power supply is switched on.

Always follow the safety rules:

- Switch off and isolate,
- Ensure that the device is no longer live,
- Secure against reclosing,
- Short-circuit and ground,
- Cover adjacent live parts.

The display system is installed in the following order:

- Mounting,
- Wiring up the inputs
- Wiring up the outputs,
- Wiring up the CL-NET network (if required),
- Setting up the serial interface (if required),
- Connecting the power supply.

Mounting

Install the display module in the front of a control cabinet, a service distribution board, operator panel or in an enclosure. Install the display base module and the display I/O module so that all connections are protected against direct contact, liquid and dust.

If you are running the display system without a display module, snap it onto an IEC/EN 60715 top-hat rail or fasten it with fixing brackets. The display system can be mounted horizontally or vertically.



When using the display system with expansion units, connect the expansion concerned before mounting (→ page 46).

For ease of wiring, leave a gap of at least 3 cm between the display system terminals and the wall or adjacent devices.

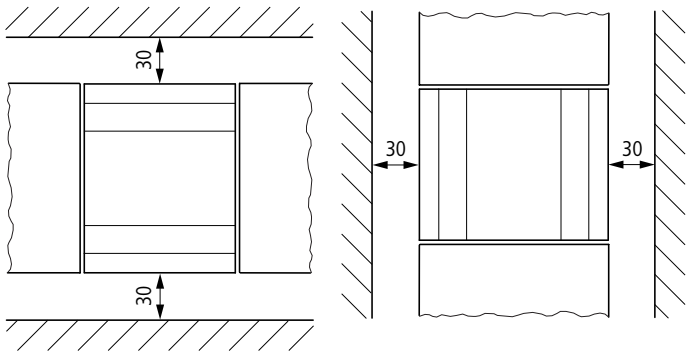


Figure: 4: Clearances to the display system

Mounting the protective cover CL-LAD.FD001

For special applications such as in the food industry, the operating unit must be protected against the ingress of dust, liquids etc.

Use the appropriate protective cover CL-LAD.FD001.

Fit the CL-LAD.FD001 protective cover before mounting the display module.

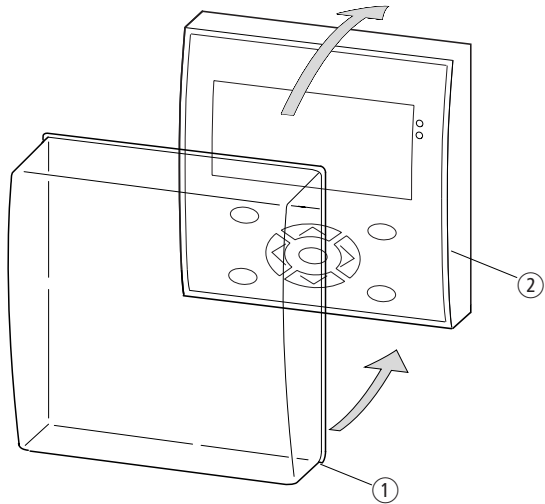


Figure: 5: Fitting the CL-LAD.FD001 protective cover

- ① Protective cover CL-LAD.FD001
- ② Display module

► Fit the protective cover over the display module.



Caution!

Ensure that the CL-LAD.FD001 protective cover is fitted in the groove all round the display module.

Otherwise a proper seal cannot be guaranteed and particles may enter underneath the protective cover. This may cause malfunctions in the keypad.

In food industry applications, there is the risk of bacteria building up underneath the protective cover.

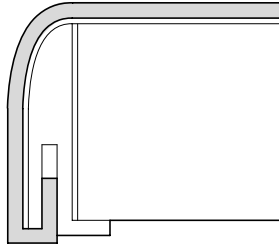


Figure: 6: Correct position of the CL-LAD.FD001 protective cover



Remove the display module in order to replace the CL-LAD.FD001 protective cover. Replace the protective cover and remount the device.

Mounting the protective cover CL-LAD.FD011

The CL-LAD.FD011 protective cover is provided for using the device in aggressive environments. This protects the display and the operating unit against mechanical damage or destruction. Protection to IP65 is maintained.

The protective cover CL-LAD.FD011 can be opened so that the operating unit can be used.

The protective cover CL-LAD.FD011 can be closed with a sealing facility to provide protection against unauthorised operation.

Fit the CL-LAD.FD001 protective cover before mounting the display module.

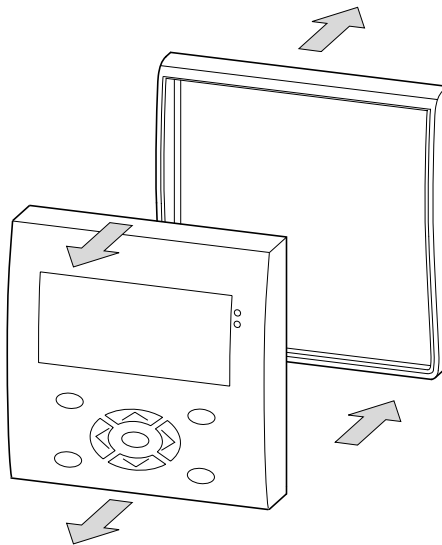


Figure 7: Removing the front frame

► Remove the front frame as shown in the figure.

The protective cover CL-LAD.FD011 can be mounted in two different positions. Choose the position that is most suitable for the application at hand and your requirements.

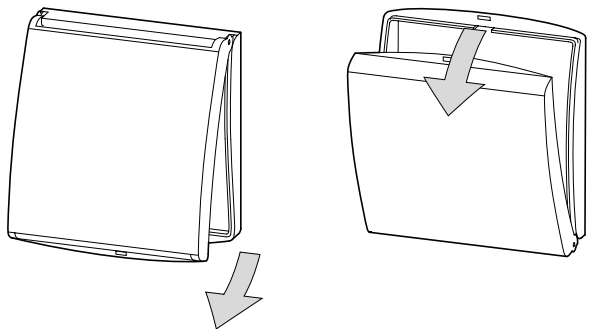


Figure 8: Position of the protective cover CL-LAD.FD011

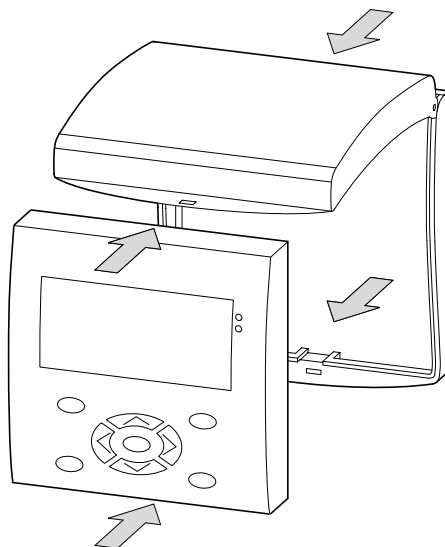


Figure: 9: Mounting the CL-LAD.FD011 protective cover

- Mount the protective cover CL-LAD.FD011 as shown in the figure.

Sealing the protective cover CL-LAD.FD011

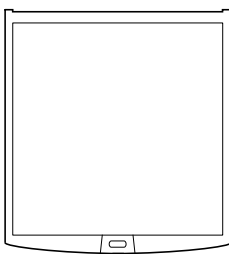


Figure: 10: Sealing the protective cover CL-LAD.FD011

The grip handle of the protective cover is provided with holes that can be used in any mounting position. You can fit a wire or similar material through these holes in order to seal the cover. If the wire is provided with a lead seal, the cover is sealed. The cover can then only be opened by breaking the seal or the wire.

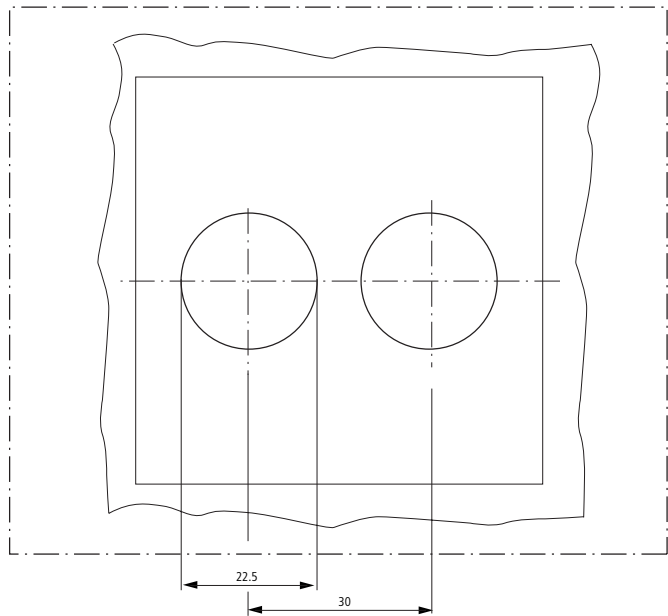
Mounting of the display module (flush mounting)

Figure: 11: Drill holes of the display system

- Drill and punch out two 22.5 mm diameter holes. The diameter is the same as is normally required for control circuit devices.



Observe the following technical requirements:

- The hole spacing is 30 mm.
- The maximum thickness of the front plate for mounting the display base module must not exceed 6 mm.
- The maximum thickness of the front plate for mounting an expansion unit with a top-hat rail in addition to the display base module must not be more than 4 mm.
- Leave enough space at the side for the display base module and, if necessary, the expansion unit.
- In order to ensure protection to IP 65, the surface of the mounting front must be even and smooth.

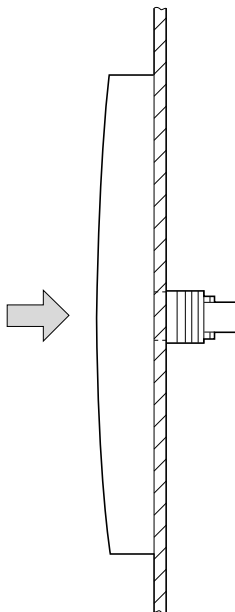


Figure: 12: Mounting display module

The CL-LAD.FD001 or CL-LAD.FD011 protective cover must be fitted beforehand!

- Fit the display module in the fixing holes provided.

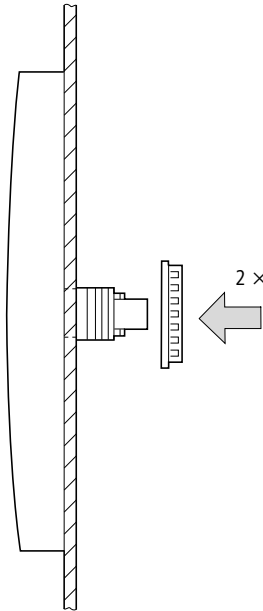


Figure 13: Screw fastening the display module

► Screw fasten the display module

The tightening torque must be between 1.2 and 2 Nm



Ensure that the correct torque is used. If the tightening torque is too low or high, this may impair the seal.

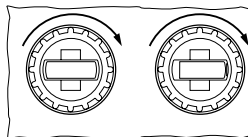


Figure 14: Rear of mounted display module

Removing the display module (flush mounting)

- Unscrew the fixing element and remove the display module.

Mounting the display base module

If you wish to add expansion units to the display base module, the top-hat rail must be fitted beforehand.

Fitting the top-hat rail

Ensure that the cutout of the top-hat rail was prepared for the fixing shafts according to the specified dimensions.

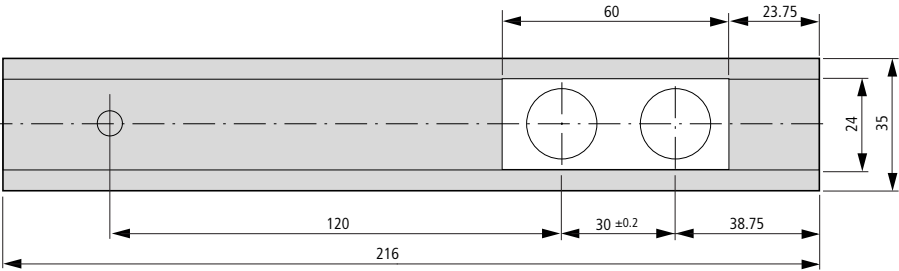


Figure: 15: Top-hat rail with cutout



The two fixing shafts of the display module are mechanically designed for a 2 space unit expansion module.

If you wish to fit wider expansion units, the top-hat rail must be supported at a third support point.

This third support point should be located in the area 216 mm from the end of the device. It should not be possible to twist the top-hat rail.



Caution!

The fixing shafts of the display/operating unit are designed for mounting the expansion units. Other devices such as contactors must not be mounted on this top-hat rail.

Attach the expansion unit before fitting the top-hat rail.

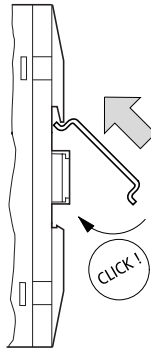


Figure 16: Fitting the top-hat rail

- ▶ Fit the top-hat rail in the groove using the slide catch of the power supply/CPU module and the expansion unit.
- ▶ Turn the top-hat rail towards the housing.
- ▶ Let the top-hat rail snap into position.
- ▶ Press the display base module onto the fixing shaft.

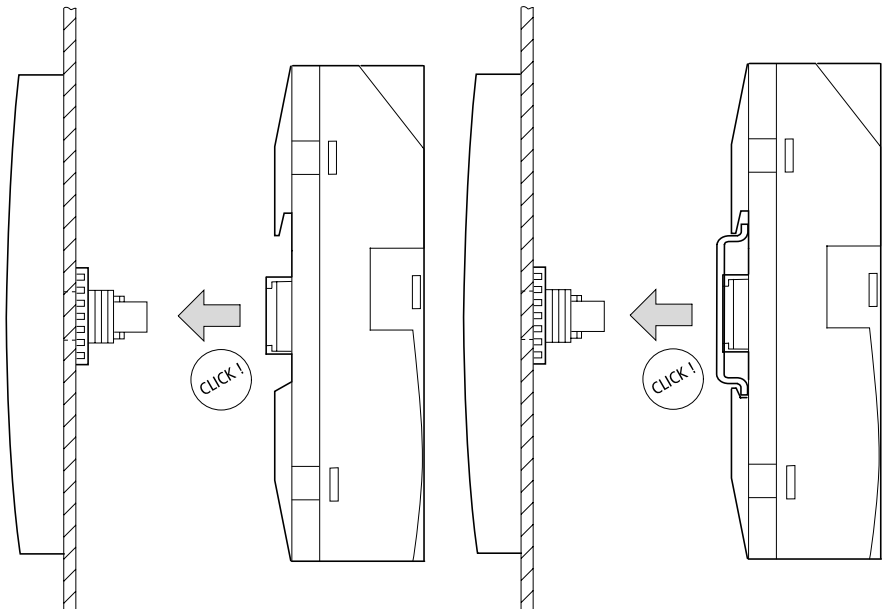


Figure 17: Display base module with and without top-hat rail

Mounting the display I/O module onto the display base module

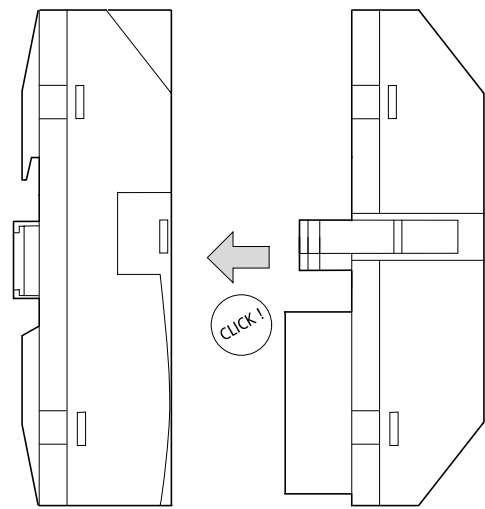


Figure: 18: Fitting the display I/O module



The display I/O module can be mounted onto the fixing shaft before or after the display base module is mounted.

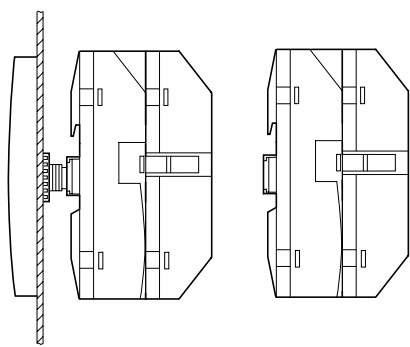


Figure: 19: Display base with display I/O module

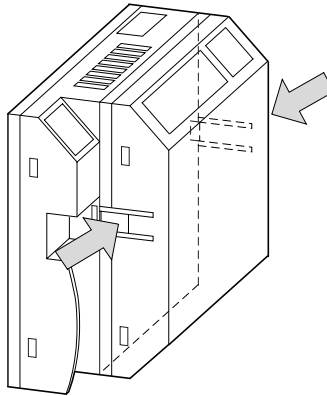
Removing the display module (flush mounting)

Figure 20: Unlocking the display I/O module

- Press the two catches together.
- Pull one side out of the catch.
- Pull the other side out of the second catch.

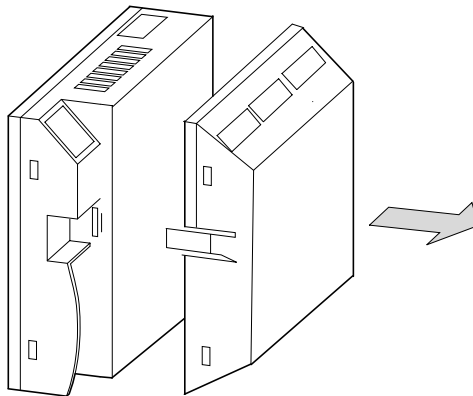


Figure 21: Removing the display I/O module

- Pull off the display I/O module.

Removing the display base module

The display base can be removed with or without the display I/O module



If there is another fixing point for the top-hat rail that is apart from the one for the display module, undo it.

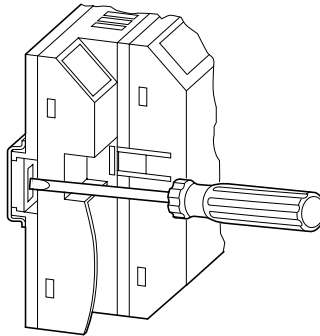


Figure: 22: Releasing the fixing shaft

Use a screwdriver with a 100×3.5 mm slot width.

- Insert the screwdriver into the lug of the fixing shaft catch.
- Lever out the slide catch.
- Pull out the display base module from the fixing shafts.

Mounting on top-hat rail

The display base module can be mounted without a display module on a top-hat rail.

The fastening catches must be removed in order to mount the device on a fastened top-hat rail.

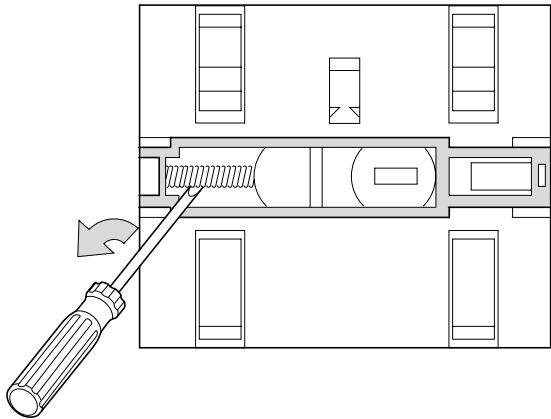


Figure: 23: Removing the spring

- Remove the spring with a screwdriver.

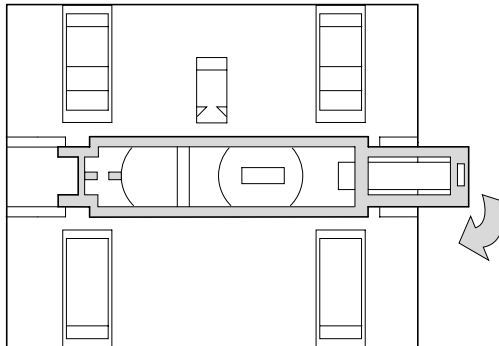
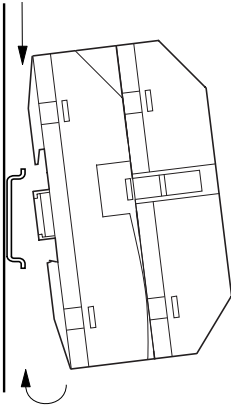


Figure: 24: Pulling the slide catch and removing

- Pull the slide catch out of the guide and remove it.



- Slightly push the display system down and against the top-hat rail until it also snaps onto the top lip of the top-hat rail. Slightly push the device down and against the top-hat rail until it also snaps onto the bottom lip of the rail.

The display system will clip into place automatically.

- Check that the device is seated firmly.

The device is mounted vertically on a top-hat rail in the same way.

Screw mounting

Fixing brackets that can be inserted on the rear of the display system are required for screw mounting. The fixing brackets are available as an accessory. The display base module can be screw fastened without the display module.

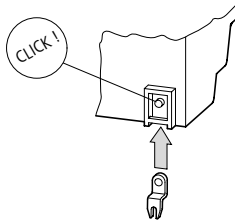


Figure: 25: Inserting a fixing bracket



Three fixing brackets are sufficient for a device with four fixing points.

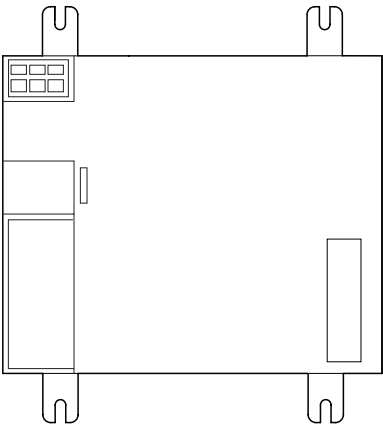


Figure: 26: Screw mounting the display system

CL-LER.20,
CL-LEC.CI000:

CL-LER.18AC2, CL-LER.18DC2,
CL-LET.20DC2:

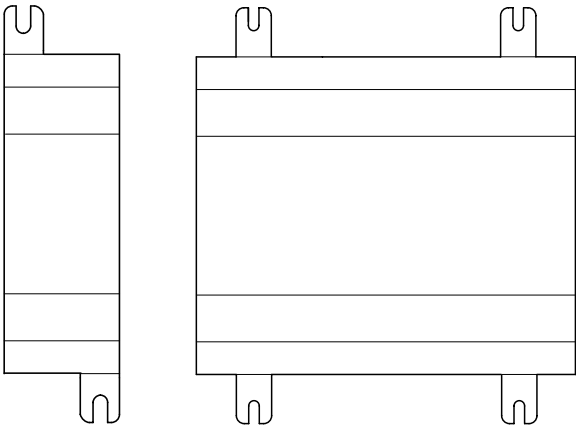


Figure: 27: Screw mounting the logic relay expansion

Connecting the expansion device

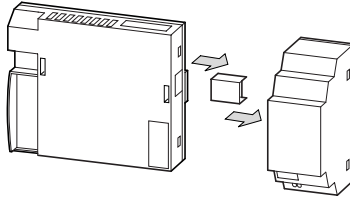


Figure: 28: Connecting expansion units

Terminals

Tool for cage clamp terminals

Slot-head screwdriver, width 3.5 mm × 0.6 mm.

Connection cross-sections of the cage clamp terminal cables for the display system

- Solid: 0.2 to 4 mm² (AWG 24-12)
- Flexible with ferrule: 0.2 to 2.5 mm² (AWG 24-12)

Tool for the screw terminals of the CL expansion

Slot-head screwdriver, width 3.5 × 0.6 mm, tightening torque 0.6 Nm.

Connection cross-sections of screw terminal cables of the CL expansions

- Solid: 0.2 to 4 mm² (AWG 22-12)
- Flexible with ferrule: 0.2 to 2.5 mm² (AWG 22...12)

Network cables and plugs

If possible use the prepared cables CL-LAD.TK002, CL-LAD.TK003, CL-LAD.TK004.

The first and last stations in the network must each be terminated with the CL-LAD.TK009 bus termination resistor.

Connecting the power supply

For the connection data of device types CL-DC2 with 24 V DC and CL-AC2 with standard voltages of 100 V to 240 V AC, refer to chapter "Technical data" page 389.

The display system devices run a system test for one second after the power supply has been switched on. Either RUN or STOP mode will be activated after this time depending on the default setting.

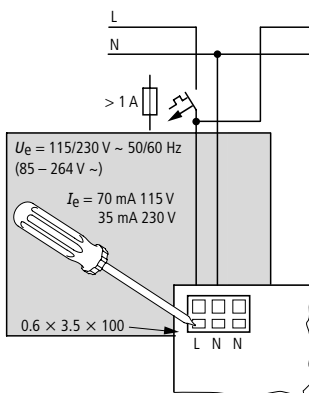
CL-AC2 power supply

Figure: 29: AC power supply on the display system

**Attention!**

A short current surge will be produced when switching on for the first time. Do not switch on the CL-AC2 power supply via reed contacts since these may burn or melt.

CL-AC2 expansion device CL-LER.18AC2

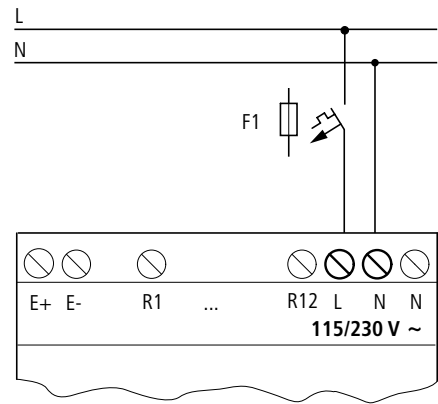


Figure: 30: Power supply on the AC expansion units



Attention!

A short current surge will be produced when switching on for the first time. Do not switch on the CL-AC2 by means of reed contacts since these may burn or melt.

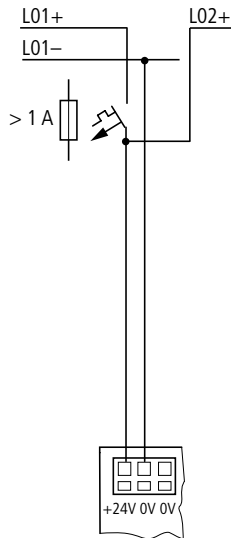
CL-DC2 power supply

Figure: 31: Power supply on the display system

The display base module provides power for the display module, display I/O module, the CL-LINK, optionally the CL-NET and also for itself.



The display base module is protected against reverse polarity. Ensure the correct polarity of the terminals to ensure that the display system functions correctly.

**CL-DC2 expansion devices CL-LER.18DC2,
CL-LET.20DC2**

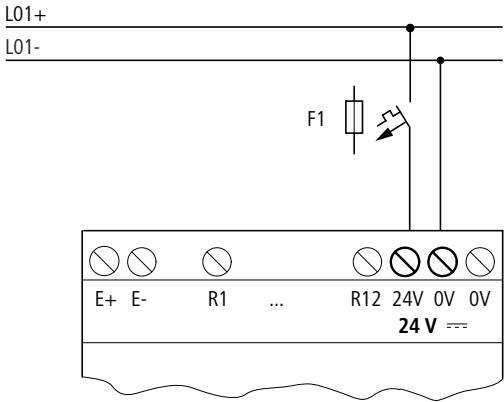


Figure: 32: Supply voltage to DC expansion devices



CL-DC2 is protected against polarity reversal. To ensure that the logic relay works correctly, ensure that the polarity of each terminal is correct.

Cable protection

Connect a cable fuse protection (F1) of at least 1 A (slow) to the CL-AC2 and CL-DC2 as well as to the display base module.



On initial power up both the logic relay and the display base module act as a capacitor. Use a suitable device for switching on the power supply and do not use any reed relay contacts or proximity switches.

Connecting inputs

The inputs of the logic relay or display system switch electronically. Once you have connected a contact via an input terminal, you can reuse it as a contact in the display system circuit diagram as often as you like.

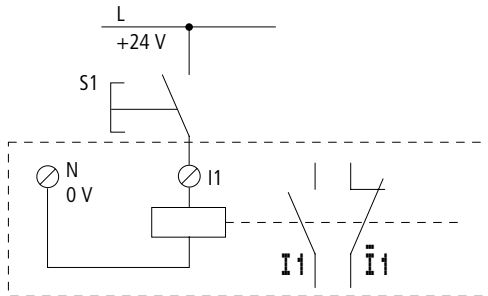


Figure: 33: Connecting inputs

Connect contacts to the input terminals of the logic relay or display system, e.g. pushbutton actuators or switches

Connecting AC display I/O modules



Caution!

Connect the inputs for AC in accordance with the safety regulations of VDE, IEC, UL and CSA with the same phase conductor that provides the power supply voltage. Otherwise the device will not detect the switching signal or may be destroyed by the overvoltage.

AC display system

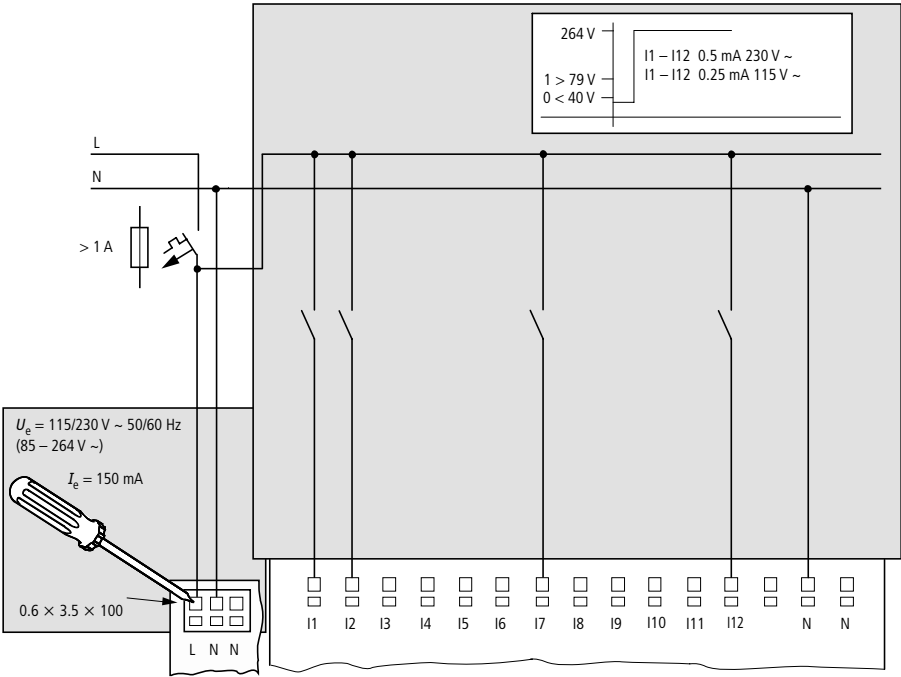


Figure: 34: Connecting inputs



Warning!

The AC display I/O modules must only be used with the devices CL-LDC.LAC2 and CL-LDC.LNAC2. Other devices may be destroyed.

AC expansion device CL-LER.18AC2

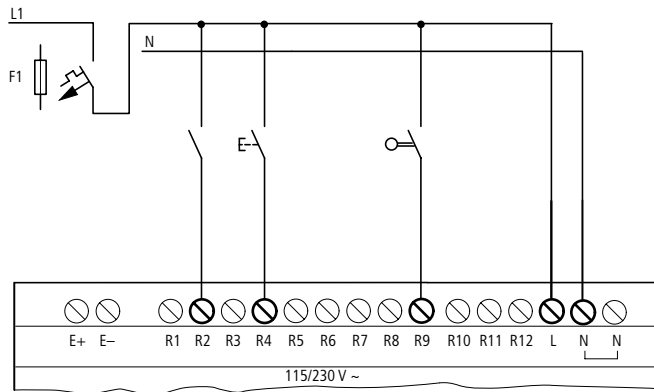


Figure: 35: Inputs on the CL-LER.18AC2 expansion device

Connect the inputs, for example, to pushbutton actuators, switches or relay/contacter contacts.

Input signal voltage range

- Off signal: 0 to 40 V
- On signal: 79 to 264 V

Input current

- I1 to I12 0.5 mA/0.2 mA at 230 V/115 V
- R1 to R12 0.5 mA/0.25 mA at 230 V/115 V

Cable lengths

Severe interference can cause a signal 1 on the inputs without a proper signal being applied. Observe therefore the following maximum cable lengths:

- I1 to I2 and
- R1 to R12: 40 m without additional circuit

The following applies to the expansion devices:
With longer cables you can connect a diode (e.g. 1N4007) with 1 A, minimum blocking voltage in series to the input of the expansion device. Ensure that the diode is connected in relation to the input as shown in the circuit diagram, otherwise the logic relay will not detect the signal 1.

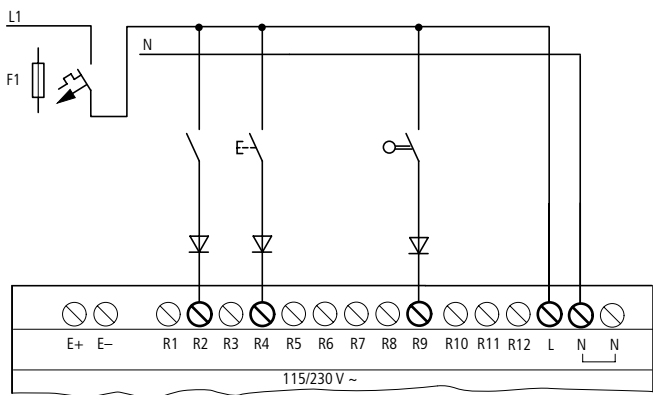


Figure: 36: CL-AC2 with a diode on the inputs

Two-wire proximity switches have a residual current in the state 0. If this residual current is too high, the logic relay input may only detect a signal 1.

If inputs with a higher input current are required, an additional input circuit must be used.

Increasing the input current

The following input circuit can be used in order to prevent interference and also when using two-wire proximity switches:

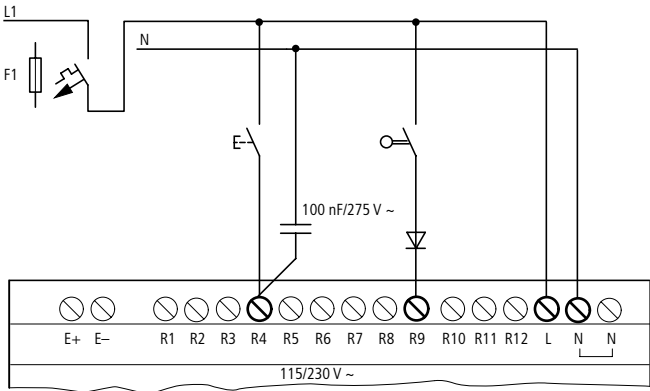


Figure: 37: Increasing the input current



When using a 100 nF capacitor, the drop-out time of the input increases by 80 (66.6) ms at 50 (60) Hz.

A resistor can be connected in series with the circuit shown in order to restrict the inrush current.

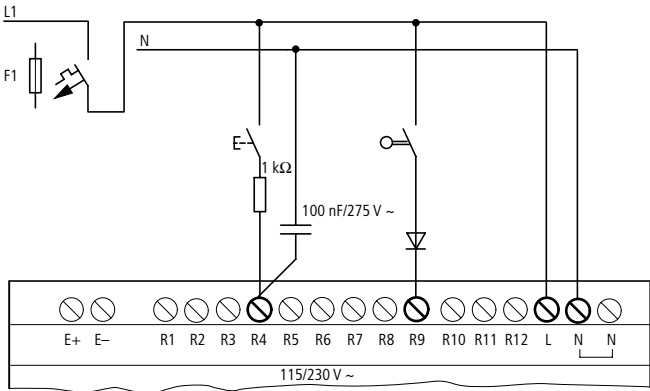


Figure: 38: Limitation of the inrush current with a resistor

Connecting DC display I/O modules

Use input terminals I1 to I12 to connect pushbutton actuators, switches or 3 or 4-wire proximity switches. Do not use any 2-wire proximity switches due to the high residual current.

Input signal voltage range

- I1 to I6, I9, I10
 - Off signal: 0 to 5 V
 - On signal: 15 to 28.8 V
- I7, I8, I11, I12
 - Off signal: < 8 V
 - On signal: > 8 V

Input current

- I1 to I6, I9, I10, R1 to R12: 3.3 mA at 24 V
- I7, I8, I11, I12: 2.2 mA at 24 V

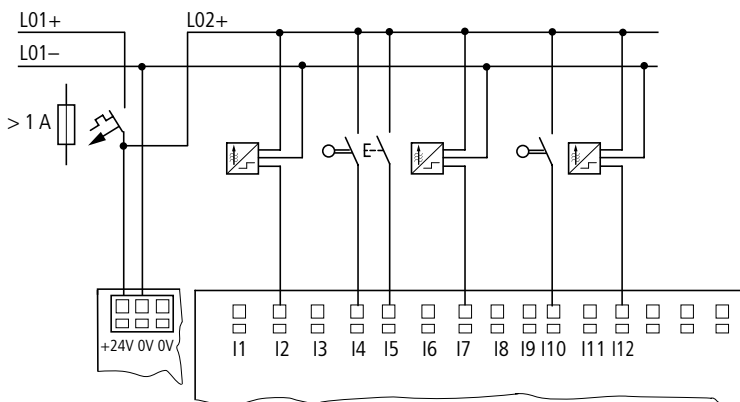


Figure: 39: DC display I/O module



The digital inputs must be fed with the same voltage as the power supply of the display base module.

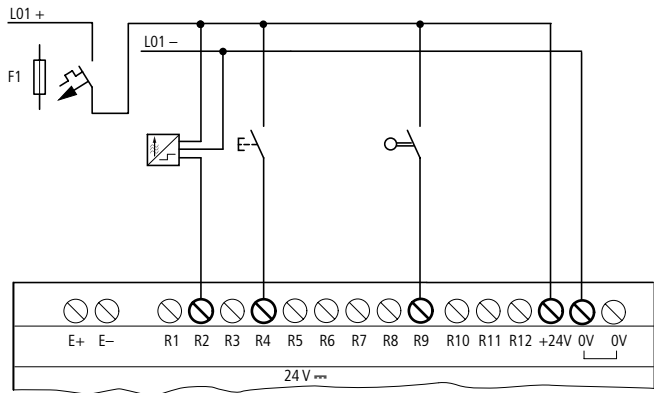


Figure: 40: CL-LER.18DC2, CL-LET.20DC2

Connecting analog inputs

Inputs I7, I8, I11 and I12 can also be used to connect analog voltages ranging from 0 V to 10 V.

The following applies:

- I7 = IA01
- I8 = IA02
- I11 = IA03
- I12 = IA04

The resolution is 10 bits = 0 to 1023.



Caution!

Analog signals are more sensitive to interference than digital signals. Consequently, greater care must be taken when laying and connecting the signal lines. Incorrect switching states may occur if they are not connected correctly.

- Use shielded twisted pair cables to prevent interference with the analog signals.
- With short cable lengths, ground the shield 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 equalisation 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 cables parallel to power cables.
- ▶ Connect inductive loads to be switched via the display system outputs to a separate power feed, or use a suppressor circuit for motors and valves. If loads such as motors, solenoid valves or contactors are operated with display system via the same power feed, switching may result in interference on the analog input signals.

The following circuits contain examples of applications for analog value processing.



Ensure that the reference potential is galvanically connected. Connect the 0 V of the power supply unit for the setpoint potentiometers and various sensors shown in the examples with the 0 V of the display system power supply.

Setpoint potentiometer

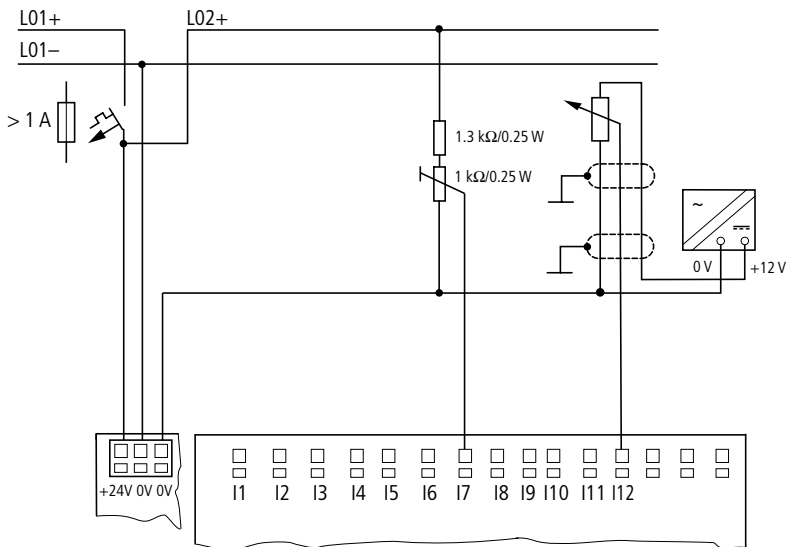


Figure: 41: Setpoint potentiometer with upstream resistor

Use a potentiometer with a resistance of $\leq 1 \text{ k}\Omega$, e.g. $1 \text{ k}\Omega$, 0.25 W .

Temperature sensor, brightness sensor, 20 mA sensor

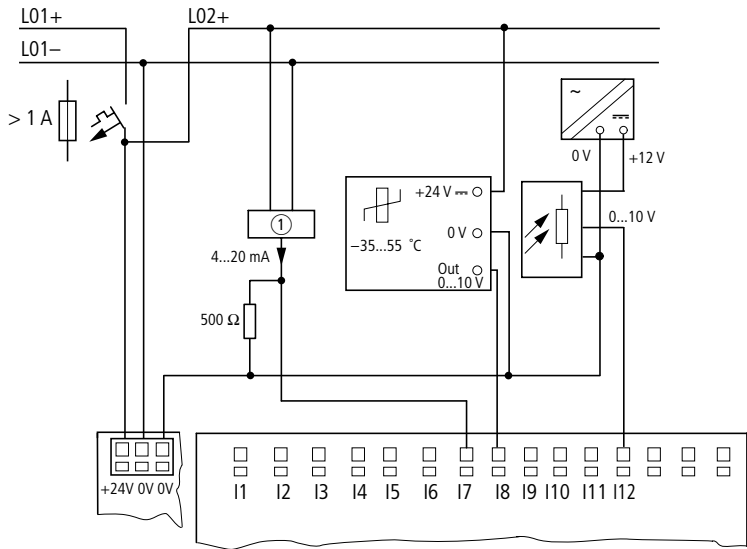


Figure: 42: Temperature sensor, brightness sensor, 20 mA sensor

4 to 20 mA (0 to 20 mA) sensors can be connected easily without any problem using an external 500 Ω resistor.

The following values apply:

- 4 mA = 1.9 V
- 10 mA = 4.8 V
- 20 mA = 9.5 V

(according to $U = R \times I = 478 \Omega \times 10 \text{ mA} \sim 4.8 \text{ V}$)

Connecting high-speed counters and frequency generators

High-speed counter signals on the display system can be counted correctly on inputs I1 to I4 independently of the cycle time.

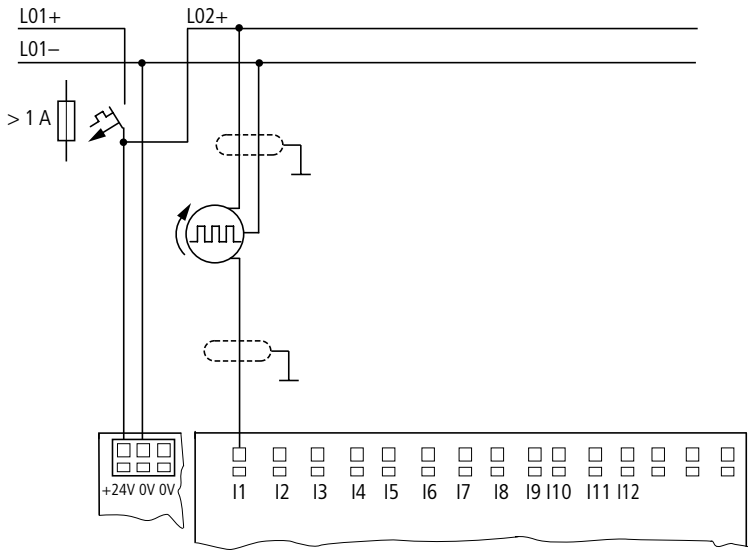


Figure: 43: High-speed counters, frequency generators

Connecting incremental encoders

Inputs I1, I2 and I3, I4 on the display system can each be used for the high-speed counting of an incremental encoder independently of the cycle time. The incremental encoder must generate two 24 V DC square wave signals with a 90° phase shift between them.

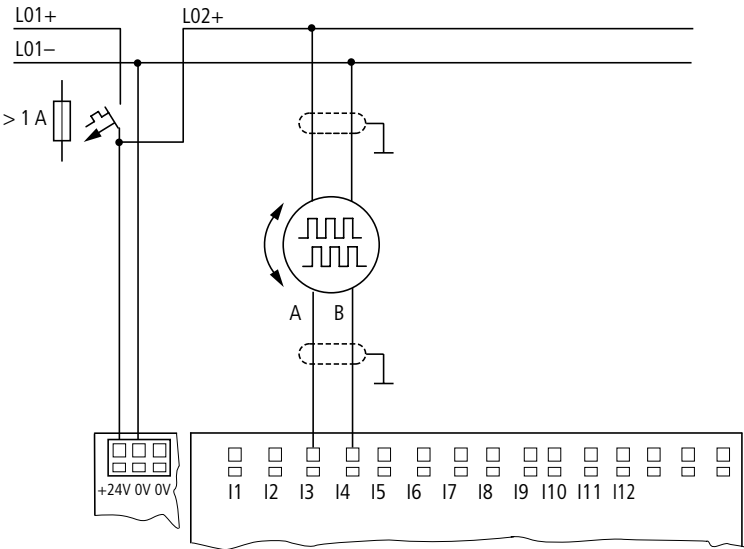


Figure: 44: Connecting incremental encoders

Connecting outputs

The Q... outputs function inside the display system as isolated contacts.

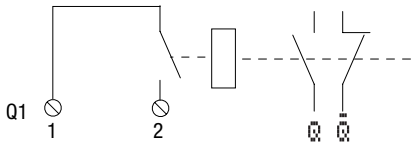


Figure: 45: Output Q

The respective relay coils are actuated in the display system circuit diagram via the output relays Q 01 to Q 04 or S 01 to S 06 (S 08). You can use the signal states of the output relays as N/O or N/C contacts in the display system circuit diagram for additional switching conditions.

The relay or transistor outputs are used to switch loads such as fluorescent tubes, filament bulbs, contactors, relays or motors. Check the technical thresholds and output data before installing such devices (→ chapter „Technical data“,page 389).

Connecting relay outputs CL-LDR...

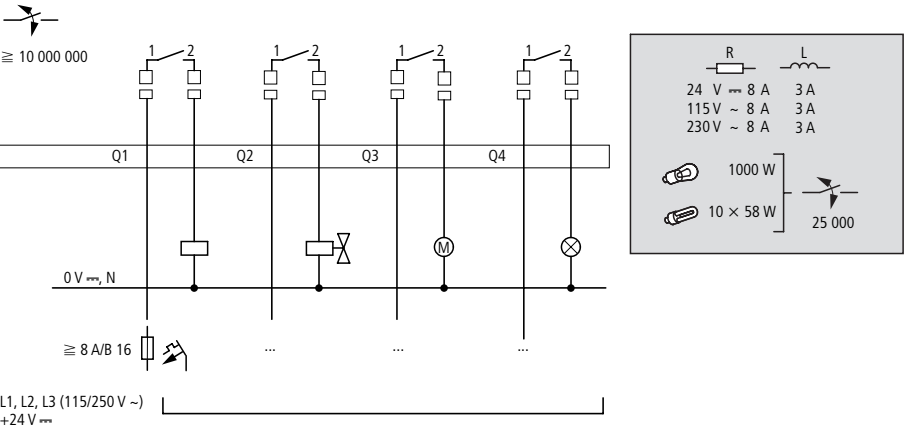


Figure: 46: Relay outputs CL-LDR...

CL-LER.18AC2, CL-LER.20DC2

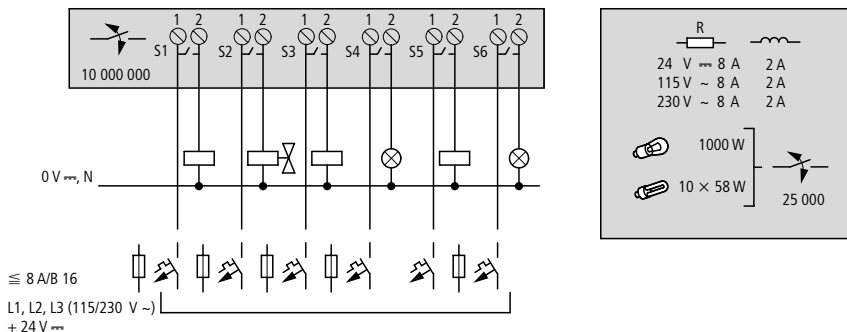


Figure: 47: Relay outputs CL-LER.18AC2, CL-LER.20DC2

CL-LER.20

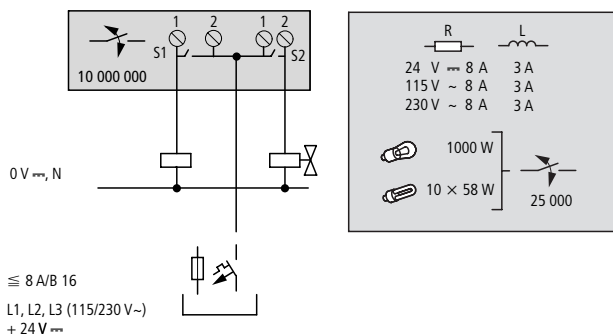


Figure: 48: Relay outputs CL-LER.20

Unlike the inputs, the CL-LDR., CL-LER.18AC2, CL-LER.18DC2 relay outputs can be connected to different phase conductors.



Do not exceed the maximum voltage of 250 V AC on a relay contact. If the voltage exceeds this threshold, flashover may occur at the contact, resulting in damage to the device or a connected load.

Connecting transistor
outputs

CL-LDT...

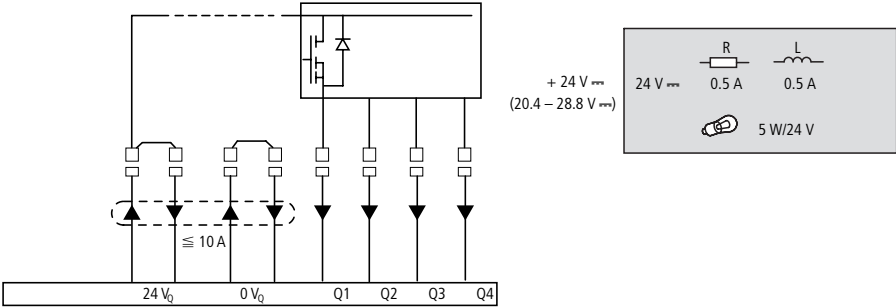


Figure 49: Transistor outputs CL-LDT...

CL-LET.20DC2

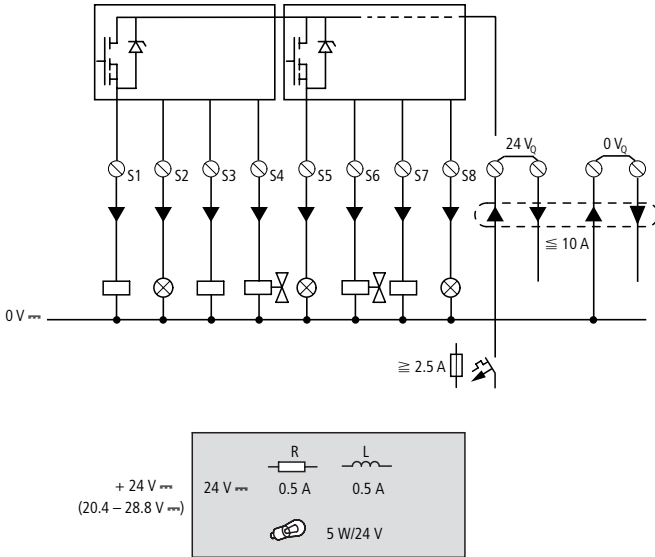


Figure 50: Transistor outputs CL-LET.20DC2

Parallel connection:

Up to four outputs can be connected in parallel in order to increase the output power. This enables a maximum output current of 2 A.



Caution!

Only outputs within a group (Q1 to Q4 or Q5 to Q8, S1 to S4 or S5 to S8) can be switched in parallel; e.g. Q1 and Q3 or Q5, Q7 and Q8. Outputs switched in parallel must be activated at the same time.



Caution!

Note the following when disconnecting inductive loads: Suppressed inductive loads cause less interference in the entire electrical system. For optimum suppression the suppressor circuits are best connected directly in the proximity of the inductive load.

If inductive loads are not suppressed, the following applies: Several inductive loads 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 switched off by means of a contact, and if this would mean switching off more than one controlled output with an inductive load, then you must provide suppressor circuits for these loads (→ the following diagrams).

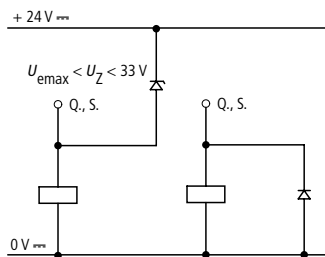


Figure: 51: Inductive load with suppressor circuit

Behaviour in the event of a short-circuit/overload

Should a short circuit or overload occur on a transistor output, this output will switch off. The output will switch back on up to the maximum temperature after a cooling time that depends on the ambient temperature and the current level. If the fault condition persists, the output will keep switching off and on until the fault is corrected or until the power supply is switched off (→ section “Monitoring of short-circuit/overload with CL-LST, CL-LMT and CL-LET”, page 376).

Connecting the analog output

CL-LDR.17DC2 und CL-LDT.17DC2 are each provided with one analog output QA 01, 0 V to 10 V DC, 10-bit resolution (0 to 1023). The analog output allows you to control servo valves and other final controlling elements.

**Caution!**

Analog signals are more sensitive to interference than digital signals. Consequently, greater care must be taken when laying and connecting the signal lines. Incorrect switching states may occur if they are not connected correctly.

Connecting servo valves

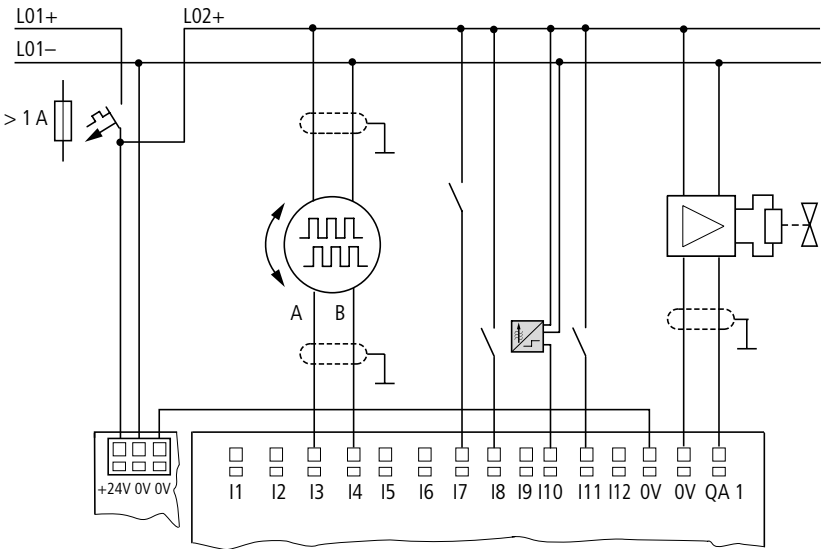


Figure 52: Connecting servo valves

Setpoint entry for a drive

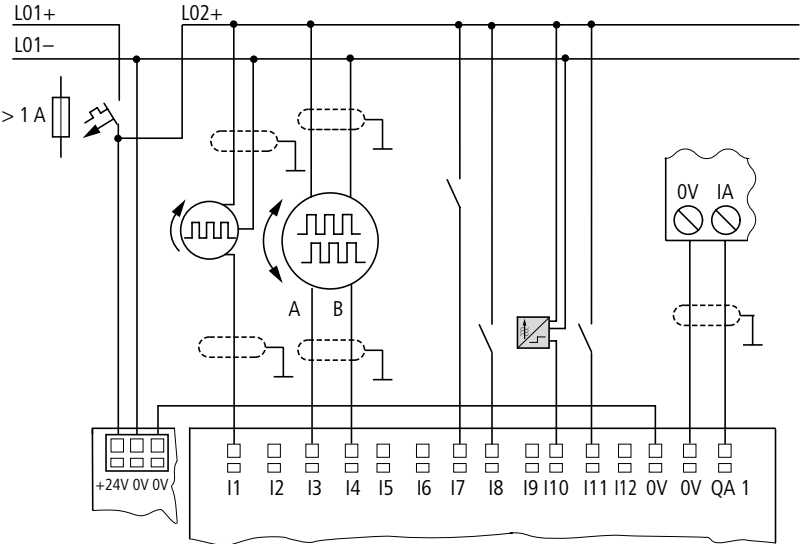


Figure 53: Setpoint entry for a drive

Connecting the CL-NET network

The display system with the network connection (CL-LDC.LNDC2, CL-LDC.LNAC2) can be used for creating the CL-NET network. Up to eight devices can be connected to this network. For further information refer to the chapter “CL-NET network, COM-LINK serial connection”, page 319.

Accessories

Connection plug:

8-pole RJ45

Connection assignment of the RJ45 socket on the device

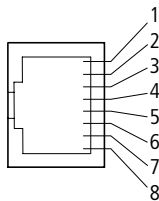


Figure: 54: RJ45 socket

Connecting cable:

4-core, twisted pair; → chapter „Technical data“, page 408

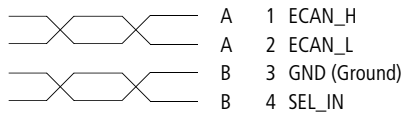


Figure: 55: Connection assignment

ECAN_H data cable, pin 1, cable pair A
ECAN_L data cable, pin 2, cable pair A
Ground cable GND, pin 3, cable pair B
Select cable SEL_IN, pin 4, cable pair B



Minimum operation with CL-NET functions with the cables ECAN_H, ECAN_L and GND. The SEL_IN cable is only used for automatic addressing.

Table 5: Pre-assembled cables, RJ45 plug on both ends

Cable length cm	Type designation
30	CL-LAD.TK002
80	CL-LAD.TK003
150	CL-LAD.TK004

Material for unassembled cables

e.g.: $4 \times 0.18 \text{ mm}^2$

Bus termination resistor

The first and last stations in the network must be provided with a bus termination resistor.

- Value: $124 \, \Omega$
- Termination plug: CL-LAD.TK009

Cable length with cross-sections

For correct operation of the network the cable lengths, cross-sections and cable resistances must match those listed in the following table.

Cable length m	Cable resistance m Ω /m	Cross-section mm ²	AWG
Up to 40	≤ 140	0.13	26
Up to 175	≤ 70	0.25 to 0.34	23, 22
Up to 250	≤ 60	0.34 to 0.5	22, 21, 20
Up to 400	≤ 40	0.5 to 0.6	20, 19
Up to 600	≤ 26	0.75 to 0.8	18
Up to 1000	≤ 16	1.5	16

The impedance of the cables used must be $120 \, \Omega$.



The installation of an expensive fibre optic link is recommended with cable lengths $> 500 \text{ m}$.

Calculating the cable length for a known cable resistance

If the resistance of the cable per unit length is known (resistance per unit length R' in Ω/m), the entire cable resistance R_L must not exceed the following values. R_L depends on the selected baud rate:

Baud rate Kbaud	Cable resistance R_L Ω
10 to 125	≤ 30
250	≤ 25
500 1000	≤ 12

- l_{max} = Maximum cable length in m
- R_L = Total cable resistance in Ω
- R' = Cable resistance per unit length in Ω/m

$$l_{max} = \frac{R_L}{R'}$$

Calculating cross-section with known cable lengths

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

- l = Cable length in m
- S_{min} = Minimum cable cross-section in mm^2
- ρ_{cu} = Resistivity of copper, if not otherwise stated $0.018 \Omega mm^2/m$

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



If the calculation result does not correspond to a standard cross section, take the next higher cross section.

Calculating length with known cable cross-section

The maximum cable lengths are calculated for a known conductor cross-section

l_{\max} = Cable length in m

S = Cable cross-section in mm²

ρ_{Cu} = Resistivity of copper, if not otherwise stated 0.018 $\Omega\text{mm}^2/\text{m}$

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

Plugging and unplugging network cables

The display base module is provided with two RJ45 network sockets.

The socket 1 in the first station is for the bus terminating resistor. For other stations, socket 1 is used for plugging in the incoming cable. Socket 2 is used for the outgoing cable or for the bus termination resistor on the last physical station in the network.

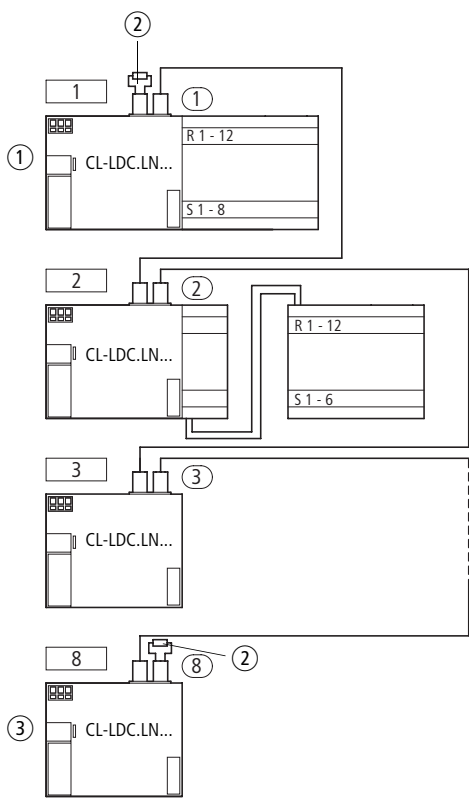


Figure: 56: Bus terminating resistors

- ① First station on the CL-NET network
- ② Bus terminating resistor CL-LAD.TK009
- ③ Last station on the CL-NET network
- Physical location, place
- Station number

Both RJ45 interfaces are visible after the cover plate has been removed.

When a cable is plugged in, the mechanical connection must be audible (click) and visible① .

Before a plug or cable is removed, the mechanical locking feature must be undone②, ③.

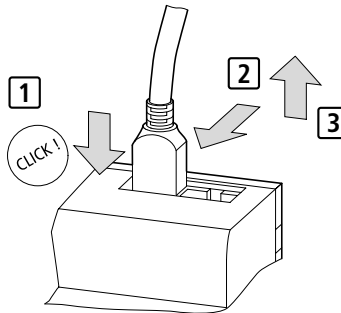


Figure: 57: Plugging and unplugging cables

Connecting the serial interface

The display base module is provided with a multi-function interface. This can be used to set up point-to-point communication between different devices. The interface is also used for connecting the CL-LAD.TK001 connecting cable.

This enables a display system to be connected with another one.

The serial interface must be implemented using special cables.

The standard CL-LAD.TK006 cable is 5 m in length.



The CL-LAD.TK006 cable must not be lengthened in order to ensure compliance with EMC regulations.

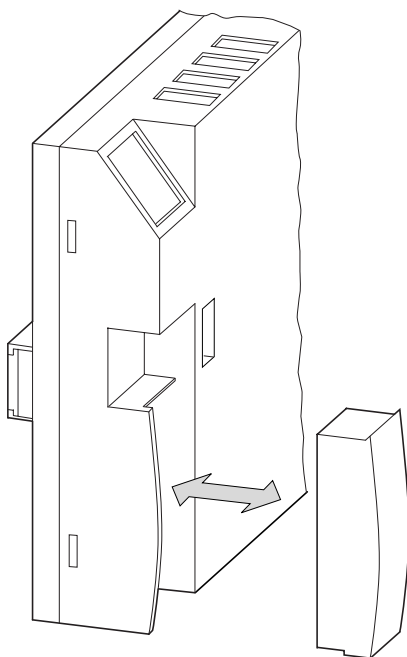


Figure: 58: Fitting/removing the interface cover.

- Remove the interface cover or other plugs from the interface.
- Fit the connection plug in the devices.

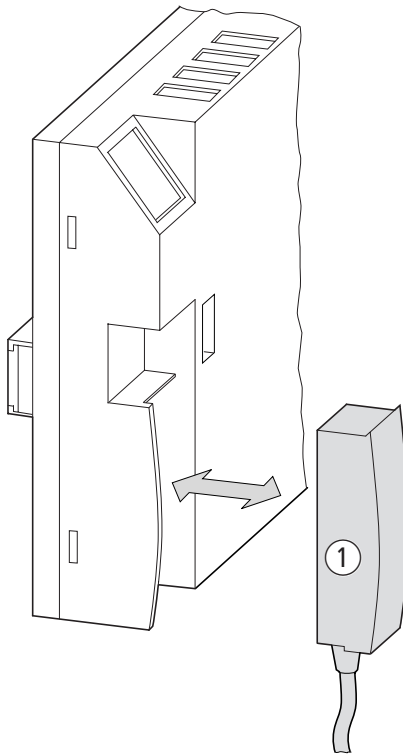


Figure: 59: Connection plug



It must be ensured in all circumstances that the connector with the marking POW-Side is fitted in the interface of the display base module. The serial interface only functions if the display base module is providing the power feed required for the interface cable.

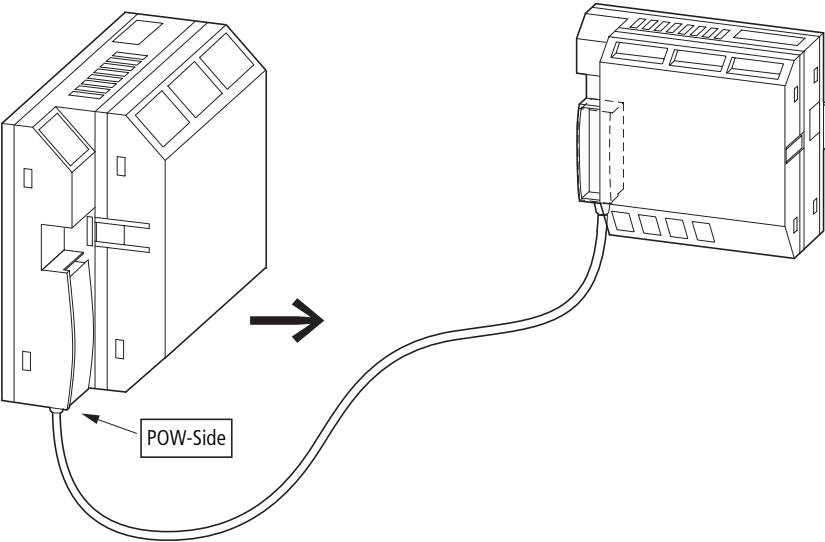


Figure: 60: Serial interface point-to-point connection

Expanding inputs/outputs In order to increase the number of inputs/outputs, you can connect expansion devices to all display base module types with a CL-LINK terminal:

Expandable CL basic units	Expansion units	
CL-LDC.L..	CL-LER.18AC2 CL-LER.18DC2	<ul style="list-style-type: none">• 12 AC inputs,• 6 relay outputs
	CL-LET.20DC2	<ul style="list-style-type: none">• 12 DC inputs,• 8 transistor outputs
	CL-LER.20	2 relay outputs, common potential ¹⁾

1) Common supply for multiple outputs

Local expansion

With local expansion the expansion unit is fitted directly next to the display base module with the CL-LINK terminal.

- Connect the CL expansion unit with the display base module using CL-LAS.TK011.

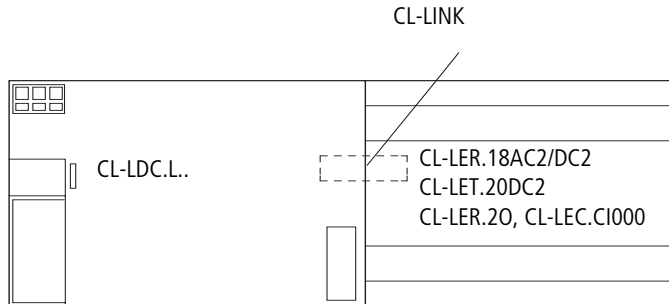


Figure: 61: Connecting local expansions with CL-LDC.L..



The following electrical isolation is provided between the display base module and the expansion device (isolation always in local connection of the expansion device):

- Basic isolation 400 V AC (+10 %)
- Safe isolation 240 V AC (+10 %)

Units may be destroyed if the value 400 V AC +10 % is exceeded, and may cause the malfunction of the entire system or machine!



The display base module and expansion unit can be provided with different DC power supplies.

Remote expansion

Remote expansion units can be installed and run up to 30 m away from the display base module.



Warning!

The two-wire or multiple-wire cable between the devices must comply with the insulation voltage requirement which is stipulated for the installation environment. Otherwise, a fault (ground fault, short-circuit) may lead to the destruction of the units or injury to persons.

A cable such as NYM-0 with a rated operational voltage of $U_e = 300/500$ V AC is normally sufficient.

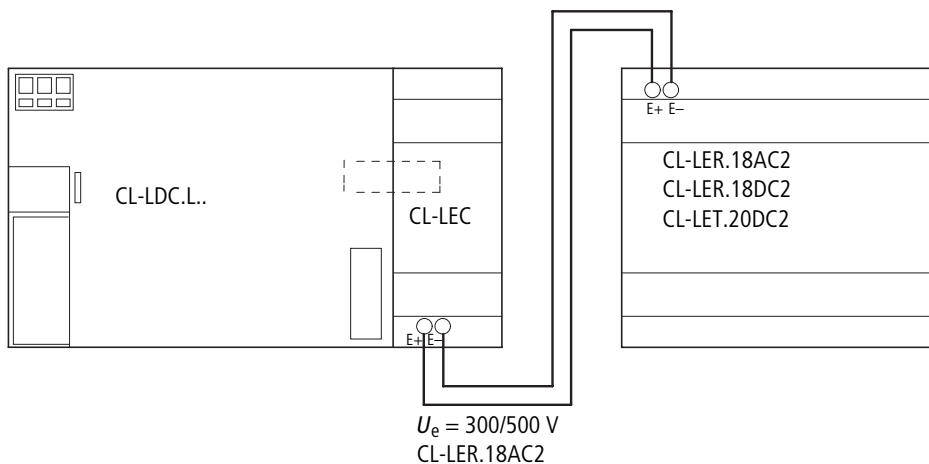


Figure 62: Connecting remote expansion units to the display base module



The terminals E+ and E- of the CL-LEC.CI000 are protected against short-circuits and polarity reversal. Functionality is only ensured if E+ is connected with E+ and E- with E-.

3 Commissioning

Switching on

Before switching on, check that the terminals of the display base module, the display I/O module, the serial interface and the CL-NET connection are properly connected:

- 24 V DC version:
 - Terminal +24 V: Voltage +24 V
 - Terminal 0 V: Voltage 0 V
 - Terminals I1 to I12, R1 to R12:
Actuation via +24 V
- 230 V AC version:
 - Terminal L: Phase conductor L
 - Terminal N: Neutral conductor N
 - Terminals R1 to R12:
Actuation via phase conductor L

If you have already integrated devices into a system, secure any parts of the system connected to the working area to prevent access and ensure that no-one can be injured if, for example, motors start up unexpectedly.

Setting the menu language

When you switch on the display system for the first time, you will be asked to select the menu language.



```

ENGLISH  ✓
DEUTSCH
FRANCAIS
ESPANOL
  
```

- Use the cursor buttons \wedge or \vee to select the language required.
 - English
 - German
 - French
 - Spanish
 - Italian
 - Portuguese
 - Dutch
 - Swedish
 - Polish
 - Turkish

- Press **OK** to confirm your choice and press **ESC** to exit the menu.

The device will then switch to the status display.



You can change the language setting at a later time, (→ section “Changing the menu language”, page 350).

If you do not set the language, the display system will display this menu every time you switch on and wait for you to select a language.

Display system operating modes

The display system has the operating modes – RUN, STOP and TERMINAL.

In RUN mode the display system continuously processes a stored program until you select STOP, disconnect the power supply or switch to TERMINAL mode. The program, parameters and the display system settings are retained in the event of a power failure. All you will have to do is reset the real-time clock after the back-up time has elapsed. Circuit diagram entry is only possible in STOP mode.



Caution!

In RUN mode, the display system will immediately run the program saved in the unit when the power supply is switched on. This will not happen if STOP or TERMINAL mode was set as startup mode. In RUN mode outputs are activated according to the switch logic of the circuit diagram.

The following is required of a device without a display module:

- Memory module containing a valid circuit diagram must be fitted.
- The device must be switched on.

If the device has no program, the program stored on the memory module is loaded automatically and the device immediately starts running the program in RUN mode.

Creating your first
circuit diagram

The following single line diagram takes you step by step through wiring up your first circuit diagram. In this way you will learn all the rules, quickly enabling you to use the display system for your own projects.

As with conventional wiring, you use contacts and relays in the display system diagram. With the display system however, you no longer have to connect up components individually. At the push of a few buttons, the display system circuit diagram produces all the wiring required. All you have to do is then connect any switches, sensors, lamps or contactors you wish to use.

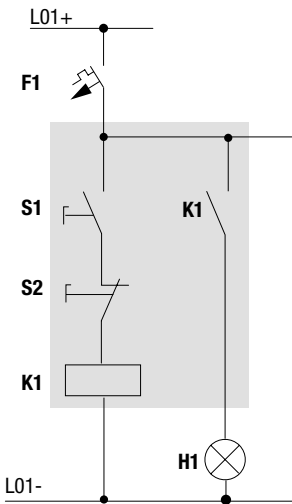


Figure: 63: Lamp controller with relays

In the following example, the display system carries out all the wiring and performs the tasks of the circuit diagram shown below.

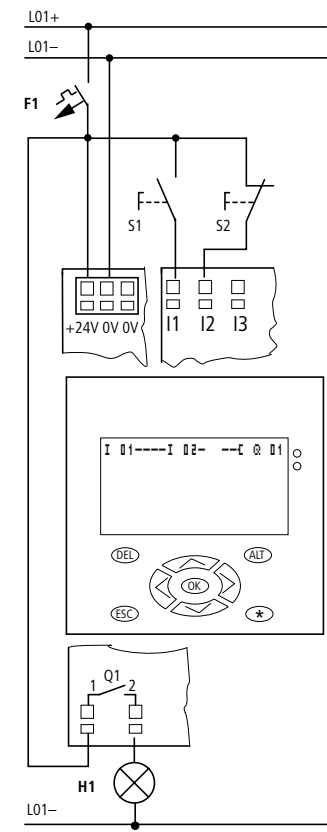


Figure: 64: Lamp controller with display system

Starting point: Status display

```

I .....
      I      P-
MO 02:00
Q..... STOP

```

When you switch on the display system it opens the status display immediately. This shows the switching state of the inputs and outputs and also indicates whether the display system is already running a program. **Note:** If another display is showing, this means that a visualization screen is displayed.



The examples were written without the use of expansion units. If an expansion unit is connected, the status display will first show the status of the display system and then the status of the expansion unit before showing the first selection menu.

```

PROGRAM...
STOP / RUN
PARAMETER
SET CLOCK...

```

► Press **OK** to switch to the main menu.

Press **OK** to switch to the next menu level, and press **ESC** to move one level back.



OK has two other functions:

- Press **OK** to save modified settings.
- In the circuit diagram, you can also press **OK** to insert and modify contacts and relay coils.

The display system must be in STOP mode.

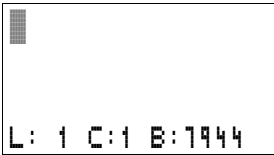
```

CIRCUIT DIAGRAM
FUNCTION RELAYS

```

► Press **OK** 2 × to enter the circuit diagram display via menu items PROGRAM... → PROGRAM. This is where you will create the circuit diagram.

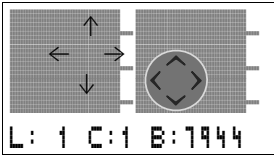
Circuit diagram display



The circuit diagram display is currently empty. The cursor flashes at the top left, which is where you will start to create your diagram.

The location of the cursor is indicated in the status line.
L: = Rung (line), C: = Contact or coil field (contact),
B: = Number of free memory locations in bytes.
Start value 7944, with the first three circuit connections already generated.

The display system circuit diagram supports 4 contacts and one coil in series. The display system can show 6 circuit diagram contact fields.



Use the ^ v < > cursor buttons to move the cursor over the invisible circuit diagram grid.

The first four columns are contact fields, the fifth column is a coil field. Each line represents a rung. The display system automatically connects the contact to the power supply.

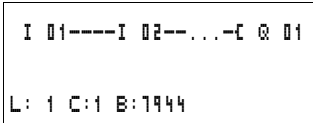


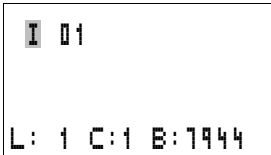
Figure: 65: Circuit diagram with inputs I1, I2 and output Q1

► Now try to wire up the following display system circuit diagram.

The switches S1 and S2 are at the input whilst I 01 and I 02 are the contacts for the input terminals. Relay K1 is represented by the relay coil K 01. The symbol K identifies the coil's function, in this case a relay coil acting as a contactor. Q 01 is one of the display system output relays.

From the first contact to the output coil

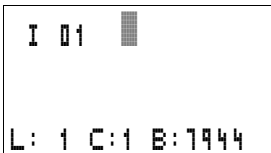
With the display system you work from the input to the output. The first input contact is **I 01**.



► Press **OK**.

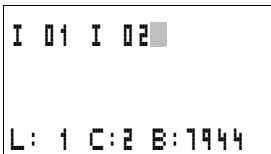
The display system proposes the first contact **I 01** at the cursor position.

I flashes and can be changed, for example, to a **P** for a pushbutton input using the cursor buttons \wedge or \vee . However, nothing needs to be changed at this point.



► Press **OK 2 x** to move the cursor across the **01** to the second contact field.

You could also move the cursor to the next contact field using the \wedge cursor button.



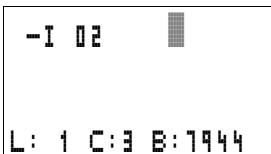
► Press **OK**.

Again, the display system inserts a contact **I 01** at the cursor position. Change the contact number to **I 02**, so that N/C contact S2 can be connected to input terminal I2.

► Press **OK** so that the cursor jumps to the next position and press cursor button \wedge or \vee to change the number to **02**.




Press **DEL** to delete a contact at the cursor position.



► Press **OK** to move the cursor to the third contact field.

You do not need a third relay contact, so you can now wire the contacts directly up to the coil field.

Wiring

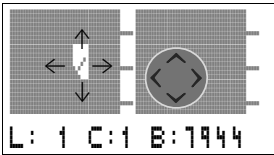
The display system displays a small arrow  in the circuit diagram when creating the wiring.

Press **ALT** to activate the wiring arrow cursor and use the cursor buttons $\wedge \vee < >$ to move it.



ALT also has two other functions depending on the cursor position:

- In the left contact field, you can press **ALT** to insert a new empty circuit connection.
- The contact under the cursor can be changed between a N/O and N/C contact by pressing the **ALT** button.

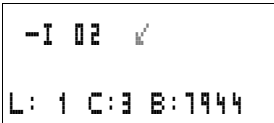


The wiring arrow works between contacts and relays. When you move the arrow onto a contact or relay coil, it changes back to the cursor and can be reactivated if required.



The display system automatically connects adjacent contacts up to the coil.

- Press **ALT** to wire the cursor from **I 02** through to the coil field.



The cursor changes into a flashing wiring arrow and automatically jumps to the next logical wiring position.

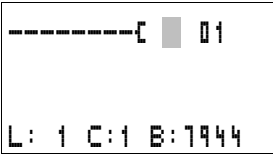
- Press the cursor button $>$. Contact **I 02** will be connected up to the coil field.



You can use **DEL** to erase a connection at the cursor or arrow position. Where connections intersect, the vertical connections are deleted first, then, if you press **DEL** again, the horizontal connections are deleted.

► Press the cursor button **>** again.

The cursor will move to the coil field.



► Press **OK**.

The display system will insert relay coil **Q 01**. The specified coil function **C** and the output relay **Q 01** are correct and do not have to be changed.

When wiring is completed, your first working display system circuit diagram now looks like this:

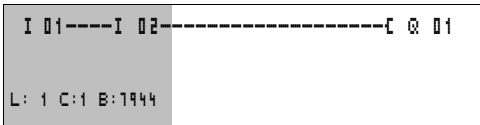



Figure 66: Your first circuit diagram

 = Visible area

► Press **ESC** to leave the circuit diagram display.

The SAVE menu appears.

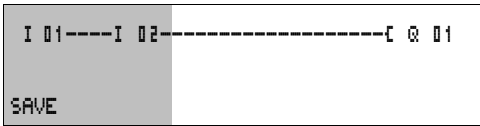



Figure 67: SAVE menu

 = Visible area

► Press the **OK** button.

The circuit diagram is stored.

Once you have connected pushbutton actuators S1 and S2, you can test your circuit diagram straight away.

Testing the circuit diagram

```
PROGRAM...
STOP / RUN
PARAMETER
SET CLOCK...
```

► Switch to the main menu and select the STOP RUN menu option.
With a tick at RUN or STOP you switch to the RUN or STOP operating modes.

The display system runs in the mode indicated by the tick.

► Press the **OK** button. The display system will change to RUN mode.



The mode assigned the tick is always active.

The status display shows the current mode and the switching states of the inputs and outputs.

```
I 12.....
      I      P-
MO 14:42
Q 1..... RUN
```

► Change to the status display and press pushbutton actuator S1.
The contacts (boxes) for inputs I1 and I2 are activated and relay Q1 picks up. This is indicated on the numbers which are displayed.

Power flow display


The display system allows you to check rungs in RUN mode. This means that you can check your circuit diagram via the built-in power flow display while it is being processed by the display system.

► Change to the circuit diagram display and press pushbutton actuator S1.

The relay picks up and the display system displays the power flow.

```
I 01====I 02===== Q 01
L: 1 C:1 RUN
```

Figure: 68: Power flow display: Inputs I1 and I2 are closed, relay Q1 has picked up

 = Visible area

- Press pushbutton actuator S2, that has been connected as a N/C contact.

The power flow is interrupted and relay Q1 drops out.

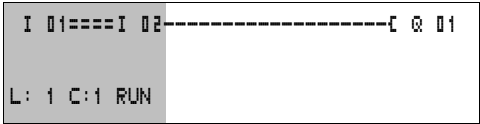



Figure: 69: Power flow display: Input I1 is closed, input I2 is open, relay Q1 has dropped out

 = Visible area

- Press **ESC** to return to the status display.



A circuit diagram does not have to be completed before you can test parts of it with the display system.

The display system simply ignores any incomplete wiring that is not yet working and only uses the finished wiring.

Power flow display with zoom function

The display system enables you to check the following at a glance:

- All four contacts plus one coil in series
- and 3 circuit connections

- Change to the circuit diagram display and press the ALT button. Press pushbutton actuator S1.

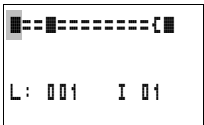


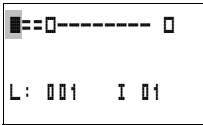


Figure: 70: Power flow display in zoom function: Input I1 and I2 are closed, relay Q1 picked up

-  Contact closed, coil is triggered:
-  Contact opened, coil dropped out

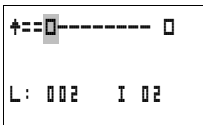
- Press pushbutton actuator S2, that has been connected as a N/C contact.

The power flow is interrupted and relay Q1 drops out.



Use the cursor buttons < > to move between the contacts or coil.

- Press the cursor button >.



The cursor moves to the second contact.

- Press the ALT button. The display changes to display status with contact and/or coil designation.

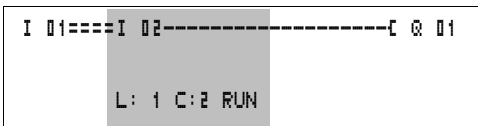


Figure: 71: Power flow display: Input I1 is closed, input I2 is open, relay Q1 has dropped out

■ = Visible area

Deleting the circuit diagram

- Switch the display system to STOP mode.



The display system must be in STOP mode in order to extend, delete or modify the circuit diagram.

- Use PROGRAM... to switch from the main menu to the next menu level.
- Select DELETE PROGRAM



```
PROGRAM...  
DELETE PROGRAM
```

The display system will display the prompt DELETE?.

- Press **OK** to delete the program or **ESC** to cancel.
- Press **ESC** to return to the status display.

Fast circuit diagram entry

You can create a circuit diagram in several ways: The first option is to enter the elements in the circuit and then to wire all the elements together. The other option is to use the enhanced operator guidance of the display system and create the circuit diagram in one go, from the first contact through to the last coil.

If you use the first option, you will have to select some of the elements in order to create and connect up your circuit diagram.

The second, faster option is what you learned in the example. In this case you create the entire rung from left to right.

Configuring a CL-NET network

If you want to work with the CL-NET network and communicate with several stations, the network must be configured first.

Proceed as follows:

- ▶ Interconnect all network stations. CL-NET socket 2↑ to CL-NET socket 1↓.
- ▶ The first station 1 (socket 1↓) and last station (socket 2↑) requires a network terminating resistor ①.
- ▶ Connect the power supply to all stations.

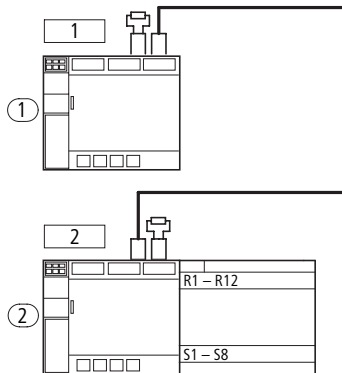


Figure: 72: Example topology with two CL-NET stations

① Network terminating resistor

□ Physical location

○ station number

- ▶ Switch on the power supply for all stations.
- ▶ Ensure that all stations have a power supply. The POW LED must light up or flash. It is only possible to configure the stations which have an active power supply.
- ▶ Proceed to the first physical station (Location 1). This station has the termination resistor inserted on socket 1.



The following tasks are only possible in STOP mode.

Entering the network station number

- ▶ Simultaneously press the **DEL** and **ALT** buttons with the status display active.

```
SECURITY
SYSTEM...
MENU LANGUAGE
CONFIGURATOR
```

The System menu appears

Select the CONFIGURATOR menu option.

- ▶ Press the **OK** button.

```
NET...
COM...
LINK....
```

The NET menu appears.

- ▶ Press the **OK** button.

```
NET PARAMETER...
STATIONS
CONFIGURE
```

The NET PARAMETER menu appears.

- ▶ Press the **OK** button.

```
NET-ID : 00 +
BAUDRATE: 125KB
BUSDELAY: 00
SEND IO / +
REMOTE RUN
REMOTE IO
```

- ▶ Press the **OK** button and select the station number with \wedge and \vee . In this case the station number (NET-ID) "01".

- ▶ Confirm with the **OK** button.

```
NET-ID : 01 +
BAUDRATE: 125KB
BUSDELAY: 00
SEND IO / +
REMOTE RUN
REMOTE IO
```

- ▶ Exit the NET PARAMETERS menu with **ESC**.



The station designated station number 1 is the active station. For this reason the REMOTE RUN and REMOTE IO functions are not available.

Entering network stations

Only the network station at physical location 1 with station number 1 has a station list.

→ The left-hand column is the physical location. You can only assign physical locations to unused station numbers. The physical location 1 is permanently assigned to station number 1.

1	1	↑
2	0	
3	0	
4	0	↓

- ▶ Use the ^ and v cursor buttons to select the STATION menu and press the **OK** button.
- ▶ Proceed to the station with physical address 2.
- ▶ Select the required physical location with the ^ and v cursor buttons. Press the **OK** button.
- ▶ Use cursor buttons ^ and v to select station number 2.

1	1	↑
2	2	
3	0	
4	0	↓

- ▶ Press the **OK** button.
At physical location 2, the station has been assigned station address 2.
- ▶ Press **ESC** to return to the STATIONS menu item.

Configuring a CL-NET network

The CL-NET network can only be configured by station 1.

Requirement:

All stations are correctly connected to the network and the termination resistors have been connected.

All stations have a power supply and are in STOP mode. The POW LED is permanently lit. The NET LED is permanently lit.



If the connected stations are configured, all stations automatically switch to the STOP mode.

```
NET PARAMETER..
STATIONS
CONFIGURE
```

► Proceed to the CONFIGURE menu item and press the **OK** button.

```
CONFIGURE?
```

You will be asked to acknowledge whether you want to configure the system.

► Press the **OK** button.

```
CONFIGURATION
IN
PROGRESS!
```

The message on the left appears:

All NET-LEDs of the stations with station numbers higher than 1 (2 to 8) switch to the CL-NET off status.

As soon as the configuration has been successfully completed, the NET LEDs on all stations flash. The CL-NET network is ready for operation.



An error message will appear if a station is assigned a station address which does not correspond to the physical location in the station list.

```
ERR: ID CONFLICT
OVERWRITE
CONFIGURATION ?
```

If you want to overwrite the station address press the **OK** button. The configuration can be aborted by pressing the ESC button.

Changing the CL-NET network configuration

The configuration of the CL-NET network can be modified at any time at station 1, physical location 1.

- ▶ The NET parameters are modified as described for inputting parameters for the first time.

Station addresses in the STATIONS menu are changed as follows:

- ▶ Go to the physical location which is to be modified.
- ▶ Press the **OK** button.



Existing station numbers can only be modified to free, non-assigned station numbers. If all eight numbers are assigned, all station numbers which are to be modified must be set to zero. Thereafter, all station numbers can be reassigned. (Display system sets all station numbers to zero which are assigned a physical location behind the leading zero.)

- ▶ Select the required station number with the \wedge and \vee cursor buttons and confirm your input with the **OK** button.
- ▶ Configure all CL-NET stations again using the CONFIGURATION menu.



Further information concerning the CL-NET network topic can be found in chapter "CL-NET network, COM-LINK serial connection", page 319.

Displaying the status display of other stations

On every device with a display, you can display the states of the inputs and outputs of any other network station.

```
1I12.....
  I NT1    P-
MO 06:42
1Q1..... RUN
```

- Change to the status display and press the **ESC** button.

The cursor switches to the display of network station NT...
The station number is displayed in front of the inputs and outputs.

```
3I12.....7....
  I NT3    P-
MO 06:42
3Q1.3..6.. RUN
```

- Change the number of the required station with the \wedge and \vee cursor buttons.

- Press the **OK** button.

```
3R12.....7....
  I NT3 DC P-
MO 06:45
3S1.3..6.. RUN
```

- If you want to view the state of the inputs and outputs of a local expansion, press the **OK** button.

If you press the **ESC** button again or the **OK** button, the display of the input and output states of the station is terminated.



The station showing the status on its display cannot read its own data from the network.

Example: NT3 flashes on station 3. The inputs and outputs 3I.., 3R.., 3Q.. and 3S.. cannot be displayed.

If the NT3 display is not flashing, the inputs and outputs are shown.

Configuring the interface for the COM-LINK mode

If you wish to set up point-to-point communication with another station, this can be done using either the serial interface or CL-NET. The display system must be provided with a display and operating unit. The connection must be configured for this purpose (→ section "Introduction to COM-LINK", page 334).



Ensure that the other station supports the COM-LINK mode.

Proceed as follows:

- Connect both stations together.

Use only the original connection cables. The connector marked POW-Side must be plugged into a display system. The display system feeds the interface electronics of the connection line at both ends.

- Connect the power supply to both stations.

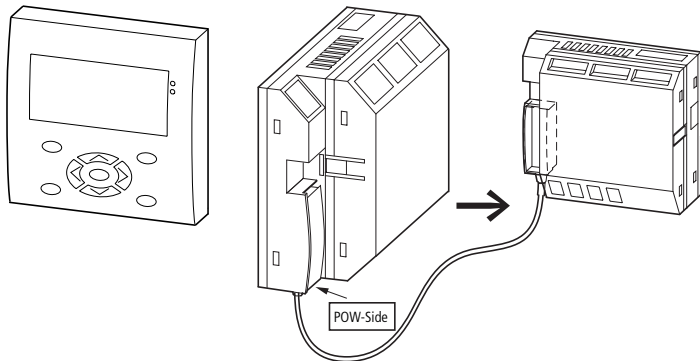


Figure: 73: Example with both COM stations.

The display base module with the program is the active station and the second station is then the remote station.

- Switch on the power supply for both stations.
- Ensure that both stations have a power supply. The POW LED must light up or flash. It is only possible to configure the stations which have an active power supply.

- Go to the display system device that is the active station running the serial interface (POW-Side).



The following steps are only possible in STOP mode.

Setting up the COM-LINK



Caution!

The display system device can either run as a station on the CL-NET or as a station in a COM-LINK connection. Do not switch the display system as CL-NET station over to COM-LINK. If this is done on CL-NET in RUN mode, the entire CL-NET network will be deactivated. No more data will be exchanged.

Solution:

- Deactivate the COM-LINK.
 - Re-enter the CL-NET address.
 - Switch the power supply off and then on again.
 - Reconfigure the CL-NET on station 1.
- Simultaneously press the **DEL** and **ALT** buttons with the status display active.

The System menu appears

```
SECURITY
SYSTEM...
MENU LANGUAGE
CONFIGURATOR
```

Select the CONFIGURATOR menu option.

- Press the **OK** button.

Select the COM... menu option.

```
NET...
COM...
LINK...
```

- Press the **▽** button.
- Press the **OK** button.

```
BAUDRATE: 9600B
COM-LINK
REMOTE MARKER...
```

The menu BAUDRATE: 9600B will appear. The two baud rates are for 9600 or 19200 baud. Select the baud rate that your connection will support. Baud rate selection.



Select 19200 baud as the baud rate. Badly laid cables may give rise to electromagnetic interference. Select 9600 baud as a solution. If this is not satisfactory, the connection cable must be laid in a different location.

```
BAUDRATE:19200B
COM-LINK
REMOTE MARKER...
```

► Press the **OK** button.

Select 19200 baud as the baud rate.

► Press the \wedge or \vee button.

► Confirm with the **OK** button.

Switch on the COM connection.



The COM-LINK must only be switched at the active station. Two devices with COM-LINK \checkmark switched on cannot communicate with each other.

```
BAUDRATE:19200B
COM-LINK ✓
REMOTE MARKER...
```

► Press the \vee button.

► Press the **OK** button.

The tick next to the COM-LINK menu indicates that COM-LINK has been selected.

No tick means that COM-LINK has not been selected.



The following applies to the active station:

If you wish to run data transfers between the two devices in both directions, you must select the marker range on the active station.

```
BAUDRATE:19200B
COM-LINK ✓
REMOTE MARKER...
```

► Select the REMOTE MARKER menu item.

The following selection will only be displayed if the COM-LINK menu item has been ticked.

```
READ:
1M000 + 1M000
WRITE:
1M000 + 1M000
```

► Press the **OK** button.

The data is present in the second station, the remote station.



The active station reads and writes data from and to the markers of the remote station. At the same time, the remote station has read and write access to the same marker range.

Ensure that both stations do not have write access to the same markers simultaneously. The last write operation will be the one that is retained.

Example:

READ 1MD2 → 1MD2

WRITE 1MD3 → 1MD3

The display system device accesses the markers with station address 1xx... These markers correspond to the local markers MD2 and MD3 in the remote station.

These marker double words contain:

MD2, MW3, MW4, MB5; MB6, MB7, MB8, M33 to M64

MD3, MW5, MW6, MB9, MB19, MB11, MB12; M65 to M96

The following marker areas can be selected:

1MD1 to 1MD20

In the remote station this corresponds to the area:

MD1 to MD20

```

READ:
 1MD00 + 1MD00
WRITE:
 1MD00 + 1MD00

```

- ▶ Press the **OK** button.
- ▶ Use the \wedge button to select the beginning of the READ marker range.

```

READ:
 1MD11 + 1MD14
WRITE:
 1MD00 + 1MD00

```

- ▶ Use the $>$ button to enter the upper limit of the READ range.
- ▶ Use the \wedge button to select the value.
- ▶ Confirm the entry with the **OK** button.


```
READ:
 1MD11 + 1MD14
WRITE:
 1MD00 + 1MD00
```

► Use the \vee button to enter the WRITE range.

```
READ:
 1MD11 + 1MD14
WRITE:
 1MD00 + 1MD00
```

Enter the WRITE range.

```
READ:
 1MD11 + 1MD14
WRITE:
 1MD15 + 1MD17
```

► Press **ESC** to leave the Entry menu.

```
BAUDRATE:19200B
COM-LINK ✓
REMOTE MARKER...
```

The COM-LINK has now been set. No COM settings must be carried out on the remote station.

► Press **ESC** to return to the status display.

```
I 12.4.67....
      I COM  P-
FR 02:02 ST
Q ..... STOP
```

The entry in the second COM line indicates that the COM connection is active.

Terminal mode operation Terminal mode

The display system device also supports the TERMINAL mode operating mode. This allows you to remotely control other devices. This is particularly useful if the other device is located in an inaccessible place. Terminal mode can also be used to show the menus and displays of devices that do not have their own display or operating unit. Terminal mode can be used both with the serial interface and in the CL-NET. The serial interface enables you to access a remote device. If you use the CL-NET network, all other network stations can be addressed.



Terminal mode is a separate operating mode like RUN mode. It only functions when a program is not running. For this mode to be active, the display system must be in STOP mode.



All connected devices must also support TERMINAL mode.

The following topologies are permissible:

Terminal mode serial interface “point-to-point connection” topology

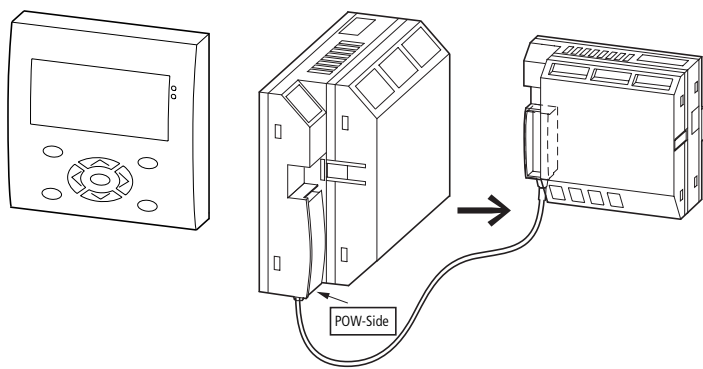


Figure: 74: Terminal mode serial interface “point-to-point connection” topology

Terminal mode using the CL-NET topology

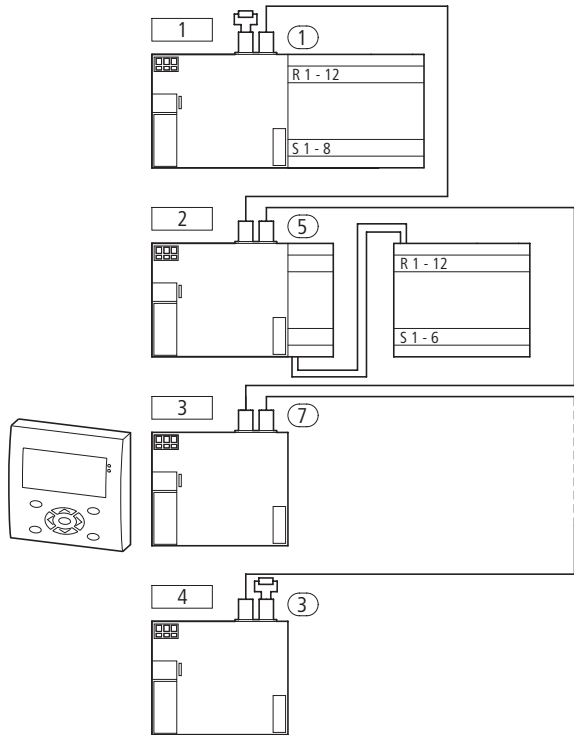


Figure: 75: Terminal mode in the CL-NET

In the above topology, the physical location is not identical to the station number. The display system device was connected in the middle of the network line. Terminal mode functions irrespective of the device location and station number.

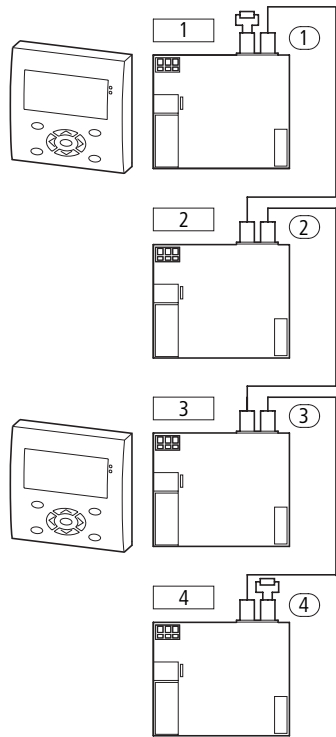


Figure: 76: Terminal mode in the CL-NET with two display systems

In the above topology, two display systems can be operated in the CL-NET terminal mode. Each display system device can run Terminal mode with the other devices.

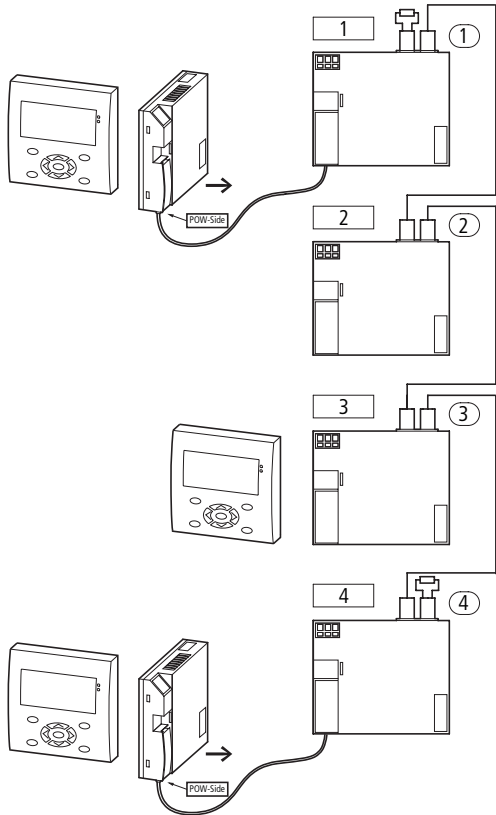


Figure: 77: Terminal mode in CL-NET as well as via two serial interfaces

The above topology is a combination of CL-NET operation and serial interface operation. Bear in mind the access rights of the individual devices in CL-NET and in the corresponding serial interface.



Caution!

Data collision!

Proper operation is possible under the following conditions.

The following applies:

If more than one display system is in Terminal mode in the CL-NET, each display system must access a different CL-NET station.

A device running in Terminal mode must not access any two devices communicating with each other in Terminal mode.

If a PLC with CL-SOFT or a display system with a serial interface is active on a CL-NET station, this station must not be accessed in Terminal mode via the CL-NET at the same time.

Proceed as follows:

Your CL-NET or your serial interface must be running correctly.

► Press the **OK** button from the status display.

The first menu will appear.

```
PROGRAM...  +
STOP / RUN
PARAMETER
SET CLOCK...  +
```

► Press the > button.

```
STOP / RUN  +
PARAMETER
SET CLOCK...
TERMINAL MODE...  +
```

This will display the TERMINAL mode menu item.

► Press the **OK** button.

```
STATION ID: 0
START MODE
```

The START MODE menu item will flash.

► Press the ^ button.

```
STATION ID: 0
START MODE
```

Select the second station. This station will control the display and respond to the operating unit.



Station ID:

- 0 = Station at the serial interface
- 1 = Station 1 CL-NET
- 2 = Station 2 CL-NET
- 3 = Station 3 CL-NET
- 4 = Station 4 CL-NET
- 5 = Station 5 CL-NET
- 6 = Station 6 CL-NET
- 7 = Station 7 CL-NET
- 8 = Station 8 CL-NET

```
STATION ID: 0
START MODE
```

► Press the **OK** button.

Select your station.

- Press the \wedge or \vee button.
- Press the **OK** button.

```
STATION ID: 0
START MODE
```

Select the START MODE menu option.

- Press the \vee button.
- Press the **OK** button.

```
STATION ID: 2
START MODE
```

In this case CL-NET station 2 is connection.

```
Connection
establishment
in progress...
```

The display system tries to establish connection to the selected device. The text flashes.

Once the connection is established, the menu appears or the status of the selected device is displayed.



If the text “Connection establishment in progress...” is displayed for longer than 10 s, the connection to the selected device is faulty. Press **ESC** to cancel the selection. Rectify the fault. Try to re-establish the connection.

The following applies if the device to be operated is in RUN mode and is displaying a screen:

This screen is not displayed in Terminal mode.

The remote
device is in
Graphic mode

Display system message: “The remote device is in Graphic mode.”

► Press the **ALT** and **ESC** button simultaneously.
This will call up the status display.

I 1..4..789... ✱
I NT2 F-
TU 06.05.2003
Q 1..45678 RUN

The CL-NET station 2 controls the display of the display system.



The activation of Terminal mode is indicated by the flashing star at the top right of the status display.



Caution!

In Terminal mode, you can operate a device that may be positioned far from your actual location. All access rights that you would also require “locally” are granted to you. However, it is not always possible to obtain a view of the situation “locally”. Use of this operating mode and the execution of any changes to device settings should therefore only be carried out with the utmost caution.

A device with a display and operating unit can also be operated locally. In this case, operation at the device concerned is always faster than operation via Terminal mode. Bear in mind that this may lead to conflicts that may trigger faults or unforeseen events.



In Terminal mode, the display system device makes its display and operating unit available to the connected device. Only data for the display and the status of the buttons is sent via the connection. This ensures that the local data of the connected device is not destroyed in the event of a communication fault.

Close Terminal mode.

Press the * button to close the Terminal mode.

```
STATION ID: 2
START MODE
```



The * button cannot be assigned to other tasks if you wish to use Terminal mode in your application. Use the * button to change from the visualization to the status display. Otherwise the Terminal mode menu cannot be reached.

► Press the "*" button.

This returns you back to your local device.

► Press the **ESC** button twice.

```
STATION ID: 2
START MODE
```

```
I ..345...09...
      I          F-
SA 06:47 ST
Q 2 4      STOP
```

The status display of the display system device is active.







The flashing star at the top right of the display is no longer present.

If the display base module was fitted to the display module in an energized state, the display must be reinitialized.

► Press the **DEL** and **ESC** button to reinitialize the display.

4 Wiring with the display system

This chapter provides information on all the functions of the display system.

Display system operation	Buttons for editing circuit diagrams and function relays
	Delete rung, contact, relay or empty rung in the circuit diagram
	Toggle between N/O and N/C contact Connect contacts, relays and rungs Add rungs
	<div>^v Change value</div> <div>Move cursor up/down</div> <div>< > Change place</div> <div>Cursor left/right</div> <div>Cursor buttons as P buttons</div> <div>< Input P1 ^ Input P2</div> <div>> Input P3 v Input P4</div>
	Undo setting from last OK Leave current display, menu
	Change, add new contact/relay, Save setting
	Toggle for Terminal mode

Operation

The cursor buttons in the display system circuit diagram perform three functions. The current mode is indicated by the appearance of the flashing cursor.

- Move
- Enter
- Connect



In Move mode you can use $\wedge \vee < >$ to move the cursor around the circuit diagram in order to select a rung, contact or relay coil.



Use **OK** to switch to Entry mode so that you can enter or change a value at the current cursor position. If you press **ESC** in Entry mode, display system will undo the most recent changes.



Press **ALT** to switch to Connect mode for wiring contacts and relays. Press **ALT** again to return to Move.

Press **ESC** to exit the circuit diagram and parameter display.



The display system performs many of these cursor movements automatically. For example, the display system switches the cursor to Move mode if no further entries or connections are possible at the selected cursor position.

Opening the parameter display for function blocks with contacts or coils

If you specify the contact or coil of a function relay type in Entry mode, the display system automatically switches from the contact number to the function block parameter display when you press **OK**.

Press $>$ to switch to the next contact or coil field without entering any parameters.

Program

A program is a sequence of commands which the display system executes cyclically in RUN mode. A display system program consists of the necessary device settings, CL-NET, COM-LINK, password, system settings, a circuit diagram and/or function blocks and/or visualization screens.

The circuit diagram is that part of the program where the contacts are connected together. In RUN mode a coil is switched on and off in accordance with the current flow and the coil function specified.

Function blocks

Function blocks are program elements with special functions. Example: Timing relays, time switches, arithmetic function blocks. Function blocks are elements provided with or without contacts and coils as required. In RUN mode the function blocks are processed according to the circuit diagram and the results are updated accordingly.

Examples:

Timing relay = Function block with contacts and coils

Time switch = Function block with contacts

Visualization screens

Visualisation screens are the sections of programs containing the display and operator functions.

Relays

Relays are switching devices which are electronically simulated in the display system. They actuate their contacts according to their designated function. A relay consists of at least a coil and a contact.



Contacts

You modify the current flow with the contacts in the circuit diagram. Contacts such as N/O contacts carry a signal 1 when closed and 0 when open. Every N/O or N/C contact in the circuit diagram can be defined as either a N/O contact or a N/C contact.

Coils

Coils are the actuating mechanisms of relays. In RUN mode, the results of the wiring are sent to the coils, which switch on or off accordingly. Coils can have seven different coil functions.

Table 6: Usable contacts

Contact	Display system display
 N/O contact, open in release position	I, Q, M, A, ... Other contacts → Table
 N/C contact, closed in release position	\bar{I} , \bar{Q} , \bar{M} , \bar{A} , ... Other contacts → Table

The display system works with different contacts, which can be used in any order in the contact fields of the circuit diagram.

Table 7: Contacts

Contact	N/O contact	N/C contact	Number	Page
Inputs				
Inputs of a network station * = Station address 1 to 8	*I	* \bar{I}	01...12	322
COM slave inputs	1I	1 \bar{I}	01...12	—
Display system input terminal	I	\bar{I}	01...12	—
Cursor button	P	\bar{P}	01...04	—
Network station expansion input terminal * = Station address 1 to 8	*R	* \bar{R}	01...12	322
Input terminal for expansion unit COM slave	1R	1 \bar{R}	01...12	—
Input terminal for expansion unit	R	\bar{R}	01...12	—
Bit inputs via the network * = Station address 1 to 8	*RN	* $\bar{R}\bar{N}$	01...32	322

Contact	N/O contact	N/C contact	Number	Page
Diagnostics inputs				
Status of expansion network station * = Station address 1 to 8	$\ast I$	$\ast \bar{I}$	14	378
Short-circuit/overload of network station * = Station address 1 to 8	$\ast I$	$\ast \bar{I}$	15...16	376
COM slave expansion unit status	1I	1 \bar{I}	14	—
COM slave short-circuit/overload	1I	1 \bar{I}	15...16	—
Expansion status	I	\bar{I}	14	378
Short-circuit/overload	I	\bar{I}	15...16	376
Short-circuit/overload with network station expansion * = Station address 1 to 8	$\ast R$	$\ast \bar{R}$	15...16	376
Short-circuit/overload in COM slave expansion	1R	1 \bar{R}	15...16	—
Short-circuit/overload with expansion	R	\bar{R}	15...16	376
Outputs				
Switch off backlight display system display	LE	$\bar{L}\bar{E}$	01	—
Red LED display system	LE	$\bar{L}\bar{E}$	02	—
Green LED display system	LE	$\bar{L}\bar{E}$	03	—
Display system output display system network station * = Station address 1 to 8	$\ast Q$	$\ast \bar{Q}$	01...08	322
COM slave output	1Q	1 \bar{Q}	01...08	—
Display system output	Q	\bar{Q}	01...08	—
Display system output expansion with network station * = Station address 1 to 8	$\ast S$	$\ast \bar{S}$	01...08	322
Output of COM slave expansion	1S	1 \bar{S}	01...08	—
Display system output expansion	S	\bar{S}	01...08	—

Contact	N/O contact	N/C contact	Number	Page
Bit outputs via the network * = Station address 1 to 8	*SN	* $\bar{S}N$	01...32	322
Other contacts				
Auxiliary relay (markers)	M	\bar{M}	01...96	125
COM slave marker (REMOTE MARKER)	1M	1 \bar{M}	01...96	337
Jump label	:		01...32	228
Diagnostics messages	ID	1 \bar{D}	01...16	332
COM slave diagnostics messages	1ID	11 \bar{D}	01...16	337
Function blocks				
Analog value comparator function block	A X 01	A X 01	X=01...32	152
Function block Analog value comparator Value overflow (CARRY)	A X CV	\bar{A} X CV	X=01...32	152
Arithmetic value overflow (CARRY) function block	AR X CV	$\bar{A}\bar{R}$ X CV	X=01...32	155
Zero arithmetic value (zero) function block	AR X ZE	$\bar{A}\bar{R}$ X ZE	X=01...32	155
Data block comparator function block, error: number of elements exceeded	BC X E1	$\bar{B}\bar{C}$ X E1	X=01...32	159
Data block comparator function block, error: range overlap	BC X E2	$\bar{B}\bar{C}$ X E2	X=01...32	159
Data block comparator function block, error: invalid offset	BC X E3	$\bar{B}\bar{C}$ X E3	X=01...32	159
Data block comparator function block, comparison result	BC X E0	BC X E0	X=01...32	166
Data block transfer function block, error: number of elements exceeded	BT X E1	BT X E1	X=01...32	166

Contact	N/O contact	N/C contact	Number	Page
Data block transfer function block, error: range overlap	BT X E2	BT̄ X E2	X=01...32	166
Data block transfer function block, error: invalid offset	BT X E3	BT̄ X E3	X=01...32	166
Boolean operation function block, value zero	BV X ZE	BV̄ X ZE	X=01...32	177
Counter function block, upper setpoint value exceeded (Overflow)	C X OF	C̄ X OF	X=01...32	180
Counter function block, lower setpoint value undershot (Fall below)	C X FB	C̄ X FB	X=01...32	180
Counter function block, actual value equal to zero	C X ZE	C̄ X ZE	X=01...32	180
Counter function block, actual value has exceeded counter range (CARRY)	C X CV	C̄ X CV	X=01...32	180
Frequency counter function block, upper setpoint value exceeded (Overflow)	CF X OF	CF̄ X OF	X=01...04	187
Frequency counter function block, lower setpoint value undershot (Fall below)	CF X FB	CF̄ X FB	X=01...04	187
Frequency counter function block, actual value equal to zero	CF X ZE	CF̄ X ZE	X=01...04	187
High-speed counter function block, upper setpoint value exceeded (Overflow)	CH X OF	CH̄ X OF	X=01...04	191
High-speed counter function block, lower setpoint value undershot (Fall below)	CH X FB	CH̄ X FB	X=01...04	191
High-speed counter function block, actual value equal to zero	CH X ZE	CH̄ X ZE	X=01...04	191
High-speed counter function block, actual value has exceeded counter range (CARRY)	CH X CV	CH̄ X CV	X=01...04	191

Contact	N/O contact	N/C contact	Number	Page
Incremental encoder counter function block, upper setpoint value exceeded (Overflow)	CI X OF	CI X OF	X=01...02	196
Incremental encoder counter function block, lower setpoint value undershot (Fall below)	CI X FB	CI X FB	X=01...02	196
Incremental encoder counter function block, actual value equal to zero	CI X ZE	CI X ZE	X=01...02	196
Incremental encoder counter function block, actual value has exceeded counter range (CARRY)	CI X CV	CI X CV	X=01...02	196
Comparator function block, less than	CP X LT	CP X LT	X=01...32	201
Comparator function block, equal to	CP X EQ	CP X EQ	X=01...32	201
Comparator function block, Greater than	CP X GT	CP X GT	X=01...32	201
Data function block	DB X Q1	DB X Q1	X=01...32	203
PID controller, value range of manipulated variable exceeded	DC X LI	DC X LI	X=01...32	205
Receive a variable from a station (Get)	GT X Q1	GT X Q1	X=01...32	205
Seven-day time switch	HW X Q1	HW X Q1	X=01...32	215
Year time switch function block	HV X Q1	HV X Q1	X=01...32	220
Master reset, sets all outputs and markers to zero state	MR X Q1	MR X Q1	X=01...32	231
Operating hours counter function block, set time reached	OT X Q1	OT X Q1	X=01...04	237

Contact	N/O contact	N/C contact	Number	Page
Operating hours counter, value overflow (CARRY)	OT X CY	OT X CY	X=01...04	237
Send a variable to the network, enable active Put	PT X Q1	PT X Q1	X=01...32	239
Pulse width modulation, error, outside minimum on or off duration exceeded	PW X E1	PW X E1	X=01...02	240
Send date and time via the network (CL-NET) function block	SC X Q1	SC X Q1	X=01	244
Timing relay function block	T X Q1	T X Q1	X=01...32	247

Usable relays and function blocks (coils)

The display system provides various relay types as well as function blocks and their coils for wiring in a circuit diagram.

Relay/function block	Display system display	Number	Coil	Parameter
Outputs				
Display system output relay, network station (only network master) * = Station address 2 to 8	*Q	01...08	✓	—
output relay	Q	01...08	✓	—
Display system output relay expansion, network station (only network master) * = Station address 2 to 8	*S	01...08	✓	—
Display system output relay expansion	S	01...08	✓	—
Bit outputs * = Station address 1 to 8	*SM	01...32	✓	—
General coils				
Auxiliary relay (markers)	M	01...96	✓	—
COM slave marker (REMOTE MARKER)	1M	01...96	✓	—
Jump label	:	01...32	✓	—
Function blocks				
Analog value comparator function block	A	01...32	—	✓
Arithmetic function block	AR	01...32	—	✓
Data block comparator, activate	BC X EN	01 32	✓	✓
Transfer data block, trigger coil	BT X T_	01 32	✓	✓
Boolean operation	BV	01...32	—	✓
Counter function block, counter input	C X C_	X=01...32	✓	✓
Counter function block, direction	C X D_	X=01...32	✓	✓

Relay/function block	Display system display	Number	Coil	Parameter
Counter function block, set counter value (Preset)	C X SE	X=01...32	✓	✓
Counter function block, reset counter value	C X RE	X=01...32	✓	✓
Frequency counter function block, activate counter (enable)	CF X EN	X=01...04	✓	✓
High-speed counter function block, direction	CH X D_	X=01...04	✓	✓
High-speed counter function block, activate counter (enable)	CH X EN	X=01...04	✓	✓
High-speed counter function block, set counter value (Preset)	CH X SE	X=01...04	✓	✓
High-speed counter function block, reset counter value	CH X RE	X=01...04	✓	✓
Incremental encoder counter function block, set counter value (Preset)	CI X SE	X=01...02	✓	✓
Incremental encoder counter function block, activate counter (enable)	CI X EN	X=01...02	✓	✓
Incremental encoder counter function block, reset counter value	CI X RE	X=01...02	✓	✓
Comparator function block	CP	X=01...32	—	✓
Activate text output function block (enable)	D X EN	X=01...32	✓	✓
Data function block, trigger coil	DB X T_	X=01...32	✓	✓
PID controller, activate	DC X EN	X=01...32	✓	✓
PID controller, activate P component	DC X EP	X=01...32	✓	✓
PID controller, activate I component	DC X EI	X=01...32	✓	✓
PID controller, activate D component	DC X ED	X=01...32	✓	✓
PID controller, accept manual manipulated variable	DC X SE	X=01...32	✓	✓
Activate signal smoothing filter	FT X EN	X=01...32	✓	✓

Relay/function block	Display system display	Number	Coil	Parameter
Get from network station function block	GT	X=01...32	—	✓
Seven-day time switch	HW	X=01...32	—	✓
Year time switch function block	HV	X=01...32	—	✓
Activate value scaling function block	LS X EN	X=01...32	✓	✓
Master reset function block	MR X T_	X=01...32	✓	✓
Activate numerical converter function block	NC X EN	X=01 32	✓	✓
Function block operating hours counter, enable	OT X EN	X=01...04	✓	✓
Operating hours counter function block, reset	OT X RE	X=01...04	✓	✓
Send to the network (CL-NET) function block, trigger	PT X T_	X=01...32	✓	✓
Activate pulse width modulation function block	PW X EN	X=01...02	✓	✓
Send time to the network (CL-NET) function block, trigger	SC X T_	X=01	✓	—
Activate set cycle time function block	ST X EN	X=01		
Timing relay function block, trigger control coil (enable)	T X EN	X=01...32	✓	✓
Timing relay function block, stop	T X ST	X=01...32	✓	✓
Timing relay function block, reset	T X RE	X=01...32	✓	✓
Activate value limitation function block	VC X EN	X=01...32	✓	✓

You can set the switching behaviour of these relays by means of the coil functions and parameters selected.

The options for setting output and marker relays are listed with the description of each coil function.

The coil functions and parameters for the function blocks are explained with the description of each function block.

Markers, analog operands

Specific markers are available for actively addressing values or inputs/outputs.

Table 8: Markers

Markers	Display system display	Number	Value range	Access type r = Read w = Write
Analog operand				
Marker 32 bit	MD	01...96	32 bit	r, w
Marker 16 bit	MW	01...96	16 bit	r, w
Marker 8 bit	MB	01...96	8 bit	r, w
Marker 1 bit	M	1...96	1 bit	r, w
Analog inputs display system	IA X	X= 01...04	10 bit	r
Analog output	OA X	X= 01	10 bit	r, w

The following data accesses can be made to the slave in COM communication mode. Note the REMOTE MARKER setting in the following table.

Markers	Display system display	Number	Value range	Access type r = Read w = Write
Analog operand				
Marker 32 bit	1MD	01...20	32 bit	r, w
Marker 16 bit	1MW	01...40	16 bit	r, w
Marker 8 bit	1MB	01...80	8 bit	r, w
Marker 1 bit	1M	1...96	1 bit	r, w
Analog inputs display system	1IA X	X= 01...04	10-bit	r
Analog output	1OA X	X= 01	10 bit	r

The following rules apply if you want to use selective binary operands (contacts) from the markers MD, MW, MB:

Table 9: Composition of the markers

Applies to MD, MW, MB, M	Left = Most significant bit, byte, word		Right = Least significant bit, byte, word	
32 bit	MD1			
16 bit	MW2		MW1	
8 bit	MB4	MB3	MB2	MB1
1 bit	M32 to M25	M24 to M17	M16 to M9	M8 to M1
32 bit	MD2			
16 bit	MW4		MW3	
8 bit	MB8	MB7	MB6	MB5
1 bit	M64 to M57	M56 to M49	M48 to M41	M40 to M33
32 bit	MD3			
16 bit	MW6		MW5	
8 bit	MB12	MB11	MB10	MB9
1 bit	M96 to M89	M88 to M81	M80 to M73	M72 to M65
32 bit	MD4			
16 bit	MW8		MW7	
8 bit	MB16	MB15	MB14	MB13
32 bit	MD5			
16 bit	MW10		MW9	
8 bit	MB20	MB19	MB18	MB17
...				
...				
...				
32 bit	MD23			
16 bit	MW46		MW45	
8 bit	MB92	MB91	MB90	MB89
32 bit	MD24			
16 bit	MW48		MW47	

Applies to MD, MW, MB, M	Left = Most significant bit, byte, word			Right = Least significant bit, byte, word
8 bit	MB96	MB95	MB94	MB93
32 bit	MD25			
16 bit	MW50		MW49	
32 bit	MD26			
16 bit	MW52		MW51	
...				
...				
32 bit	MD48			
16 bit	MW96		MW95	
32 bit	MD49			
32 bit	MD50			
...				
32 bit	MD95			
32 bit	MD96			



You should only write the markers once.

Marker double words always contain all data formats. When several write accesses to MD, MW, MB or M (within an MD) are made, it is the last write operation that is retained. This also applies if you are writing markers from a visualization screen.

Number formats

The display system makes computations with a signed 31-bit value.

The value range is:

–2 147 483 648 to +2 147 483 647

With a 31-bit value, the 32nd bit is the sign bit.

Bit 32 = Signal 0 means a positive number.

Example:

0000 0000 0000 0000 0000 0100 0001 0010_{bin} = 412_{hex} =
1 042_{dec}

Bit 32 = Signal 1 means a negative number

Example:

1111 1111 1111 1111 1101 1100 1010 1110_{bin} =
FFFDCAE_{hex} = –9042_{dec}



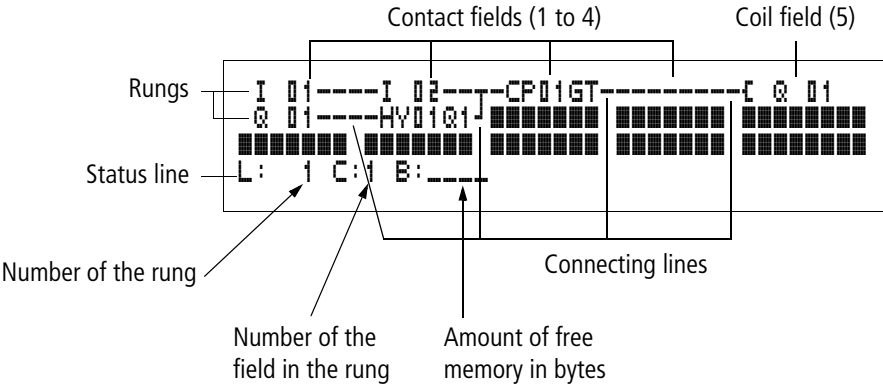
The marker byte (MB) and marker word (MW) number formats are unsigned.

Circuit diagram display

In the display system circuit diagram, contacts and coils of relays are connected up from left to right – from the contact to the coil. The circuit diagram is created on a hidden wiring grid containing contact fields, coil fields and rungs. It is then wired up with connections.

- Insert contacts in the four **contact fields**. The first contact field on the left is automatically connected to the voltage.
- Insert the relay coil to be controlled together with its function and designation in the **coil field**. The coil designation consists of the coil name, coil number and function block from the function designation. The coil function defines the method of operation of the coil.

- Every line in the circuit diagram forms a **rung**. With the display system up to 256 rungs can be wired in a circuit diagram



- **Connections** are used to produce the electrical contact between relay contacts and the coils. They can be created across several rungs. Each point of intersection is a connection.
- The number of **free bytes** is displayed so that you can recognise how much memory is available for the circuit diagram and function blocks.

Display system circuit diagram display

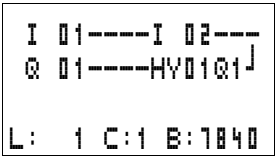
For greater legibility, the circuit diagram display of the display system shows two contacts per rung or one contact plus a coil in series. A total of 16 characters per rung and three rungs plus the status line can be displayed simultaneously.

You can move between the contact fields with the < > cursor buttons. The number of the rung and the contact are displayed in the lower status line.



The circuit diagram display performs two functions:

- In STOP mode it is used to edit the circuit diagram.
- In RUN mode it is used to check the circuit diagram using the Power flow display.



Saving and loading programs

Display system provides you with two ways of saving circuit diagrams externally:

- Saving with the memory module.
- Saving to a PC running CL-SOFT.

Once they have been saved, programs can be reloaded into display system, edited and run.

All program data is saved in display system. In the event of a power failure the data will be retained until the next time it is overwritten or deleted.

Memory module

Each memory module contains a program and is inserted in the interface of the display system.

The display system behaves in the following manner in accordance with the type and setting.

Requirement:

A valid circuit diagram must be stored on the module.

Variants with display:

- Go to the CARD menu and load the circuit diagram into the unit in STOP mode via CARD → DEVICE.

CARD MODE setting → page 360

Variants without display:

If the circuit diagram on the module is different to the circuit diagram in the device, the program from the module is loaded as soon as the power supply is turned on.

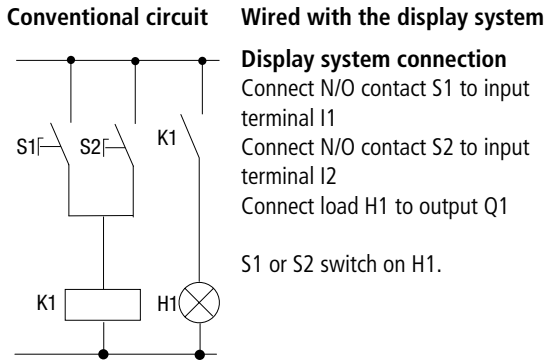
CL-SOFT

CL-SOFT is a PC program with which you can create, store, test and manage display system programs, visualization applications and circuit diagrams.

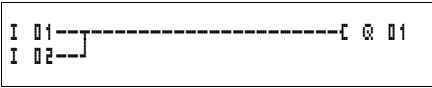
Completed programs are exchanged between the PC and display system via the connection cable. Once you have transferred a circuit diagram, you can start display system straight from your PC.

Working with contacts
and relays

In display system circuit diagrams, the switches, buttons and relays of conventional circuit diagrams are connected up using input contacts and relay coils.



Display system circuit diagram:



First specify which input and output terminals you wish to use in your circuit.

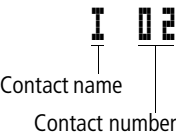
The signal states on the input terminals are detected in the circuit diagram with the input contacts I, R* or RN. The outputs are switched in the circuit diagram with the output relays Q, S or SN.

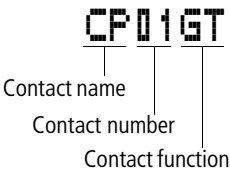
Entering and changing contact and relay function
block coil

Contacts

An input contact is selected in the display system via the contact name and contact number.

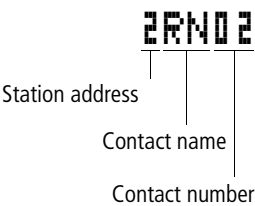
Example: Input contact





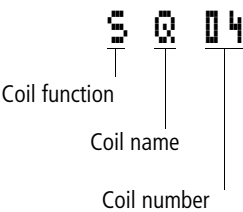
A contact of a function relay is assigned the name of the function block, the number and the contact function.

Example: Contact of comparator function block



If the contact on a network station is used, the address of the station is placed before the contact name.

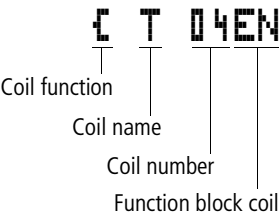
Example: Contact of a CL-NET station



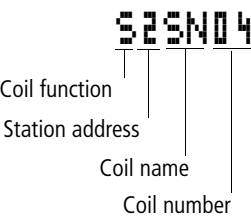
Coils

For a relay coil or function block select the coil function, coil or function block name, coil function block number and coil of the function block. For the coils of a CL-NET station you select the network address before the coil name.

Example: Relay coil output



Relay coil for timing relay function block with control coil



Relay coil of a CL-NET network station



A full list of all the contacts and relays is given in the overview starting on page 116.

I 01 Values for contacts and coil fields are changed in Entry mode. The value to be changed flashes.



The display system proposes the contact **I 01** or the coil **C 01** when starting entries in an empty field.

- ▶ Move the cursor using the buttons < > ^ v to a contact or coil field.
- ▶ Press **OK** to switch to Entry mode.
- ▶ Use < > to select the position you wish to change, or press **OK** to jump to the next position.
- ▶ Use ^ v to modify the value of the position.

The display system will leave Entry mode when you press < > or **OK** to leave a contact field or coil field.

In the contact field
to change I 01 to I 02

I 01	I 01	I 02
Q	>	02
M	or	03
HW	OK	04
C		05
T		.
P		.
D		.
S		99
:		
...		

>
or
OK

In the coil field
change C 01 to S 08

C 01	C 01	C 01	C 08
J	<	M	>
S		T	or
R		C	OK
P		.	02
L		.	03
...		.	08
...		...	
...		...	

>
or
OK

Deleting contacts and coils

- Move the cursor using the buttons < > ^ v to a contact or coil field.
- Press **DEL**.

The contact or the coil will be deleted, together with any connections.

Changing N/O contacts to N/C contacts

Every contact in the display system circuit diagram can be defined as either a N/O contact or a N/C contact.

- Switch to Entry mode and move the cursor over the contact name.
- Press **ALT**. The N/O contact will change to a N/C contact.
- Press **OK** 2 × to confirm the change.

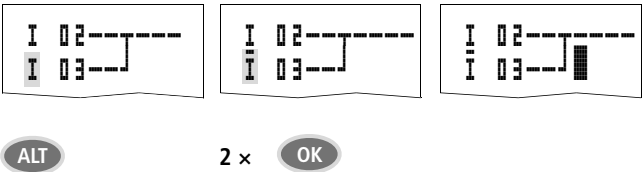


Figure: 78: Change contact I 03 from N/O to N/C

Creating and modifying connections

Contacts and relay coils are connected with the arrow in the Connect mode. Display system displays the cursor in this mode as an arrow.

- Use < > ^ v to move the cursor onto the contact field or coil field from which you wish to create a connection.



Do not position the cursor on the first contact field. At this position the **ALT** button has a different function (insert rung).

- ▶ Press **ALT** to switch to Connect mode.
- ▶ Use < > to move the diagonal arrow between the contact fields and coil fields and ^ v to move between rungs.
- ▶ Press **ALT** to leave Connect mode.

The display system will leave the mode automatically when you move the diagonal arrow onto a contact field or coil field which has already been assigned.



In a rung, the display system automatically connects contacts and the terminal to the relay coil if there are no empty fields in-between.

Never work backwards. You will learn why wiring backwards does not work in section "Effects on the creation of the circuit diagram", page 372.

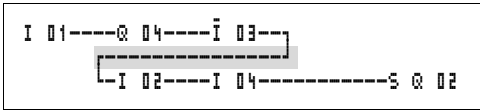


Figure: 79: Circuit diagram with five contacts, invalid

When wiring more than four contacts in series, use one of the 96 M marker relays.

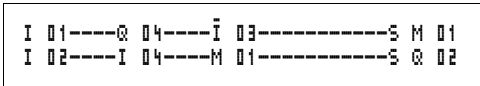


Figure: 80: Circuit diagram with M marker relay

Deleting connections

- ▶ Move the cursor onto the contact field or coil field to the right of the connection that you want to delete. Press **ALT** to switch to Connect mode.
- ▶ Press **DEL**.

The display system will delete a connection. Closed adjacent connections will be retained.

If several rungs are connected to one another, the display system first deletes the vertical connection. If you press **DEL** again, it will delete the horizontal connection as well.



You cannot delete connections that the display system has created automatically.

Close the delete operation with **ALT** or by moving the cursor to a contact or coil field.

Inserting and deleting a rung

The display system circuit diagram shows three of the 256 rungs in the display at the same time. If you move the cursor past the top or bottom of the display, the display system automatically scrolls up or down the display to show hidden rungs – even empty ones.

A new rung is added below the last connection or inserted above the cursor position:

- Position the cursor on the **first** contact field of a rung.
- Press **ALT**.

The existing rung with all its additional connections is “shifted” downwards. The cursor is then positioned directly in the new rung.

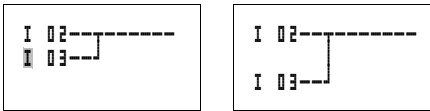


Figure: 81: Inserting a new rung

Saving circuit diagrams

- Press the **ESC** button to save a circuit diagram.

```

I 01----I 02---
Q 01----HY01Q1J
      ↑
SAVE +

```

The menu on the left appears in the status line.

- Press **OK**. The entire program, circuit diagram and function blocks will be saved.

After saving you will be in the CIRCUIT DIAGRAM menu.

Aborting circuit diagram entry

```

I 01----I 02---
Q 01----HY01Q1J
      ↑
CANCEL +

```

- If you want to exit without saving the circuit diagram, press **ESC**.
- Use the cursor buttons $\wedge \vee$ to select the CANCEL menu.
- Press **OK**.

The circuit diagram is closed without saving.

Searching for contacts and coils

You can search for contacts and coils in the following way:

```

I 01----I 02---
Q 01----HY01Q1J
      ↑
SEARCH +

```

- Press **ESC**. Use the cursor buttons $\wedge \vee$ to select the SEARCH menu.
- Press **OK**.

```

I 01----I 02---
Q 01----HY01Q1J
SEARCH I 01

```

- Select the desired contact, coil and number with the \vee and $\lt \gt$ cursor buttons.

With function relays, select the function block, the number and the coil.

- Confirm the search with the **OK** button.

```

I 01----I 02---
Q 01----HY01Q1J
L: 1 C:1 B:1140

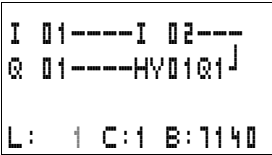
```

The device will search for the first occurrence of the contact or coil from the start of the search to the end of the circuit diagram. If no contact or coil is found, the display system circuit diagram editor will continue the search from the start of the circuit diagram. If a contact or coil is found, the display system editor automatically jumps to the respective field in the circuit diagram.

“Go to” a rung

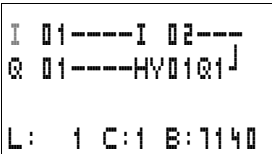
The display system circuit diagram editor provides a GO TO function in order to enable fast access to a rung.

- ▶ Press **ESC** and use the ^v cursor buttons to select the GO TO menu.
- ▶ Press **OK**.
- ▶ Select the required rung (L...) with the ^v cursor buttons.



The first contact on the rung is always indicated.

- ▶ Press **OK**.



The cursor remains stationary at the required rung contact L 1.

Deleting a rung

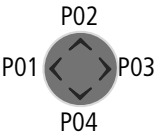
The display system will only remove empty rungs, i.e. those without contacts or coils.

- ▶ Delete all the contacts and coils from the rung.
- ▶ Position the cursor on the first contact field of the empty rung.
- ▶ Press **DEL**.

The subsequent rung(s) will be “pulled up” and any existing links between rungs will be retained.

Switching with the cursor buttons

With the display system, you can also use the four cursor buttons as hard-wired inputs in the circuit diagram.



The buttons are wired in the circuit diagram as contacts **F 01** to **F 04**. The P buttons can be activated and deactivated in the → System menu.

The P buttons can also be used for testing circuits or manual operation. These button functions are also useful for servicing and commissioning purposes.

Example 1

A lamp at output Q1 is switched on and off via inputs I1 and I2 or by using cursor buttons ^ or v.

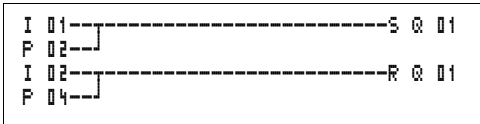


Figure: 82: Switch Q1 via I1, I2, ^, or v

Example 2

Input I1 is used to control output Q1. I5 switches over to cursor operation and via M 01 disconnects the rung I 01.

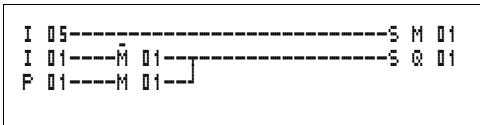
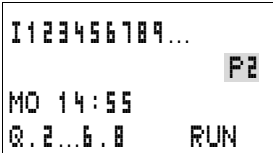


Figure: 83: I5 switches to cursor buttons.



The P buttons are only detected as switches in the Status menu.

The Status menu display shows whether the P buttons are used in the circuit diagram.



Displayed on the status display:

- P: button function wired and active.
- P2: Button function wired, active and P2 button ^ pressed.
- P-: Button function wired and not active.
- Empty field: P buttons not used.

Checking the circuit diagram

The display system contains a built-in measuring device enabling you to monitor the switching states of contacts, relays and function block coils during operation.

► Create the small parallel circuit below and save it.

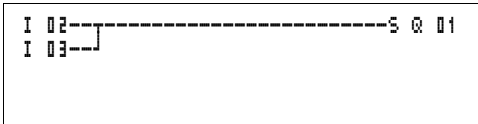


Figure: 84: Parallel circuit

- Switch display system to RUN mode via the main menu.
- Return to the circuit diagram display.

You are now unable to edit the circuit diagram.



If you switch to the circuit diagram display and are unable to modify a circuit diagram, first check whether the display system is in STOP mode.

The circuit diagram display performs two functions depending on the mode:

- STOP: Creation of the circuit diagram
- RUN: Power flow display

► Switch on I3.

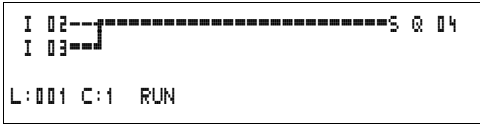


Figure: 85: Power flow display

In the power flow display, energized connections are thicker than non-energized connections.

You can follow energized connections across all rungs by scrolling the display up and down.

The bottom right of the power flow display indicates that the controller is in RUN mode (→ section “Power flow display with zoom function”, page 89).



The power flow display will not show signal fluctuations in the millisecond range. This is due to the inherent delay factor of LCD displays.

Function block editor

The display system has the FUNCTION RELAYS menu in order to edit the function blocks without circuit diagrams. The function blocks are an inherent component of the program.

Calling the function blocks via the FUNCTION RELAYS menu

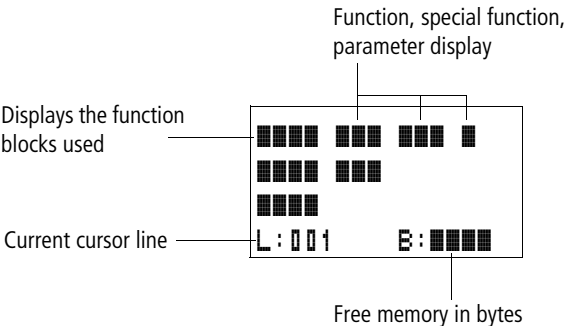


Figure: 86: Explanation of the function block display

Display of the function blocks for editing

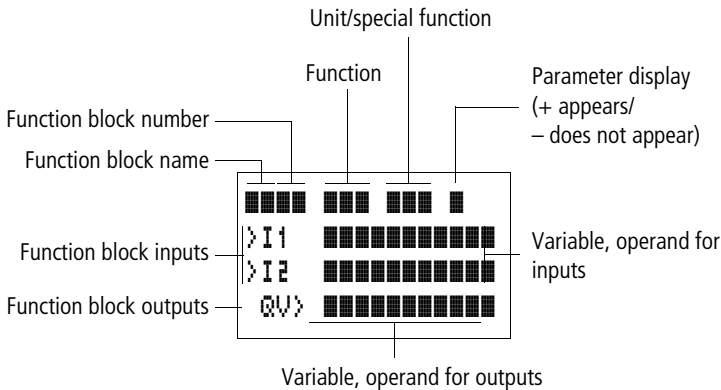
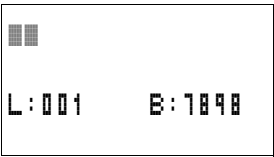


Figure: 87: Function block display during editing

Editing function blocks

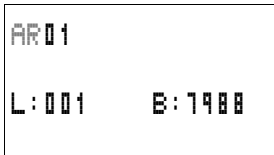
- Go to the FUNCTION RELAYS menu.
- Press the **OK** button.



The following display appears if no function blocks are present.

The cursor flashes.

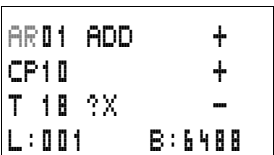
- Press the **OK** button.



The editor for inputting a function block is displayed.

Select the desired function block and number with the ^<> cursor buttons.

The functions of the individual function blocks are explained in the individual function block descriptions on the following pages.



This display appears if there are function blocks present.

The function blocks are created in the sequence in which they were edited.

Calling up function blocks from the circuit diagram

When you transfer parameters from the circuit diagram to a function block, move from the circuit diagram editor to the function block editor. Once you have assigned the parameters, you will return to the position where you left the circuit diagram with Save or Cancel. The operation is carried out in the same way as with circuit diagram operation.

```
T 01 X? M:S +
>I1 20:30
>I2
QV> MD96
L:001      B:7008
```

Example: Timing relay function block

Function block:	Timing relay
Switch function:	On time with random switching
Time range:	M:S (Minutes:Seconds)
Set time >I1:	20 min 30 s
Actual time QV>:	Copied to MD96

Assigning operands to an > input of a function block



Only the following variables can be assigned to the input of a function block:

- Constants, e.g.: 42,
- Markers such as MD, MW, MB,
- Analog output QA,
- Analog inputs IA,
- All output variables of the function blocks ...QV>

Assigning operands to a QV> output of a function block



A variable output of a function block can only be assigned markers such as MD, MW, MB or the analog output QA.

Deleting operands on the function block inputs/ outputs

Position the cursor on the required operand.

- Press the **DEL** button.

```
T 01 X? M:S +
>I1 ■■:30
>I2
QV> MD96
```

```

T 01 X? M:S +
>I1 ■■
>I2
QV> MD96
L:001      B:7808

```

The operand is deleted.

```

AR01 ADD      +
CP10          +
T 18 ?X       -
L:002      B:7808

```

Deleting an entire function block

Ensure that all contacts and coils of the function block are deleted.

► Select the required function block from the list.

In this case CP10.

► Press the **DEL** button.

```

AR01 ADD      +
T 18 ?X       -
L:001

```

The function block is deleted.

Checking function blocks

You can check function blocks in the same way as circuit diagrams. The device is in RUN mode.

Checking from the circuit diagram:

Position the cursor on a contact or a coil of the required function block. Press **OK**.

```

T 01 X? M:S +
>I1 20:30
>I2
QV> 14:42
.. EN..

```

The function block will be displayed, in this case a timing relay.

- >I1 = Set time of the timing relay,
- QV> = The actual value is 14 minutes 42 seconds.
- The enable coil is actuated, EN is visible.

If a coil of a function block is actuated in RUN mode, the coil name with the coil designation will appear on the display.

Checking the function block via the function block editor:

You access the function block list via the FUNCTION RELAYS menu.

```

AR01 ADD      +
CP10          +
T 10 ?X       -
L:001        RUN

```

```

AR01 ADD      +
>I1  20056
>I2   1095
QV> 21151

```

```

AR01 ADD      +
>I1  C 01QV>
>I2   1095
QV> MD 56

```

```

AR01 ADD      +
>I1  20056
>I2   1095
QV> 21151

```

Select the required function block:

In this case the arithmetic function block AR01 in the Adder mode.

► Press the **OK** button.

The function block is presented with the actual values and the result.

Displaying the operands when checking the function blocks:

If you want to know which operands are used on the function block inputs and outputs when checking the function block, press the **ALT** button on the displayed value.

The operand is displayed.

- >I1 = Actual value of counter C 01
- >I2 = Constant 1095
- QV> = Marker double word MD56






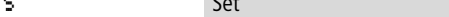

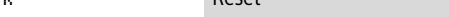






► Press the **ALT** button again.

The display shows the values.

Coil functions

You can set the coil function to determine the switching behaviour of relay coils. The following coil functions are assigned to all coils:




Table 10: Coil function





Display system display	Coil function	Example
	Contactor function	
	Impulse relay function	
	Set	
	Reset	
	Contactor function with negated result	
	Cycle pulse on rising edge	
	Cycle pulse on falling edge	

→ The function block descriptions state which coil functions can be used with the function block concerned.

Rules for wiring relay coils

Relay with contactor function

→ A coil should only be used once in order to retain an overview of the relay states. However, retentive coil functions such as , ,  can be used several times.

The following applies to non-retentive coil functions such as  (contactor),  (negated contactor), ,  (rising and falling edge detection): Each coil must only be used once. The last coil in the circuit diagram determines the status of the relay.

Exception: When working with jumps, the same coil can be used twice.

Coil with contactor function C

The output signal follows immediately after the input signal and the relay acts as a contactor.

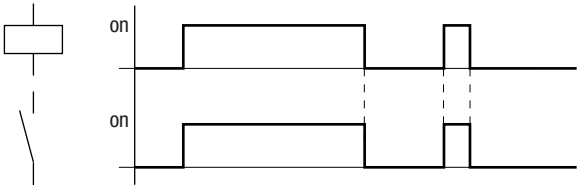


Figure: 88: Signal diagram of contactor function

Impulse relay J

The relay coil switches with every change of the input signal from 0 to 1. The relay behaves like a bistable flip-flop.

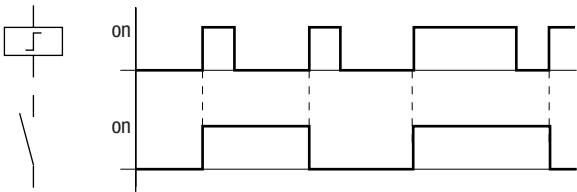


Figure: 89: Signal diagram of impulse relay

A coil is automatically switched off if the power fails and if STOP mode is active. Exception: Retentive coils retain signal 1 (see → section "Retention", page 363).

Set S and Reset R coil function

The Set S and Reset R coil functions are normally used in pairs.

The relay picks up when the coil is set (A) and remains in this state until it is reset (B) by the coil function.

The supply voltage is switched off (C), the coil does not have a retentive effect.

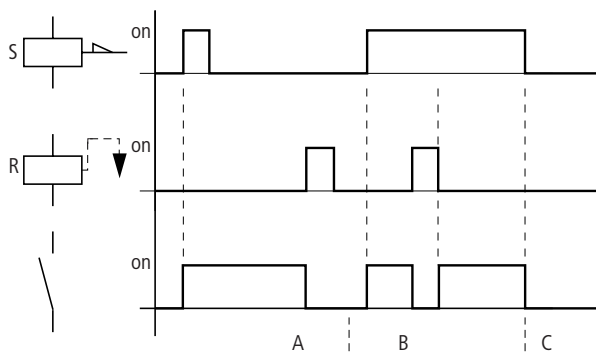


Figure: 90: Signal diagram of Set and Reset

If both coils are triggered at the same time, priority is given to the coil in the circuit diagram with the higher rung number. This is shown in the above signal diagram in section B.

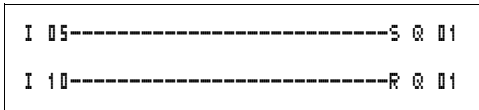


Figure: 91: Simultaneous triggering of Q 01

In the example above, the reset coil has priority with simultaneous triggering of the set and reset coils.

Coil negation (inverse contactor function) ¶

The output signal is simply an inversion of the input signal; the relay operates like a contactor with contacts that have been negated. If the coil is triggered with the state 1, the coil switches its N/O contacts to the state 0.

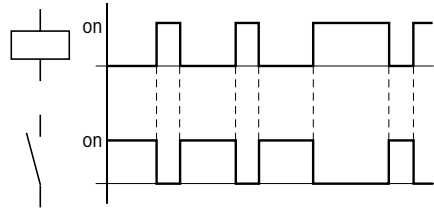


Figure: 92: Signal diagram of inverse contactor function

Rising edge evaluation (cycle pulse) \uparrow

This function is used if the coil is only meant to switch on a rising edge. With a change in the coil state from 0 to 1, the coil switches its N/O contacts to the state 1 for one cycle.

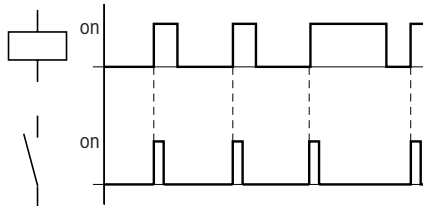


Figure: 93: Signal diagram of cycle pulse with rising edge

Falling edge evaluation (cycle pulse) \downarrow

This function is used if the coil is only meant to switch on a falling edge. With a change in the coil state from 1 to 0, the coil switches its N/O contacts to the state 1 for one cycle.

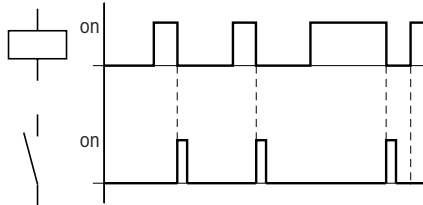


Figure: 94: Signal diagram of cycle pulse with falling edge



A set coil is automatically switched off if the power fails and if the device is in STOP mode.

Exception: Retentive coils retain signal 1 (see → section "Retention", page 363).

Function blocks

The function blocks are used to simulate some of the devices used in conventional open-loop and closed-loop control systems. The display system provides the following function blocks:

- Analog value comparator/threshold value switch (only with display system 24 V DC versions)
- Arithmetic,
 - addition, subtraction, multiplication, division
- Compare data blocks
- Transfer data blocks
- Boolean operation
- Counter,
 - up/down counters with upper and lower limit value,
 - preset,
 - Frequency counter,
 - High-speed counters,
 - Incremental counter
- Comparator
- Text, output freely editable texts, enter values
- Data function block
- PID controller
- Smoothing filters
- Value scaling
- Pulse width modulator
- Read (GET) data from the CL-NET
- Time switches,
 - Weekday/Time,
 - year, month, day (date),
- Numerical converter
- Master reset
- Operating hours counter
- Write (PUT) data to the CL-NET
- Synchronisation of date and time via the CL-NET

- Timing relay,
 - On-delayed,
 - On-delayed with random switching,
 - Off-delayed, also retriggerable
 - Off-delayed with random switching, also retriggerable
 - On- and off-delayed
 - On- and off-delayed with random switching,
 - single pulse,
 - synchronous flashing,
 - asynchronous flashing,
- Set cycle time
- Value limitation

The following applies to function blocks:



The most recent actual values are cleared if the power supply is switched off or if the display system is switched to STOP mode. Exception: Retentive data keeps its state (→ section "Retention", page 363).

The most recent actual values are transferred to the operands every cycle. The data function block is an exception.



Caution!

The following applies to RUN mode: The display system processes the function block after it passes through the circuit diagram. The last state of the coils is used for this.



If you want to prevent other people from modifying the parameters, change the access enable symbol from + to – when creating the circuit diagram and setting parameters. You can then protect the circuit diagram with a password.



Attention!

The function blocks are designed in such a way that a function block output can be assigned directly to the input of another function block. This enables you always to have an overview of which value is transferred.

If different data formats are used, such as if the first function block uses 32 bits and an 8-bit or 16-bit format is used for further processing, sign value errors or value errors may occur when transferring from one function block to another one.

Analog value comparator/threshold value switch

The display system provides 32 analog value comparators A 01 to A 32.

With an analog value comparator or threshold value switch you can, for example, compare analog input values with a set value.

All display system DC variants have analog inputs.

The following comparisons are possible:

- Function block input **> I 1 greater than/equal to, equal to, less than/equal to** function block input **> I 2**
- Using the factors **> F 1** and **> F 2** as inputs enables you to amplify and adjust the values of the function block inputs.
- Function block input **> O S** can be used as an offset for input **> I 1**.
- Function block input **> H V** is used as a positive and negative switching hysteresis of the **> I 2**. The contact switches according to the comparison mode of the function block.

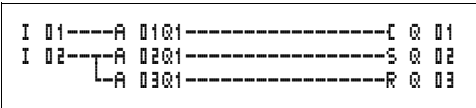


Figure: 95: Display system circuit diagram with analog value comparators

A 02 GT	+
>I1	
>F1	
>I2	
>F2	
>OS	
>HV	

Parameter display and parameter set for analog value comparators:

A 02	Analog value comparator function block number 02
GT	Greater than mode
+	Appears in the parameter display
>I1	Comparison value 1
>F1	Gain factor for >I1 ($>I1 = >F1 \times \text{value}$)
>I2	Comparison value 2
>F2	Gain factor for >I2 ($>I2 = >F2 \times \text{value}$)
>OS	Offset for the value of >I1
>HV	Switching hysteresis for value >I2 (Value HV applies to positive and negative hysteresis.)

Inputs

The function block inputs >I1, >F1, >I2, >F2, >OS and >HV can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Analog value comparator operating modes

Parameter	Function
GT	>I1 greater than >I2
EQ	>I1 equal to >I2
LT	>I1 less than >I2

Contacts

A 01Q1 to A 32Q1

Memory requirement of the analog value comparator

The analog value comparator function block requires 68 bytes of memory plus 4 bytes per constant on the function block inputs.

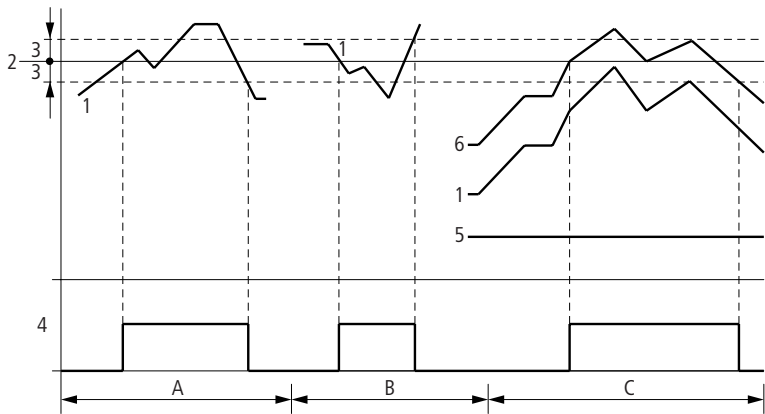


Figure: 96: Operational diagram analog value comparator

- 1: Actual value at >I1
- 2: Setpoint value on >I2
- 3: Hysteresis on >HV
- 4: Switching contact (N/O contact)
- 5: Offset for value >I1
- 6: Actual value plus offset

- Range A: Compare $\text{I1} > \text{I2}$
 - The actual value I1 increases.
 - The contact switches when the actual reaches the setpoint value.
 - The actual value changes and falls below the setpoint value minus the hysteresis.
 - The contact goes to the normal position.
- Range B: Compare $\text{I1} < \text{I2}$
 - The actual value drops.
 - The contact switches if the actual value reaches the setpoint value.
 - The actual value changes and rises above the value of the setpoint value plus hysteresis.
 - The contact goes to the normal position.
- Range C: Compare $\text{I1} > \text{I2}$ with offset
 - This example behaves as described in Range A. The offset value is added to the actual value.
- Comparison $\text{I1} = \text{I2}$ The contact switches on:
 - If the setpoint is exceeded with the actual value rising.
 - If the setpoint is undershot with the actual value decreasing.
 The contact switches off:
 - If the hysteresis limit is exceeded with the actual value rising.
 - If the hysteresis limit is undershot with the actual value decreasing.

Arithmetic function block

The display system provides 32 arithmetic function blocks AR01 to AR32.

The arithmetic function block is used for arithmetic operations. All four basic arithmetic operations are supported:

- add,
- subtract,
- multiply,
- divide.

Inputs

The function block inputs **>I1** and **>I2** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

An arithmetic function block is not wired in the circuit diagram.

```
AR32 ADD      +
>I1
>I2
QV>
```

Parameter display and parameter set for arithmetic function blocks:

AR32	Arithmetic function block number 32
ADD	Addition mode
+	Appears in the parameter display
>I1	First value
>I2	Second value
QV>	Result of the addition

Only constants can be modified in the parameter display of a function block.

Arithmetic function block modes

Parameter	Function
ADD	Addition of summand value ›I1 plus summand ›I2
SUB	Subtraction of minuend ›I1 minus subtrahend ›I2
MUL	Multiplication of factor ›I1 by factor ›I2
DIV	Division of dividend ›I1 by divisor ›I2

Value range

The function block operates in the integer range from –2 147 483 648 to +2 147 483 647.

Behaviour when value range is exceeded

- The function block sets the switching contact AR..CY to status 1.
- The function block retains the value of the last valid operation. The value is zero when it is first called.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

AR01CY to AR32CY: CARRY overflow bit, value on function block output greater than or less than the value range.

AR01ZE to AR32ZE: zero bit ZERO, value at the function block output equals zero

Coils

The arithmetic function block does not have any coils.

Memory requirement of the arithmetic function block

The arithmetic function block requires 40 bytes of memory plus 4 bytes per constant on the function block inputs.

Addition

$$42 + 1000 = 1042$$

2 147 483 647 + 1 = Last valid value of this arithmetic operation, due to overflow (CARRY)

AR..CY = Status 1

$$-2048 + 1000 = -1048$$

Subtraction

$$1134 - 42 = 1092$$

-2 147 483 648 - 3 = Last valid value of this arithmetic operation, due to overflow (CARRY)

AR..CY = Status 1

$$-4096 - 1000 = -5096$$

$$-4096 - (-1000) = -3096$$

Multiplication

$$12 \times 12 = 144$$

1 000 042 \times 2 401 = Last valid value of this arithmetic operation, due to overflow (CARRY)

Correct value = 2 401 100 842

AR..CY = Status 1

$$-1000 \times 10 = -10000$$

Division

$$1024:256 = 4$$

1024:35 = 29 (The places after the decimal point are omitted.)

1024:0 = Last valid value of this arithmetic operation, due to overflow (CARRY)

(mathematically correct: "Infinite") AR..CY = Status 1

$$-1000:10 = -100$$

$$1000:-10 = -100$$

$$-1000:(-10) = 100$$

$$10:100 = 0$$

Data block comparator

The display system provides 32 function blocks BC01 to BC32 for comparing values of two consistent marker ranges. The comparison is in byte format. The following marker types can be compared:

- MB,
- MW,
- MD.

The function block is enabled in the circuit diagram.

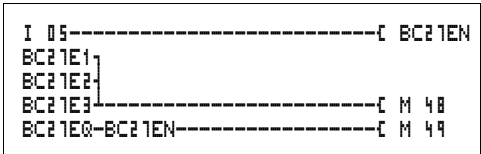


Figure: 97: Display system circuit diagram with enabling of data block comparator function block

BC27	+
>I1	
>I2	
>N0	

Parameter display and parameter set for a data block comparison function block:

BC27	Data block comparator function block number 27
+	Appears in the parameter display
>I1	Start of comparison range 1
>I2	Start of comparison range 2
>N0	Number of elements to be compared in bytes per range. Value range 1 to + 383

Only constants can be modified in the parameter display of a function block.

According to the operands at the inputs >I1 and >I2 the following operating modes are possible:

Inputs

The function block inputs **>I1**, **>I2** and **>NO** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Specifying the marker range without offset

If MB, MW or MD markers are specified at both **>I1** and **>I2** the number of the markers is the start of comparison range 1 or 2.

Specifying the marker range with offset

If you wish to work with an offset, specify one of the following variables at function block input **>I1** or **>I2**:

- Constant,
- Actual value ..QV of a function block,
- Analog input IA...,
- Analog output QA..

The value at the input is taken as the offset to marker MB01.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Call disabled

Contacts

BC01E1 to BC32E1: The number of comparison elements exceeds one of the comparison ranges.

BC01E2 to BC32E2: The two comparison ranges overlap.

BC01E3 to BC32E3: The specified offset of the comparison ranges is outside of the permissible range.

BC01EQ to BC32EQ: Output of the comparison result. Only valid if the BC..EN enable has been triggered. Status 0 = Comparison ranges not equal, Status 1 = Comparison ranges equal

Coils

BC01EN to BC32EN: Enable coil of the data block comparator function block.

Memory requirement of the data block comparator function block

The comparator function block requires 48 bytes of memory plus 4 bytes per constant on the function block inputs.

Function of the data block comparator function block

The data block comparator function block compares two contiguous data blocks.

The comparison is active if the BC..EN (enable) is triggered.



No data blocks are compared if an error is present.

The error outputs E1, E2 and E3 are evaluated regardless of the status of the enable.

Example:

Comparison of marker blocks, definition of marker ranges direct

Two marker blocks are to be compared. Block 1 starts at MB10, Block 2 starts at MB40. Each block is 10 bytes long.

Parameters of BC01 function block:

Comparison range 1: >I1 MB10

Comparison range 2: >I2 MB40

Number of bytes: >NO 10

Comparison range 1	Value of marker range 1 (decimal)	Comparison range 2	Value of marker range 2 (decimal)
MB10	39	MB40	39
MB11	56	MB41	56
MB12	88	MB42	88
MB13	57	MB43	57
MB14	123	MB44	123
MB15	55	MB45	55
MB16	134	MB46	134
MB17	49	MB47	49
MB18	194	MB48	194
MB19	213	MB49	213

The comparison result of the function block BC01 is:
BC01EQ = 1, the data block ranges have the same content.

Example:
Comparison of marker blocks, definition of a marker range with offset

Two marker blocks are to be compared. Block 1 starts at MB15, Block 2 starts at MB65. Each block is 4 bytes long.

Parameters of BC01 function block:
Comparison range 1: >I1 MB15
Comparison range 2: >I2 64
Number of bytes: >NO 4
Marker MB01: 1

→ Comparison range 2: Constant 64:
MB01 plus offset: 1 + 64 = 65 → MB65.

Comparison range 1	Value of marker range 1 (decimal)	Comparison range 2	Value of marker range 2 (decimal)
MB15	45	MB65	45
MB16	62	MB66	62
MB17	102	MB67	102
MB18	65	MB68	57

The comparison result of the function block BC01 is:
BC01EQ = 0, the data block ranges do not have the same content.

MB18 and MB68 are not identical.

Example:

Comparison of marker blocks, definition of a marker range in a different format.

Two marker blocks are to be compared. Block 1 starts at MB60, Block 2 starts at MD80. Each block is 6 bytes long.

Parameters of BC01 function block:

Comparison range 1: I1 MB60

Comparison range 2: I2 MD80

Number of bytes: >NO 6



The comparison is in byte format. MD80 has 4 bytes.
Therefore the first two bytes of MD81 are also compared.

Comparison range 1	Value of marker range 1 (decimal/binary)	Comparison range 2	Value of marker range 2 (decimal/binary)
MB60	45/ 00101101	MD80 (Byte 1, LSB)	1097219629/ 01000001011001100011111000 101101
MB61	62/ 00111110	MD80 (Byte 2)	1097219629/ 01000001011001100 01111100 0101101
MB62	102/ 01100110	MD80 (Byte 3)	1097219629/ 01000001 01100110 0011111000101101
MB63	65/ 01000001	MD80 (Byte 4, MSB)	1097219629/ 01000001 011001100011111000101101
MB64	173/ 10101101	MD81 (Byte 1, LSB)	15277/ 00111011 10101101
MB65	59/ 00111011	MD81 (Byte 2)	15277/ 00001000 10101101

The comparison result of the function block BC01 is: BC01EQ = 0, the data block ranges do not have the same content.

MB65 and MD81 (Byte 2) are not identical.

Example:

Comparison of marker blocks, range violation error.

Two marker blocks are to be compared. Block 1 starts at MD60, Block 2 starts at MD90. Each block is 30 bytes long.

Parameters of BC01 function block:

Comparison range 1: > **I1 MD60**

Comparison range 2: > **I2 MD90**

Number of bytes: > **N0 30**



The comparison is in byte format. MD90 to MD96 is 28 bytes. The number of bytes is 30 bytes.

The error message "Number of comparison elements exceeds one of the comparison ranges" is output.

BC01E1 is 1.

Example:

Comparison of marker blocks, range overlap error.

Two marker blocks are to be compared. Block 1 starts at MW60, Block 2 starts at MW64. Each block is 12 bytes.

Parameters of BC01 function block:

Comparison range 1: **I1 MW60**

Comparison range 2: **I2 MW64**

Number of bytes: **>NO 12**



The comparison is in byte format. MW60 to MW64 is 8 bytes. The number of bytes is 12 bytes.

The error message "Comparison ranges overlap" is output.

BC01E2 is 1.

Example:

Comparison of marker blocks, invalid offset error.

Two marker blocks are to be compared. Block 1 starts at MW40, block 2 starts at MW54. The block length is defined by the value of counter C 01QV.

Parameters of BC01 function block:

Comparison range 1: **I1 MW40**

Comparison range 2: **I2 MW54**

Number of bytes: **>NO C 01QV**



The value of C 01QV is 1024. This value is too big.
The value at **>NO** can be between 1 and +383.

The message "The specified offset of the comparison ranges is outside of the permissible range" is output.

BC01E3 is 1.

Data block transfer

The display system is provided with 32 function blocks BT01 to BT32 for transferring values from one marker range to another (copy data). The marker ranges can be overwritten with a particular value (data initialisation). The following marker types can be transferred and overwritten:

- MB,
- MW,
- MD.

The function block is enabled in the circuit diagram.

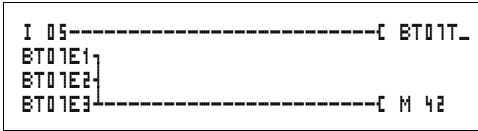


Figure: 98: Display system circuit diagram with enabling of transfer data block function block

BT01	INI	+
>I1		
>I2		
>NO		

Parameter display and parameter set for a data block transfer function block:

BT01	Data block transfer function block number 07
INI	INI mode, initialise marker ranges
+	Appears in the parameter display
>I1	Source range start
>I2	Destination range start
>NO	Number of elements to be written in bytes per range. Value range 1 to + 383

Only constants can be modified in the parameter display of a function block.

Operating modes of the transfer data block function block

Parameter	Function
INI	Initialise marker ranges
CPV	Copy marker ranges

Inputs

The function block inputs >I1, >I2 and >NO can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Specifying the marker range without offset

If MB, MW or MD markers are specified both at >I1 and at >I2, the number of markers defines the source or destination range.

Specifying a marker range with offset

If you wish to work with an offset, specify one of the following variables at function block input >I1 or >I2 :

- Constant,
- Actual value ..QV of a function block,
- Analog input IA...,
- Analog output QA..

The value at the input is taken as the offset to marker MB01.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Call disabled

Contacts

BT01E1 to BT32E1: The number of marker bytes exceeds the source or destination range.

BT01E2 to BT32E2: Source and destination range overlap. Only valid for CPY mode, copy marker ranges.

BT01E3 to BT32E3: The specified offset is invalid.

Coils

BT01T_ to BT32T_: Trigger coil of the transfer data block function block.

Memory requirement of the transfer data block function block

The transfer data block function block requires 48 bytes of memory plus 4 bytes per constant at the function block inputs.

Function of the transfer data block function block

The transfer data block comparator function block has two operating modes.



No data blocks are initialised or copied if an error occurs.

INI mode, initialise marker ranges

There is one source range and one destination range. The source range is specified at $\text{I}1$. The length of the source range is one byte. The destination range is specified at $\text{I}2$. The length of the destination range is specified by the number of bytes at the $\text{I}0$ input.

The content of the source range is transferred to the marker bytes in the destination range.

The function block executes the transfer if there is a rising edge from 0 to 1 at the BT..T_ (Trigger) coil.

The error outputs E1, E2 and E3 are evaluated regardless of the status of the trigger.

Example:

Initialising marker blocks, specifying marker ranges directly
The value of marker byte 10 is to be transferred to marker bytes 20 to 29.

Parameters of BT01 function block:
Source range: >I1 MB10
Destination range:>I2 MB20
Number of bytes: >NO 10

Source range	Value of source marker range (decimal)	Target range	Value of destination marker range (decimal)
MB10	123	MB20	123
		MB21	123
		MB22	123
		MB23	123
		MB24	123
		MB25	123
		MB26	123
		MB27	123
		MB28	123
		MB29	123

After a rising edge from 0 to 1 at coil BT01T_ the value 123 is present in the marker bytes MB20 to MB29.

Example:

Initialisation of marker blocks, definition of a range with offset
The content of marker byte MB15 is to be transferred to marker bytes MB65 to MB68.

Parameters of BT01 function block:
Source range: >I1 MB15
Destination range:>I2 64
Number of bytes: >NO 4
Marker MB01: 1



Destination range: Constant 64:
Marker MB01 plus Offset: 1 + 64 = 65 → MB65.

Source range	Value of source marker range (decimal)	Target range	Value of destination marker range (decimal)
MB15	45	MB65	45
		MB66	45
		MB67	45
		MB68	45

After a rising edge from 0 to 1 at coil BT01T_ the value 45 is present in the marker bytes MB65 to MB68.

Example:
Initialisation of marker blocks, definition of a range in a different format.

The value of marker byte MB60 is to be transferred to MD80 and MD81.

Parameters of BT01 function block:
Source range: >I1 MB60
Destination range:>I2 MD80
Number of bytes: >N0 8



The transfer is in byte format. MD80 has 4 bytes and MD81 has 4 bytes, which means that <N0 has the value 8.

Comparison range 1	Value of marker range 1 (decimal/binary)	Comparison range 2	Value of marker range 2 (decimal/binary)
MB60	45/ 00101101	MD80 (Byte 1, LSB)	757935405/ 001011010010110100101101 00101101
		MD80 (Byte 2)	757935405/ 0010110100101101 00101101 00101101
		MD80 (Byte 3)	757935405/ 00101101 00101101 0010110100101101
		MD80 (Byte 4, MSB)	757935405/ 00101101 001011010010110100101101
		MD81 (Byte 1, LSB)	757935405/ 001011010010110100101101 00101101
		MD81 (Byte 2)	757935405/ 0010110100101101 00101101 00101101
		MD81 (Byte 3)	757935405/ 00101100 01011011 0010110100101101
		MD81 (Byte 4, MSB)	757935405/ 00101101 001011010010110100101101

After a rising edge from 0 to 1 at coil BT01T_ the value 757935405 is present in the marker double words MD80 and MD81.

Example:

Transfer of marker byte, range violation error.

The value of marker byte MB96 is to be transferred to MD93, MD94, MD95 and MD96. The length is 16 bytes.

Parameters of BT01 function block:

Source range: >I1 MD96

Destination range:>I2 MD93

Number of bytes: >N0 18



The transfer is in byte format. MD93 to MD96 is 16 bytes. 18 bytes were incorrectly defined as length.

The error message “Number of elements exceeds the destination range” is output.

BT01E1 is 1.

Example:

Transfer of marker bytes, invalid offset error.

The value of marker byte MB40 is to be transferred to MW54 and subsequent marker words. The block length is specified by the value of the counter C 01QV.

Parameters of BT01 function block:

Comparison range 1: **I1 MB40**

Comparison range 2: **I2 MW54**

Number of bytes: **NO C 01QV**



The value of C 01QV is 788. This value is too big.
The value at **NO** can be between 1 and +383.

The message “The specified offset of the destination range is outside of the permissible range” is output.

BT01E3 is 1.

CPY mode, copy marker ranges

There is one source range and one destination range. The source range is specified at **I1**. The destination range is specified at **I2**. The length of the source and destination range is specified by the number of bytes at the **NO** input.

The content of the source range is copied to the marker bytes in the destination range.

The function block executes the copy operation if there is a rising edge from 0 to 1 at the BT..T_ (Trigger) coil.

The error outputs E1, E2 and E3 are evaluated regardless of the status of the trigger.

Example:

Copy of marker blocks, definition of marker ranges direct

The content of marker bytes 10 to 19 is to be transferred to marker bytes 20 to 29.

Parameters of BT01 function block:

Source range: >I1 MB10

Destination range: >I2 MB20

Number of bytes: >NO 10

Source range	Value of source marker range (decimal)	Target range	Value of destination marker range (decimal)
MB10	42	MB20	42
MB11	27	MB21	27
MB12	179	MB22	179
MB13	205	MB23	205
MB14	253	MB24	253
MB15	17	MB25	17
MB16	4	MB26	4
MB17	47	MB27	47
MB18	11	MB28	11
MB19	193	MB29	193

After a rising edge from 0 to 1 at coil BT01T_ the content of MB10 to MB19 is copied to the marker bytes MB20 to MB29.

Example:

Copying of marker blocks, definition of a marker range with offset

The content of marker bytes MB15 to MB18 is to be copied to marker bytes MB65 to MB68.

Parameters of BT01 function block:

Source range: >I1 MB15

Destination range:>I2 64

Number of bytes: >NO 4

Marker MB01: 1



Destination range: Constant 64:
Marker MB01 plus offset: 1 + 64 = 65 → MB65.

Source range	Value of source marker range (decimal)	Target range	Value of destination marker range (decimal)
MB15	68	MB65	68
MB16	189	MB66	189
MB17	203	MB67	203
MB18	3	MB68	3

After a rising edge from 0 to 1 at coil BT01T_ the content of MB15 to MB18 is copied to the marker bytes MB65 to MB68.

Example:

Copying of marker blocks, definition of a marker range in a different format.

The value of marker byte MD60 to MD62 is to be copied to MW40 to MW45.

Parameters of BT01 function block:

Source range: >I1 MD60

Destination range:>I2 MW40

Number of bytes: >N0 12



The transfer is in byte format. 12 bytes are to be copied. The range MD60 to MD62 is 12 bytes. This is copied to the range MW40 to MW45.

Comparison range 1	Value of marker range 1 (decimal/binary)	Comparison range 2	Value of marker range 2 (decimal/binary)
MD60	866143319/ 0011001110100000 0100110001010111	MW40 (LSW)	19543/ 0011001110100000 0100110001010111
MD60	866143319/ 0011001110100000 0100110001010111	MW41 (MSW)	13216/ 0011001110100000 0100110001010111
MD61	173304101/ 0000101001010100 0110100100100101	MW42 (LSW)	26917/ 0000101001010100 0110100100100101
MD61	173304101/ 0000101001010100 0110100100100101	MB43 (MSW)	2644/ 0000101001010100 0110100100100101
MD62	982644150/ 0011101010010001 1111010110110110	MB44 (LSW)	62902/ 0011101010010001 1111010110110110
MD62	982644150/ 0011101010010001 1111010110110110	MB45 (MSW)	14993/ 0011101010010001 1111010110110110

After a rising edge from 0 to 1 at coil BT01T_ the values are copied to the appropriate range.

Example:

Copying of marker bytes, destination range violation error.

The value of marker bytes MB81 to MB96 is to be transferred to MD93, MD94, MD95 and MD96. The length is 16 bytes.

Parameters of BT01 function block:

Source range: >I1 MB81

Destination range:>I2 MD93

Number of bytes: >NO 18



The transfer is in byte format. MD93 to MD96 is 16 bytes. 18 bytes were incorrectly defined as length.

The error message “Number of elements exceeds the destination range” is output.

BT01E1 is 1.

Example:

Comparison of marker blocks, range overlap error.

12 bytes are to be copied starting from MW60. MW64 is specified as destination address.

Parameters of BT01 function block:

Comparison range 1: >I1 MW60

Comparison range 2: >I2 MW64

Number of bytes: >NO 12



The copy operation is in byte format. MW60 to MW64 is 8 bytes. The number of bytes is 12 bytes.

The error message "Both ranges overlap" is output.

BC01E2 is 1.

Example: Copying of marker bytes, invalid offset error.

The value of marker word MW40 is to be copied to MW54 and subsequent marker words. The block length is specified by the value of the counter C 01QV.

Parameters of BT01 function block:

Comparison range 1: >I1 MW40

Comparison range 2: >I2 MW54

Number of bytes: >NO C 01QV



The value of C 01QV is 10 042. This value is too big. The value at >NO can be between 1 and +383.

The message "The specified offset of the destination range is outside of the permissible range" is output.

BT01E3 is 1.

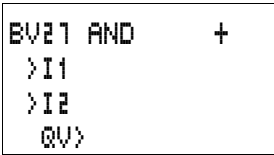
Boolean operation

The display system provides 32 function blocks from BV01 to BV32 for Boolean operations with values.

The following possibilities are provided by the Boolean operation function block:

- Masking out of particular bits from values,
- Bit pattern recognition,
- Bit pattern modification.

A Boolean operation function block is not wired in the circuit diagram.



Parameter display and parameter set for Boolean operation function block:

BV27	Boolean operation function block number 27
AND	AND operation
+	Appears in the parameter display
>I1	First value
>I2	Second value
@V>	Result of the operation

Only constants can be modified in the parameter display of a function block.

Operating modes of the Boolean operation function block

Parameter	Function
AND	AND operation
OR	OR operation
XOR	Exclusive OR operation
NOT	Negation of the Boolean value of >I1

Value range

32 bit signed value

Inputs

The function block inputs $\rightarrow I1$ and $\rightarrow I2$ can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Call disabled

Contacts

BV01ZE to BV32ZE: zero bit ZERO, value at the function block output equals zero

Coils

The Boolean operation function block does not have coils.

Memory requirement Boolean operation function block

The Boolean operation function block requires 40 bytes of memory plus 4 bytes per constant on the function block inputs.

NOT Boolean operation

Value $\rightarrow I1$: $13219_{dec} = 00000000000000000011001110100011_{bin}$

Value $\rightarrow I2$: Omitted

Result QV>: $-13220_{dec} = 11111111111111111100110001011100_{bin}$

The NOT operation operates as follows:

$\rightarrow I1$, positive value

Negate value of $\rightarrow I1$ and subtract 1:

$$-|\rightarrow I1| - 1 = \rightarrow I2$$

$\rightarrow I1$, negative value

Negate value of $\rightarrow I1$ and subtract 1:

$$-|\rightarrow I1| - 1 = \rightarrow I2$$

Counter

The display system provides 32 up/down counters C 01 to C 32 for use. The counter relays allow you to count events. You can enter upper and lower threshold values as comparison values. The contacts will switch according to the actual value. To specify a start value, for example, counting from the value 1 200, this can be implemented using a "C.." counter.

The "C.." counters are cycle time dependent.

Wiring of a counter

You integrate a counter into your circuit in the form of a contact and coil. The counter relay has different coils and contacts.



To prevent unpredictable switching states, use each coil of a relay once only in the circuit diagram.

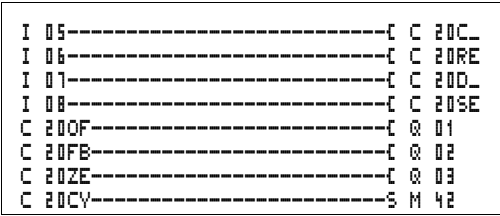


Figure: 99: Display system circuit diagram with counter relay

C 20	+
>SH	
>SL	
>SV	
QV>	

Parameter display and parameter set for counter relays:

C 20	Counter relay function block number 20
+	Appears in the parameter display
>SH	Upper setpoint
>SL	Lower setpoint
>SV	Defined actual value (Preset)
QV>	Actual value in RUN mode

In the parameter display of a counter relay you change setpoint values and/or the preset value and the enable of the parameter display.

Value range

The function block operates in the integer range from -2 147 483 648 to +2 147 483 647.

Behaviour when value range is exceeded

The function block sets the switching contact C .. CY to the status 1 and retains the value of the last valid operation.

→ Counter C counts on every rising edge at the count input. If the value range is exceeded, the switching contact C ..CY switches to status 1 for one cycle per rising edge detected.

Inputs

The function block inputs >SH , >SL and >SV can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

- C 01OF to C 32OF: Actual value \geq upper setpoint
- C 01FB to C 32FB: Actual value \leq Lower setpoint value
- C 01ZE to C 32ZE: Actual value = Zero
- C 01CY to C 32CY: Value range exceeded

Coils

- C 01C_ to C 32C_: Counter coils, count with rising edge
- C 01D to C 32D: Count direction definition,
Status 0 = Count upwards, Status 1 = Count downwards
- C 01RE to C 32RE: Reset actual value to zero
- C 01SE to C 32SE: Accept defined actual value with rising edge.

Memory requirement of the counter relay

The counter relay function block requires 52 bytes of memory plus 4 bytes per constant on the function block inputs.

Retention

Counter relays can be operated with retentive actual values. The number of retentive counter relays can be selected in the SYSTEM → RETENTION menu.

The retentive actual value requires 4 bytes of memory.

If a counter relay is retentive, the actual value is retained when the operating mode changes from RUN to STOP as well as when the power supply is switched off.

When the display system is restarted in RUN mode, the counter relay continues with the retentively stored actual value.

Function of the counter function block

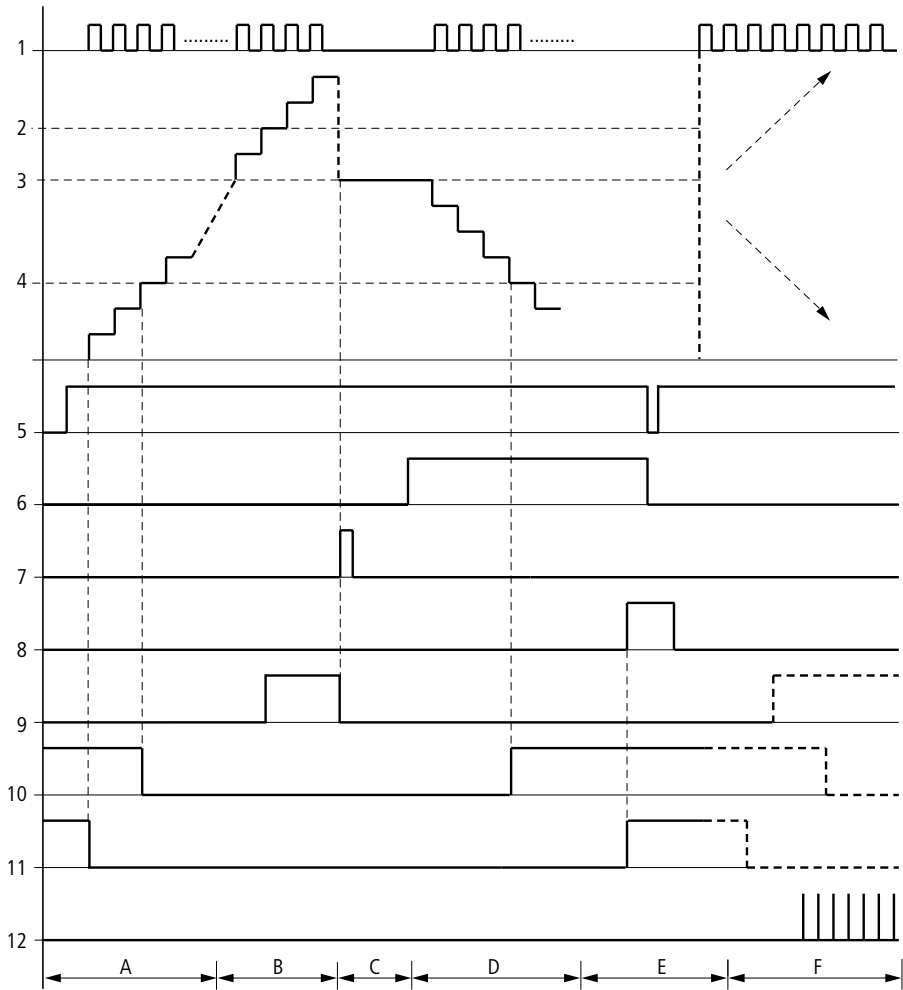


Figure: 100: Signal diagram of counter

- 1: Counter coil C..C_
- 2: Upper setpoint value >SH
- 3: Preset actual value >SV
- 4: Lower setpoint value >SL
- 5: Counting direction, coil C..D_
- 6: Accept preset actual value, coil C..SE

7: Reset coil C..RE

8: Contact (N/O contact) C..OF upper setpoint value reached, exceeded

9: Contact (N/O contact) C..FB lower setpoint value reached, undershot

10: Actual value equal to zero

11: Out of value range

- Range A:
 - The counter has the value zero.
 - The contacts C..ZE (actual value equal to zero) and C..FB (lower setpoint value undershot) are active.
 - The counter receives counter values and increases the actual value.
 - C..ZE (or CH) drop out when $f > 0$ Hz and C..FB (or CH) after the lower set value is reached.
- Range B:
 - The counter counts upwards and reaches the upper setpoint value. The “upper setpoint value reached” contact C..OF becomes active.
- Range C:
 - The coil C..SE is briefly actuated and the actual value is set to the preset actual value. The contacts switch to the appropriate position.
- Range D:
 - The counting direction coil C..D_ is actuated. If counting pulses are present, downward count is initiated.
 - If the lower setpoint value is undershot, the contact C..FB becomes active.
- Range E:
 - The reset coil C..RE is activated. The actual value is set to zero.
 - The contact C..ZE is active.
- Range F:
 - The actual value goes outside the value range of the counter.
 - The contacts become active according to the direction of the values (positive or negative).

High-speed counters

The display system provides various high-speed counter functions. These counter function blocks are coupled directly to digital inputs. The high-speed counter functions are only available with DC display I/O module.

The following functions are possible:

- Frequency counters, measure frequencies **CF..**
- High-speed counters, count high-speed signals **CH..**
- Incremental counter, count dual-channel incremental encoder signals **CI..**

The high-speed digital inputs are I1 to I4.

The following wiring rules apply:

- I1: CF01 or CH01 or CI01
- I2: CF02 or CH02 or CI01
- I3: CF03 or CH03 or CI02
- I4: CF04 or CH04 or CI02



Caution!

Each digital input I .. may only be used once by the CF, CH, CI function blocks.

The incremental encoder requires an input pair.

Example:

- I1: High-speed counter CH01
- I2: Frequency counter CF02
- I3: Incremental encoder channel A CI02
- I4: Incremental encoder channel B CI02

Example: Function block list in the FUNCTION RELAYS menu:

CI01

CF01

CH01

All function blocks access digital input I1.

Only CH01 supplies the correct value.

Frequency counter

The display system provides four frequency counters which are CF01 to CF04. The frequency counters can be used for measuring frequencies. You can enter upper and lower threshold values as comparison values. The high-speed frequency counters are permanently connected to the digital inputs I1 to I4.

The CF.. frequency counters are not dependent on the cycle time.

Counter frequency and pulse shape

The maximum counter frequency is 3 kHz.

The minimum counter frequency is 4 Hz.

The signals must be square waves. The mark-to-space ratio is 1:1.

Measurement method

The pulses at the input are counted for one second and the frequency determined irrespective of the cycle time. The measurement result is provided at the function block output CF..QV.

Wiring of a counter

The following assignment of the digital inputs apply.

- I1 count input for counter CF01
- I2 count input for counter CF02
- I3 count input for counter CF03
- I4 count input for counter CF04



Avoid unforeseeable switch states. Only use each coil of a relay once in the circuit diagram. Use a counter input for the CF, CH, CI counters only once.

Wiring of a frequency counter

You integrate a frequency counter into your circuit in the form of a contact and coil. The counter relay has different coils and contacts.



Figure: 101: Display system circuit diagram with frequency counter

CF01	-
>SH	
>SL	
QV>	

Parameter display and parameter set for frequency counter:

CF01	Frequency counter function block number 01
-	Does not appear in the parameter display
>SH	Upper setpoint
>SL	Lower setpoint
QV>	Actual value in RUN mode

In the parameter display of a counter relay you change setpoint values and/or the preset value and the enable of the parameter display.

Value range

The function block operates in the integer range from 0 to 5000

1 kHz = 1000

Behaviour when value range is exceeded

The value range cannot be exceeded as the maximum measured value is less than the value range.

Inputs

The function block inputs >SH and >SL can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

- CF01OF to CF04OF: Actual value \geq Upper setpoint
- CF01FB to CF04FB: Actual value \leq Lower setpoint
- CF01ZE to CF04ZE: Actual value = Zero

Coils

CF01EN to CF04EN: Enable of the counter with coil status = 1.

Memory requirement of the frequency counter

The frequency counter function block requires 40 bytes of memory plus 4 bytes per constant on the function block inputs.

Retention

The frequency counter does not retain actual values, as the frequency is remeasured continuously.

Function of the frequency counter function block

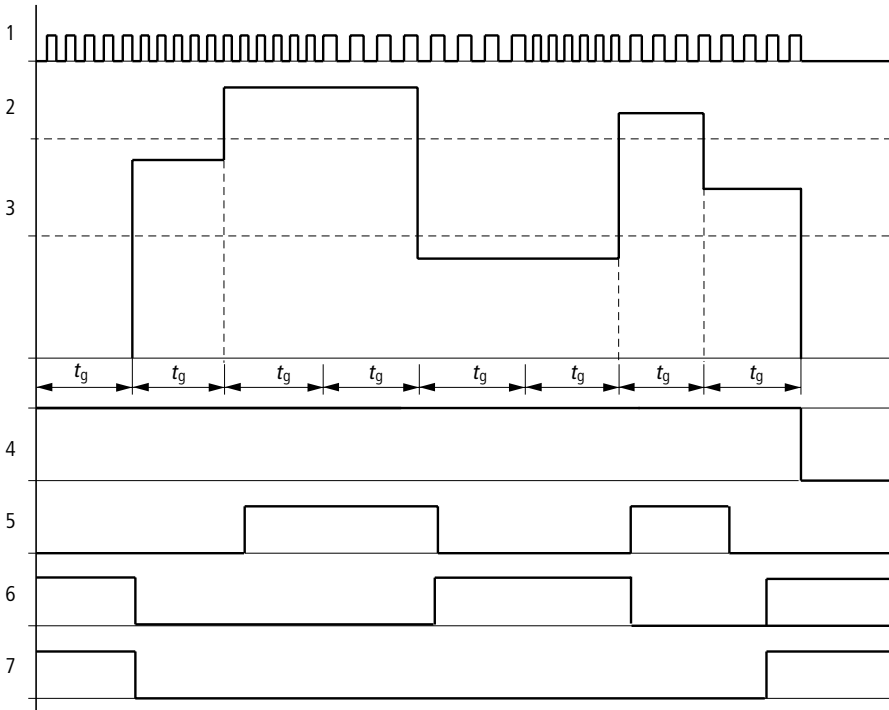


Figure: 102: Signal diagram of frequency counter

1: Counter input I1 to I4

2: Upper setpoint value $\geq H$ 3: Lower setpoint value $\leq L$

4: Enable CF..EN

5: Contact (N/O contact) CF..OF upper setpoint value exceeded

6: Contact (N/O contact) CF..FB lower setpoint value undershot

7: Actual value equal to zero CF..ZE

 t_g : Gate time for the frequency measurement

- The first measurements are made after the CF..EN enable signal has been activated. The value is output after the gate time has timed out.
- The contacts are set in accordance with the measured frequency.
- If the CF..EN enable signal is removed, the output value is set to zero.

High-speed counters

The display system provides four high-speed up/down counters CH01 to CH04 for use. The high-speed counter inputs are permanently connected to the digital inputs I1 to I4. These counter relays allow you to count events independently of the cycle time. You can enter upper and lower threshold values as comparison values. The contacts will switch according to the actual value. To specify a start value, for example, counting from the value 1989, this can be implemented using a CH... counter.

The CH... counters are not dependent on the cycle time.

Counter frequency and pulse shape

The maximum counter frequency is 3 kHz.

The signals must be square waves. The mark-to-space ratio is 1:1.

Wiring of a counter

The following assignment of the digital inputs apply.

- I1 count input for counter CH01
- I2 count input for counter CH02
- I3 count input for counter CH03
- I4 count input for counter CH04



Avoid unforeseeable switch states. Only use each coil of a relay once in the circuit diagram. Use a counter input for the CF, CH, CI counters only once.

You integrate a counter into your circuit in the form of a contact and coil. The counter relay has different coils and contacts.

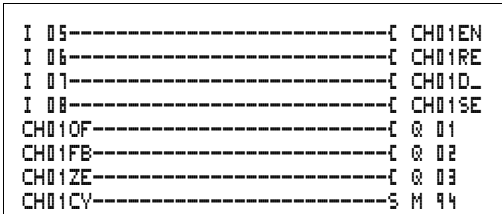


Figure: 103: Display system circuit diagram with high-speed counter

CH01	+
>SH	
>SL	
>SV	
QV>	

Parameter display and parameter set for high-speed counters:

CH01	High-speed counter function block number 01
+	Appears in the parameter display
>SH	Upper setpoint
>SL	Lower setpoint
>SV	Preset actual value
QV>	Actual value in RUN mode

In the parameter display of a counter relay you change setpoint values and/or the preset value and the enable of the parameter display.

Value range

The function block operates in the integer range from –2 147 483 648 to 2 147 483 647.

Behaviour when value range is exceeded

- The function block sets the switching contact CH..CY to status 1.
- The function block retains the value of the last valid operation.



The counter CH counts on every rising edge at the counter input. If the value range is exceeded, the switching contact CH ..CY switches to status 1 for one cycle per rising edge detected.

Inputs

The function block inputs >SH, >SL and >SV can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12,
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01



The actual value is only cleared in RUN mode with a specific reset signal.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

- CH01OF to CH04OF: Actual value \geq Upper setpoint
- CH01FB to CH04FB: Actual value \leq Lower setpoint
- CH01ZE to CH04ZE: Actual value = Zero
- CH01CY to CH04CY: Value range exceeded

Coils

- CH01EN to CH04EN: Enable of the counter
- CH01D to CH04D: Count direction definition, Status 0 = Count upwards, Status 1 = Count downwards
- CH01RE to CH04RE: Reset actual value to zero
- CH01SE to CH04SE: Accept preset actual value with rising edge.

Memory requirement of the high-speed counter

The high-speed counter function block requires 52 bytes of memory plus 4 bytes per constant on the function block inputs.

Retention

High-speed counter relays can be operated with retentive actual values. The number of retentive counter relays can be selected in the SYSTEM → RETENTION menu.

If a counter relay is retentive, the actual value is retained when the operating mode changes from RUN to STOP as well as when the power supply is switched off.

When the display system is restarted in RUN mode, the counter relay continues with the retentively stored actual value.

Function of the high-speed counter function block

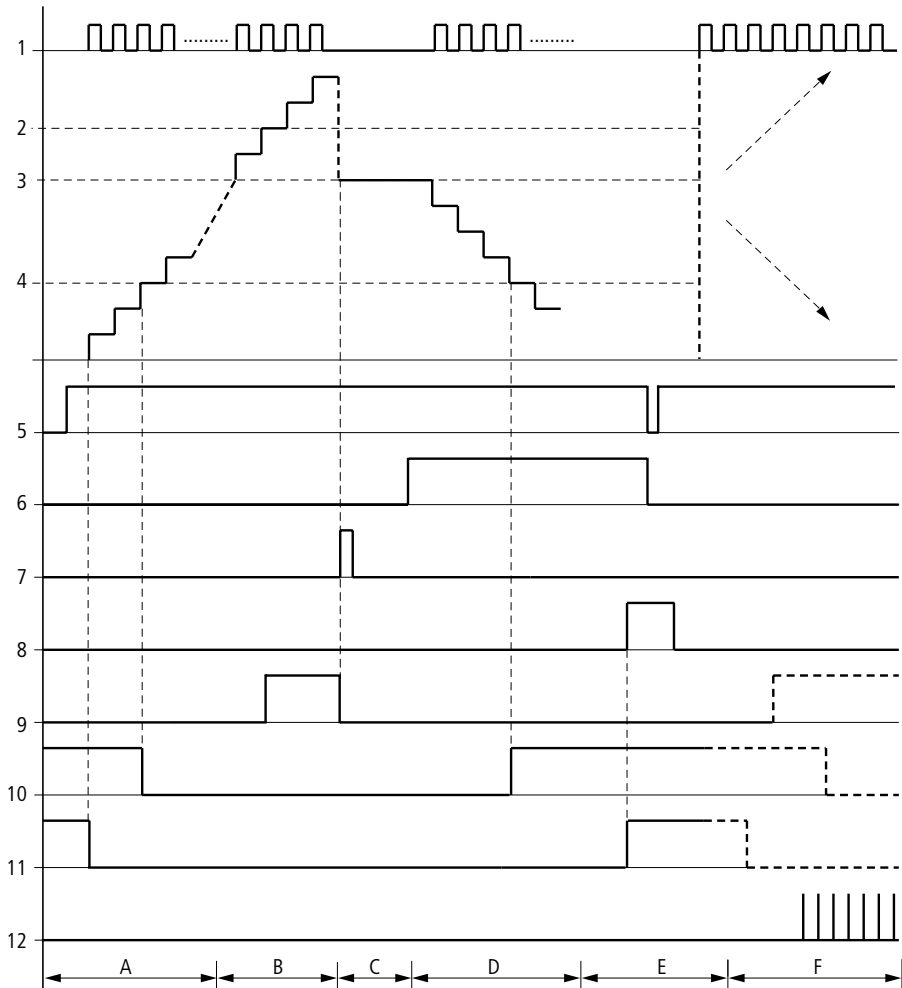


Figure: 104: Signal diagram of high-speed counter

- 1: Counter input I1 to I4
- 2: Upper setpoint value SVH
- 3: Preset actual value SV
- 4: Lower setpoint value SVL

- 5: Enable of the counter CH...EN
- 6: Counting direction, coil CH...D
- 7: Accept preset actual value, coil CH..SE
- 8: Reset coil CH...RE
- 9: Contact (N/O) CH...OF upper setpoint value reached, exceeded
- 10: Contact (N/O) CH...FB lower setpoint value reached, undershot
- 11: Contact (N/O contact) CH...ZE actual value equal to zero
- 12: Out of value range
- Range A:
 - The counter has the value zero.
 - The contacts CH..ZE (actual value = zero) and CH..FB (lower setpoint value undershot) are active.
 - The counter receives counter values and increases the actual value.
 - C..ZE (or CH) drop out when $f > 0$ Hz and C..FB (or CH) after the lower set value is reached.
- Range B:
 - The counter counts upwards and reaches the upper setpoint value. The contact "upper setpoint value" CH...OF becomes active.
- Range C:
 - The coil CH..SE is briefly actuated and the actual value is set to the preset actual value. The contacts switch to the appropriate position.
- Range D:
 - The counting direction coil CH...D is actuated. If counting pulses are present, downward count is initiated.
 - If the lower setpoint value is undershot, the contact CH..FB becomes active.
- Range E:
 - The reset coil CH...RE is activated. The actual value is set to zero.
 - The contact CH...ZE is active.
- Range F:
 - The actual value goes outside the value range of the counter.
 - The contacts become active according to the direction of the values (positive or negative).

High-speed incremental encoder counter

The display system provides two high-speed incremental counters CI01 and CI02 for use. The high-speed counter inputs are permanently connected to the digital inputs I1, I2, I3 and I4. These counter relays allow you to count events independently of the cycle time. You can enter upper and lower threshold values as comparison values. The contacts will switch according to the actual value. A CI... counter allows you to define a start value if required.

The CI.. counters are not dependent on the cycle time.

Counter frequency and pulse shape

The maximum counter frequency is 3 kHz.

The signals must be square waves. The mark-to-space ratio is 1:1. The signals of channels A and B must be offset by 90°. Otherwise the count direction cannot be determined.



Double the number of pulses are counted as a result of the internal method of operation of the incremental counter. The incremental counter evaluates the rising and falling edges. This ensures that the pulse count is not affected by oscillation of a signal edge. If the number of pulses are required, divide the value by two.

Wiring of a counter

The following assignment of the digital inputs apply:

- I1 count input for counter CI01 channel A
- I2 count input for counter CI01 channel B
- I3 count input for counter CI02 channel A
- I4 count input for counter CI02 channel B



Prevent unpredictable switching states. Use each coil of a relay once only in the circuit diagram.

Use a counter input for the CF, CH, CI counters only once.

You integrate a counter into your circuit in the form of a contact and coil. The counter relay has different coils and contacts.

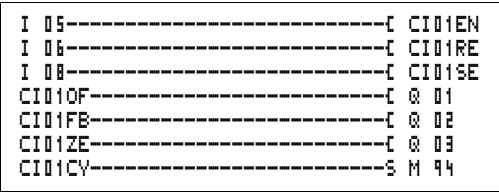
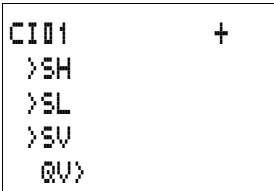


Figure: 105: Display system circuit diagram with high-speed incremental counter



Parameter display and parameter set for high-speed incremental counter:

CI01	High-speed incremental counter function block number 01
+	Appears in the parameter display
>SH	Upper setpoint
>SL	Lower setpoint
>SV	Preset actual value
QV>	Actual value in RUN mode

In the parameter display of a counter relay you change setpoint values and/or the preset value and the enable of the parameter display.

Value range

The function block operates in the integer range from –2 147 483 648 to 2 147 483 647.

Each pulse is counted twice.

Example: Value at CI...QV>= 42 000

The counter has counted 21 000 pulses.

Behaviour when value range is exceeded

- The function block sets the switching contact CI...CY to status 1.
- The function block retains the value of the last valid operation.



The counter CH counts on every rising edge at the counter input. If the value range is exceeded, the switching contact C ..CY switches to status 1 for one cycle per rising edge detected.

Inputs

The function block inputs **>SH**, **>SL** and **>SV** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01



The actual value is only erased in RUN mode with a selective reset signal.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

- CI01OF to CI02OF: Actual value \geq Upper setpoint
- CI01FB to CI02FB: Actual value \leq Lower setpoint
- CI01ZE to CI02ZE: Actual value = Zero
- CI01CY to CI02CY: Value range exceeded

Coils

- CI01EN to CI02EN: Counter enable
- CI01RE to CI02RE: Reset actual value to zero
- CI01SE to CI02SE: Accept preset actual value with rising edge.

Memory requirement of the counter relay

The high-speed counter function block requires 52 bytes of memory plus 4 bytes per constant on the function block inputs.

Retention

High-speed counter relays can be operated with retentive actual values. The number of retentive counter relays can be selected in the SYSTEM → RETENTION menu.

If a counter relay is retentive, the actual value is retained when the operating mode changes from RUN to STOP as well as when the power supply is switched off.

When the display system is restarted in RUN mode, the counter relay continues with the retentively stored actual value.

Function of the high-speed incremental counter
function block

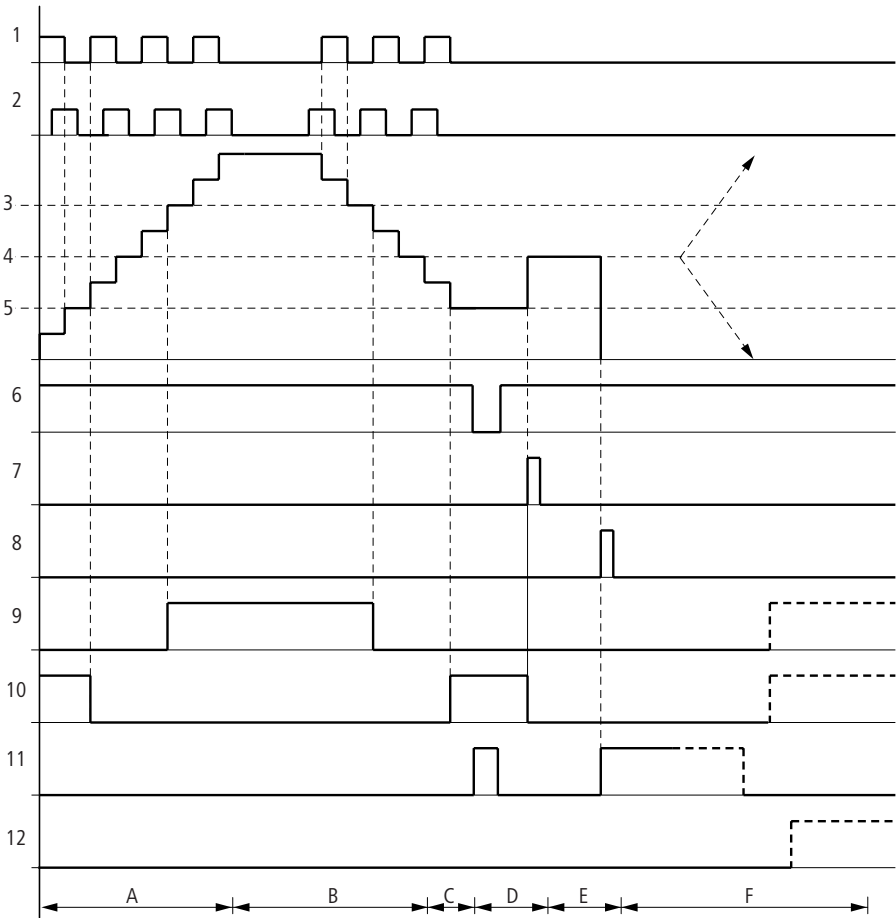


Figure: 106: Signal diagram of high-speed incremental counter

- 1: Counter input channel A
- 2: Counter input channel B
- 3: Upper setpoint value >SH
- 4: Preset actual value >SV
- 5: Lower setpoint value >SL
- 6: Counter enable
- 7: Accept preset actual value, coil CI..EN

- 8: Reset coil CI...RE
- 9: Contact (N/O) CI...OF upper setpoint value reached, exceeded
- 10: Contact (N/O) CI...FB lower setpoint value reached, undershot
- 11: Contact (N/O contact) CI...ZE actual value equal to zero
- 12: Contact (N/O contact) CI...CY value range exceeded or undershot
- Range A:
 - The counter counts upwards.
 - The value leaves the lower threshold value and reaches the upper value.
 - Range B:
 - The count direction changes to a downward count.
 - The contacts will switch according to the actual value.
 - Range C:
 - The enable signal is set to 0. The actual value becomes 0.
 - Range D:
 - The rising edge on the accept preset value coil sets the actual value to the preset value.
 - Range E:
 - The reset pulse sets the actual value to zero.
 - Range F:
 - The actual value goes outside the value range of the counter.
 - The contacts become active according to the direction of the values (positive or negative).

Comparators

Comparator function blocks allow you to compare constants and variables with one another.

The following comparisons are possible:

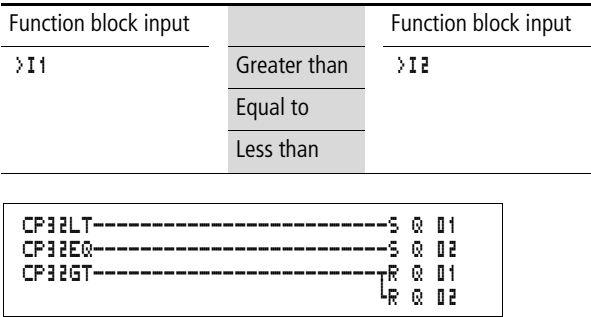
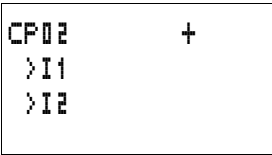


Figure 107: Display system circuit diagram with comparator



Parameter display and parameter set for the comparator function block:

CP02	Analog value comparator function block number 02
+	Appears in the parameter display
>I1	Comparison value 1
>I2	Comparison value 2

Inputs

The function block inputs **>I1** and **>I2** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Contacts

- CP01LT to CP32LT, (less than)

Contact (N/O contact) switches to status 1, if the value on **>I1** is less than the value on **>I2**; **>I1 < >I2**.

- CP01EQ to CP32EQ, (equal to)

Contact (N/O contact) switches to status 1, if the value on **>I1** is equal to the value on **>I2**; **>I1 = >I2**.

- CP01GT to CP32GT, (greater than)

Contact (N/O contact) switches to status 1, if the value at **>I1** is greater than the value at **>I2**; **>I1 > >I2**.

Memory requirement of the counter relay

The comparator function block requires 32 bytes of memory plus 4 bytes per constant on the function block inputs.

Data function block

The data function block allows you to selectively save a value. Setpoint values for the function block can be saved in this manner.

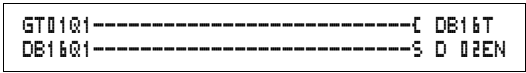
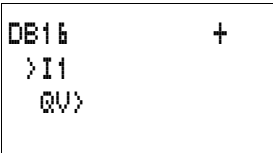


Figure: 108: Display system circuit diagram with data function block



Parameter display and parameter set for the data function block:

DE16	Data block function block number 16
+	Appears in the parameter display
>I1	Input value
QV>	Actual value

Inputs

The function block input >I1 can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Output

The function block output QV> can have the following operands:

- Markers MD, MW, MB
- Analog output QA01

Contacts

DB01Q1 to DB32Q1

Contact (N/O contact) DB...Q1 switches to status 1 if the trigger signal is set to 1.

Coils

DB01T_ to DB32T_, acceptance of the value at >I1 with a rising edge.

Memory requirement of the data function block

The data block function block requires 36 bytes of memory plus 4 bytes per constant at the function block input.

Retention

Data function blocks can be operated with retentive actual values. The quantity can be selected in the SYSTEM → RETENTION menu.

Function of the data function block

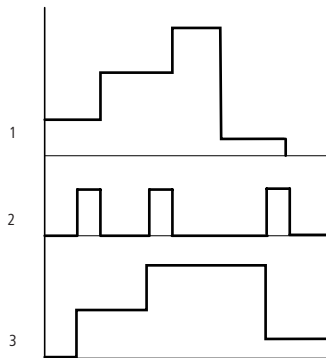


Figure: 109: Signal diagram of data function block

- 1: Value at input >I1
- 2: Trigger coil DB...T_
- 3: Value on DB...QV>



The value at input >I1 is only transferred with a rising trigger edge to an operand (e.g.: MD42, QA01) on output QV>. Output QV retains its value until it is overwritten.

PID controller

The display system provides 32 PID controllers DC01 to DC32. The PID controllers allow you to implement closed-loop control functions.



Caution!

A knowledge of closed-loop control is required in order to use the PID controllers.

The control system must be familiar so that the PID controller can function correctly.



Three separate manipulated variables can be output. One manipulated variable can be output via an analog output. Two manipulated variables can be processed via two pulse-width modulated outputs. It is therefore useful to run up to three closed-loop controllers per program simultaneously. Three separate manipulated variables can be output.

Example: Project with 3 devices

Program 1: Controller DC 10, 11

Program 2: Controller DC20, 21 and 22

Program 3: Controller DC30

Wiring of a PID controller

You integrate a PID controller in your circuit as a contact and coil.

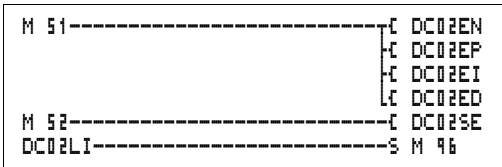


Figure 110: Display system circuit diagram with PID controller


```
DC02 UNP      +
>I1
>I2
>KP
>TN
>TV
>TC
>MV
QV>
```

Parameter display and parameter set for PID controller:

DC02	PID controller function block number 02
UNP	Unipolar mode
+	Appears in the parameter display
>I1	Setpoint of PID controller
>I2	Actual value of PID controller
>KP	Proportional gain K_p
>TN	Reset time T_n
>TV	Rate time T_v
>TC	Scan time
>MV	Manual manipulated variable
QV>	Manipulated variable

In the parameter display of a PID controller you set the operating mode, the setpoints and enable the parameter display.

Operating modes of the PID controller

Parameter	Manipulated variable is output as
UNP	Unipolar 12-bit value 0 to +4095
BIP	Bipolar 13-bit value (signed 12-bit value) -4096 to +4095

Inputs

The function block inputs >I1, >I2, >KP, >TN, >TV, >TC and >MV can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Value range for inputs and outputs

		Value range	Resolution/unit
>I1	Setpoint of PID controller	−32 768 to +32 767	
>I2	Actual value of PID controller	−32 768 to +32 767	
>KP	Proportional gain K_p	0 to 65 535	in -- /%
>TN	Reset time T_n	0 to 65 535	in 100/ms
>TV	Rate time T_v	0 to 65 535	in 100/ms
>TC	Scan time	0 to 65 535	in 100/ms
>MV	Manual manipulated variable	−4096 to +4095	
QV>	Manipulated variable	0 to 4095 (unipolar) −4096 to +4095 (bipolar)	

Example:

		Value at input	Value processed in the function block.
>KP	Proportional gain K_p	1500	15
>TN	Reset time T_n	250	25 s
>TV	Rate time T_v	200	20 s
>TC	Scan time	500	50 s
>MV	Manual manipulated variable	500	500

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

DC01LI to DC32LI, value range of the manipulated variable exceeded.

Coils

- DC01EN to DC32EN: Enable PID controller;
- DC01EP to DC32EP: Activate proportional component;
- DC01EI to DC32EI: Activate integral component;
- DC01ED to DC32ED: Activate the differential component;
- DC01SE to DC32SE: Activate the manual manipulated variable

Memory requirement of the PID controller

The PID controller function block requires 96 bytes of memory plus 4 bytes per constant on the function block input.

Function of the PID controller function block

The controller operates on the basis of the equation of the PID algorithm. According to this, the manipulated variable $Y(t)$ is the result of a proportional component, an integral component and a differential component.



The PID controller must be enabled so that it can work. Coil DC...EN is active. If coil DC...EN is not active, the entire PID controller is deactivated and reset. The manipulated variable is set to zero.

The corresponding coils for the P, I and D components must be active.

Example: If only coils DC...EP and DC...EI are activated, the controller operates as a PI controller.



The device calculates the manipulated variable every time the scan time T_c has elapsed. If the scan time is zero, the manipulated variable is calculated every cycle.

PID controller equation:

$$Y(t) = Y_P(t) + Y_I(t) + Y_D(t)$$

$Y(t)$ = Calculated manipulated variable with scan time t

$Y_P(t)$ = Value of the proportional component of the manipulated variable with scan time t

$Y_I(t)$ = Value of the integral component of the manipulated variable with scan time t

$Y_D(t)$ = Value of the differential component of the manipulated variable with scan time t

The proportional component in the PID controller

The proportional component Y_P is the product of the gain (K_p) and the control difference (e). The control difference is the difference between the setpoint (X_S) and the actual value (X_i) at a specified scan time. The equation used by the device for the proportional component is as follows:

$$Y_P(t) = K_p \times [X_S(t) - X_i(t)]$$

K_p = Proportional gain

$X_S(t)$ = Setpoint with scan time t

$X_i(t)$ = Actual value with scan time t

The integral component in the PID controller

The integral component Y_I is proportional to the sum of the control difference over time. The equation used by the device for the integral component is as follows:

$$Y_I(t) = K_p \times T_c/T_n \times [X_S(t) - X_i(t)] + Y_I(t-1)$$

K_p = Proportional gain

T_c = Scan time

T_n = Integration time (also known as reset time)

$X_S(t)$ = Setpoint with scan time t

$X_i(t)$ = Actual value with scan time t

$Y_I(t-1)$ = Value of the integral component of the manipulated variable with scan time $t-1$

The differential component in the PID controller

The differential component Y_D is proportional to the change in the control difference. So as to avoid step changes or jumps in the manipulated variable caused by the differential behaviour when the setpoint is changed, the change of the actual value (the process variable) is calculated and not the change in the control difference. This is shown in the following equation:

$$Y_D(t) = K_p \times T_v / T_c \times (X_i(t-1) - X_i(t))$$

K_p = Proportional gain

T_c = Scan time

T_v = Differential time of the control system
(also called the rate time)

$X_i(t)$ = Actual value with scan time t

$X_i(t-1)$ = Actual value with scan time $t - 1$

Scan time T_c

Scan time T_c determines the duration of the interval in which the function block is called by the operating system for processing. The value range is between 0 and 6553.5 s.

If the value 0 is set, the cycle time of the device is the pause time between the function block calls.



The device cycle time varies according to the length of the program. With a scan time of 0 s, this may cause an irregular control response.



Use the Set cycle time function block (→ page 245) in order to keep the cycle time of the device constant.

Manual mode of the PID controller

A value must be present at the MV input in order to set the manipulated variable directly. If the coil DC...SE is activated, the value at MV is transferred directly as manipulated variable QV . This value is present for as long as the DC...SE coil is activated or the value at the MV input is changed. The controller algorithm is re-activated when DC..SE is reset.

- Extreme changes in the manipulated variable can occur when the manual manipulated variable is transferred or deactivated.
- If the function block is running in UNI (unipolar) mode, a negative signed manipulated variable value will be output as the value zero.

Signal smoothing filter

The display system provides 32 signal smoothing filters FT01 to FT32. The function block enables you to smooth noisy inputs.

Wiring a signal smoothing filter

You can integrate a signal smoothing filter into your circuit as a coil.

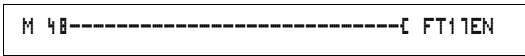


Figure: 111: Display system circuit diagram with smoothing function block

FT11	+
>I1	
>TG	
>KP	
QV>	

Parameter display and parameter set for the FT function block:

FT11	FT PT1 signal smoothing function block, number 17
+	Appears in the parameter display
>I1	Input value
>TG	Recovery time
>KP	Proportional gain
QV>	Output value, smoothed

- The recovery time T_g is the time in which the output value is calculated.
- The recovery time T_g must be set so that it is an integer multiple of the cycle time or controller scan time T_C .

Inputs

The function block inputs **>I1**, **>I2** and **>KP** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Output

The function block output QV> can have the following operands:

- Markers MD, MW, MB
- Analog output QA01

Value range for inputs and outputs

		Value range	Resolution/unit
>I1	Input value of the function block	–32 768 to +32 767	
>TG	Recovery time T _g	0 to 65 535	in 100/ms
>KP	Proportional gain K _p	0 to 65 535	in --/%
QV>	Output value	–32 768 to +32 767	

Example:

		Value at input	Value processed in the function block.
>TG	Recovery time T _g	250	25 s
>KP	Proportional gain K _p	1500	15

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Coil

FT01EN to FT32EN, function block enable

Memory requirement of the FT function block

The FT function block requires 56 bytes of memory plus 4 bytes per constant on the function block input.

Function of the signal smoothing filter function block



The signal smoothing filter must be enabled so that it can work. Coil FT...EN is active. If coil FT...EN is not active, the entire function block is deactivated and reset. The output value is set to zero.

If the function block is called for the first time, the output value is initialised with the input value when the device is started or after a reset. This speeds up the startup behaviour of the function block.



The function block updates the output value every time recovery time T_g expires.

The function block operates according to the following equation:

$$Y(t) = [T_a/T_g] \times [K_p \times x(t) - Y(t-1)]$$

$Y(t)$ = Calculated output value for scan time t

T_a = Scan time

T_g = Recovery time

K_p = Proportional gain

$x(t)$ = Actual value with scan time t

$Y(t-1)$ = Output value with scan time $t - 1$

Scan time:
Scan time T_a depends on the set recovery time value.

Recovery time T_g	Scan time T_a
0.1 s to 1 s	10 ms
1 s to 6553 s	$T_g \times 0,01$

GET, fetch a value from the network

The function block allows you to selectively read (get) a 32 bit value from the network. The GET function block fetches data which another station has made available on the CL-NET network with a PUT function block.

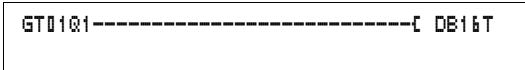
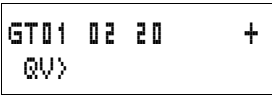


Figure: 112: Display system circuit diagram with GET function block



Parameter display and parameter set for the GET function block:

GET01	GET function block (fetch a value from the network), number 01
02	Station number from which the value is sent. Possible station number: 01 to 08
20	Send function block (PT 20) of the sending station. Possible function block number: 01 to 32
+	Appears in the parameter display
QV>	Actual value from the network

Output

The function block output QV> can have the following operands:

- Markers MD, MW, MB
- Analog output QA01

Contacts

GT01Q1 to GT32Q1

Contact (N/O contact) GT...Q1 switches to status 1 if a new value, transferred from the CL-NET network, is present.

Memory requirement of the GET function block

The GET function block requires 28 bytes of memory.

GET diagnostics

The GET function block only functions if the CL-NET is running properly (→ section “Signs of life of the individual stations and diagnostics”, page 331).

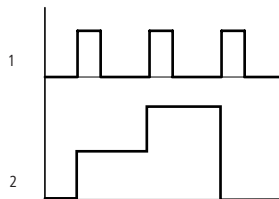
Function of the GET function block

Figure: 113: Signal diagram GET component

1: GT..Q1

2: Value on GT...QV>



The GET function blocks are assigned the value 0 when the power supply is switched on.

Seven-day time switch

The display system is equipped with a real-time clock which you can use in the circuit diagram as a 7-day time switch and a year time switch.



The procedure for setting the time is described under section “Setting date and time” on page 353.

The display system provides 32 seven-day time switches HW01 to HW32 for a total of 128 switching times. Each time switch has four channels which you can use to set four on and off times. The channels are set via the parameter display.

The timer has a back-up battery, although the time switch relays will no longer switch. When the device is in a de-energized state, the timer contacts remain open. Refer to chapter “Technical data”, page 389, for information on the buffer time.

Wiring of a 7-day time switch

You integrate a 7-day time switch in the circuit diagram as a contact.

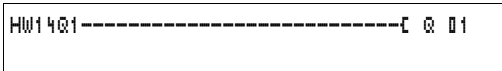


Figure: 114: Display system circuit diagram with 7-day time switch

HW14	A	+
>DY1		
>DY2		
>ON		
>OFF		

Parameter display and parameter set for the 7-day time switch HW:

HW14	7-day time switch function block number 14
A	Time switch channel A
+	Appears in the parameter display
>DY1	Day 1
>DY2	Day 2
>ON	on time
>OFF	off time

Channels

4 channels are available per time switch, channels A, B, C and D. These channels all act on the contact of the 7-day time switch.

Day 1 and day 2

Either day 1 to day 2, e.g. Monday to Friday, or only day 1.

Monday = MO, Tuesday = TU, Wednesday = WE, Thursday = TH, Friday = FR, Saturday = SA, Sunday = SU,

Time

00:00 to 23:59

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

HW01Q1 to HW32Q1

Memory requirement of the 7-day time switch

The 7-day time switch function block requires 68 bytes of memory plus 4 bytes per channel used.

Function of the 7-day time switch function block

The switching points are defined according to the parameters entered.

MO to FR: On the weekdays Mo, Tu, We, Th, Fr

ON 10:00, OFF 18:00: On and off switching times for the individual days of the week.

MO: Every Monday

ON 10:00: Switch on time

SA: Every Saturday

OFF 18:00: Switch off time

Switching on working days

Time switch HW01 switches on Monday to Friday between 6:30 and 9:30 and between 17:00 and 22:30.

HW01 A	+	HW01 B	+
>DY1 MO		>DY1 MO	
>DY2 FR		>DY2 FR	
>ON 06:30		>ON 17:00	
>OFF 09:30		>OFF 22:30	

Switching at the weekend

Time switch HW02 switches on at 16:00 on Friday and switches off at 6:00 on Monday.

HW02 A	+	HW02 B	+
>DY1 FR		>DY1 MO	
>DY2		>DY2	
>ON 16:00		>ON	
>OFF		>OFF 06:00	

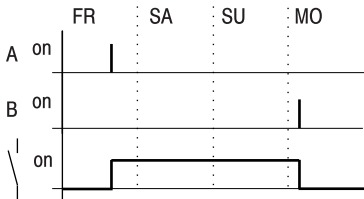


Figure: 115: Signal diagram of "weekend"

Overnight switching

Time switch HW03 switches on overnight at 22:00 Monday and switches off at 6:00 on Tuesday.

HW03 D	+
>DY1 MO	
>DY2	
>ON 22:00	
>OFF 06:00	

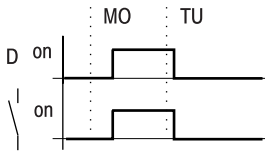


Figure: 116: Signal diagram for night switching

➔ If the off time is before the on time, the display system will switch off on the following day.

Time overlaps

The time settings of a time switch overlap. The clock switches on at 16:00 on Monday, whereas on Tuesday and Wednesday it switches on at 10:00. On Monday to Wednesday the switching-off time is 22:00.

HW04 A	+	HW04 B	+
>DY1 MO		>DY1 TU	
>DY2 WE		>DY2 WE	
>ON 16:00		>ON 10:00	
>OFF 22:00		>OFF 00:00	

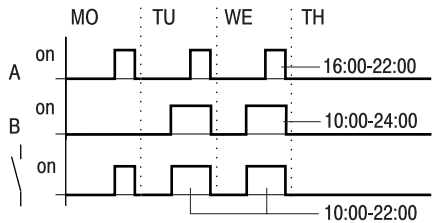


Figure: 117: Signal diagram of overlaps



On and off times always follow the channel which switches first.

Response in the event of a power failure

The power is removed between 15:00 and 17:00. The relay drops out and remains off, even after the power returns, since the first off time was at 16:00.

HW05 A	+	HW05 B	+
>DY1 MO		>DY1 MO	
>DY2 SU		>DY2 SU	
>OFF 16:00		>ON 12:00	
		>OFF 18:00	



When it is switched on, the display system always updates the switching state on the basis of all the available switching time settings.

24 hour switching

The time switch is to switch for 24 hours. Switch-on time at 0:00 on Monday and switch-off time at 0:00 on Tuesday.

HW20 A	+	HW20 B	+
>DY1 MO		>DY1 TU	
>DY2		>DY2	
>ON 00:00		>ON	
>OFF		>OFF 00:00	

Year time switch

The display system is equipped with a real-time clock which you can use in the circuit diagram as a 7-day time switch and as a year time switch.

→ The procedure for setting the time is described under section "Setting date and time" on page 353.

The display system offers 32 year time switches HY01 to HY32 for a total of 128 switch times.

Each time switch has four channels which you can use to set four on and off times. The channels are set via the parameter display.

The time and date are backed up in the event of a power supply failure and continue to run. This means that it will continue to run in the event of a power failure, although the time switch relays will not switch. When the device is in a de-energized state, the timer contacts remain open. Refer to chapter "Technical data", page 389, for information on the buffer time.

Wiring of a year time switch

A year time switch is integrated into the circuit diagram as a contact.

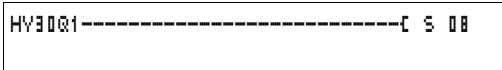
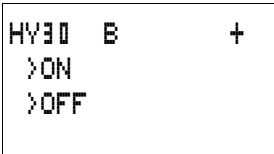


Figure: 118: Display system circuit diagram with year time switch



Parameter display and parameter set for the year time switch HY:

HY30	Year time switch function block number 30
B	Time switch channel B
+	Appears in the parameter display
>ON	Switch on time
>OFF	Switch off time

Channels

4 channels are available per time switch, channels A, B, C and D. These channels all act on the contact of the year time switch.

Date

Day.Month.Year: DD.MM. YY

Example: 11.11.02

On and off times

ON: Switch on time

OFF: Switch off time



The switch on year must not be later than the switch off year. Otherwise the year time switch will not function.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

HY01Q1 to HY32Q1

Memory requirement for the year time switch

The year time switch function block requires 68 bytes of memory plus 4 bytes per channel used.

Function of the year time switch function block

The year time switch can switch ranges, individual days, months, years or combinations of all three.

Years

ON: 2002 to OFF: 2010 means:

Switch on at 00:00 on 01.01.2002 and switch off at 00:00 on 01.01.2011.

Months

ON: 04 to OFF: 10 means:

Switch on at 00:00 on 1 April and switch off at 00:00 on 1 November

Days

ON: 02 to OFF: 25 means:

Switch on at 00:00 on day 2 and switch off at 00:00 day 26

Rule for the year time switch

The contact switches in the defined years (ON to OFF), the defined months (ON to OFF) and in the days entered (ON to OFF).

Time ranges must be input with two channels, one for ON and one for OFF.

Overlapping channels:

The first ON date switches on and the first OFF date switches off.



Avoid incomplete entries. It hinders transparency and leads to unwanted functions.

```
HY01  A      +
>ON   --.--.02
>OFF  --.--.05
```

Example 1

Year range selection

The year time switch HY01 should switch on at 00:00 on January 1 2002 and remain on until 23:59 on 31 December 2005.

```
HY01  A      +
>ON   --.03.--
>OFF  --.09.--
```

Example 2
Month range selection
The year time switch HY01 should switch on at 00:00 on March 1 and remain on until 23:59 on September 30.

```
HY01  A      +
>ON   01.--.--
>OFF  28.--.--
```

Example 3
Day range selection
The year time switch HY01 should switch on at 00:00 on the 1st of each month and remain on until 23:59 on the 28th of each month.

```
HY01  A      +
>ON   25.12.--
>OFF  26.12.--
```

Example 4
"Holiday" selection
The year time switch HY01 should switch on at 00:00 on 25.12. and remain on until 23:59 on the 26.12. "Christmas program"

Example 5
Time range selection
The year time switch HY01 should switch on at 00:00 on 01.05. each year and remain on until 23:59 on the 31.10 of each year.

```
HY01  A      +
>ON   01.05.--
>OFF  --.---.--
```

```
HY01  B      +
>ON   --.---.--
>OFF  31.10.--
```

Example 6
Overlapping ranges

The year time switch HY01 channel A switches on at 00:00 on day 3 of months 5, 6, 7, 8, 9, 10 and remains on until 23:59 on day 25 of these months.

The year time switch HY01 channel B switches on at 00:00 on day 2 of months 6, 7, 8, 9, 10 11, 12 and remains on until 23:59 on day 17 of these months.

HY01	A	+
>ON	03.05.--	
>OFF	25.10.--	

HY01	B	+
>ON	02.06.--	
>OFF	17.12.--	

Total number of channels and behaviour of the contact HY01Q1:
The time switch will switch on at 00:00 from the 3rd May and off at 23:59 on the 25th May.
In June, July, August, September, October, the time switch will switch on at 00:00 on day 2 of the month and switch off at 23:59 on day 17.
In November and December, the time switch will switch on at 00:00 on the 2nd of the month and switch off at 23:59 on the 17th.

Value scaling

The display system provides 32 value scaling function blocks LS01 to LS32. The function block enables you to convert values from one value range to another one. In this way it is possible to reduce or increase values.

Wiring of a scaling function block

You can integrate a value scaling function block into your circuit as a coil.

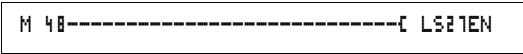
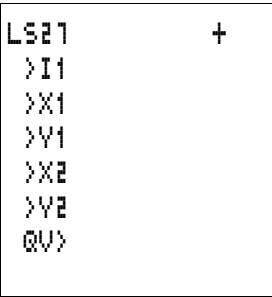


Figure: 119: Display system circuit diagram with value scaling LS



Parameter display and parameter set for the LS function block:

LS27	LS value scaling function block number 27
+	Appears in the parameter display
>I1	Input value, actual value source range
>X1	Lower value of source range
>Y1	Lower value of target range
>X2	Upper value of source range
>Y2	Upper value of target range
QV>	Output value, scaled

Inputs

The function block inputs >I1, >X1, >X2, >Y1 and >Y2 can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Output

The function block output QV> can have the following operands:

- Markers MD, MW, MB
- Analog output QA01

Value range for inputs and outputs

		Value range
>I1	Input value of the function block	-2 147 483 648 to +2 147 483 647
>X1	Lower value of source range	
>X2	Lower value of target range	
>Y1	Upper value of source range	
>Y2	Upper value of target range	
QV>	Output value	

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Coil

VC01EN to VC32EN, function block enable

Memory requirement of the LS function block

The LS function block requires 64 bytes of memory plus 4 bytes per constant on the function block input.

Function of the function block



The scaling function block must be enabled so that it can work. Coil LS...EN is active. If coil LS...EN is not active, the entire function block is deactivated and reset. The output value is set to zero.

The function block operates according to the following equation

$$Y(x) = X \times \frac{Y_2 - Y_1}{X_2 - X_1} + \frac{X_2 \times Y_1 - X_1 \times Y_2}{X_2 - X_1}$$

$Y(x)$ = Actual output value of target range

X = Actual input value of source range

X_1 = Lower value of source range

X_2 = Upper value of source range

Y_1 = Lower value of target range

Y_2 = Upper value of target range

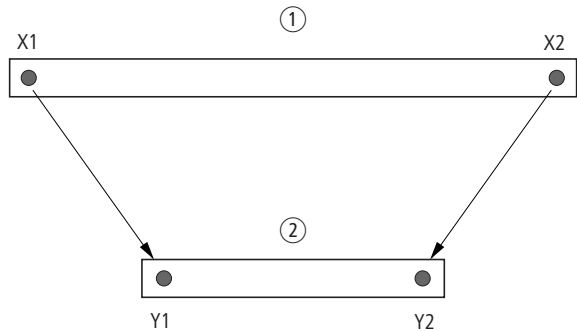


Figure 120: Value scaling function block – reduce value range

① Source range

② Target range

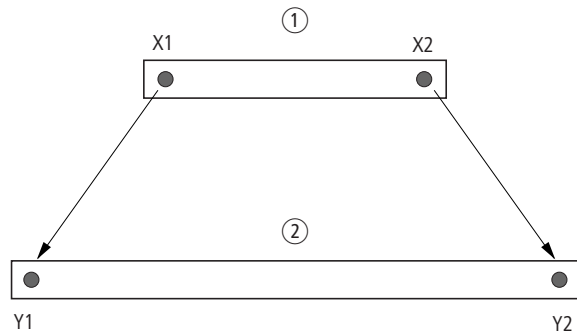


Figure 121: Function block value scaling – increasing value range

① Source range

② Target range

Example 1:
The source range is a 10-bit value, source is the analog input IA01.

The target range has 12 bits.

Parameter display and parameter set for the LS01 function block:

```
LS01      +
>I1  IA01
>X1  0
>Y1  0
>X2  1023
>Y2  4095
QV>
```

The actual value at the analog input IA01 is 511.
The scaled output value is 2045.

Example 2:
The source range has 12 bits.

The target range has 16 signed bits.

>I1 = DC01QV

>X1 = 0

>X2 = 4095

>Y1 = -32768

>Y2 = +32767

The actual value at the analog input DC01QV is 1789.
The scaled output value is -4137.

Jumps

Jumps can be used to optimise the structure of a circuit diagram or to implement the function of a selector switch. Jumps can be used for example to select whether manual/automatic operation or other machine programs are to be set.

Jumps consist of a jump location and a jump destination (label).

Circuit diagram symbols for jumps

Contact	
N/O contact ¹⁾	:
Numbers	01 to 32
Coils	1
Numbers	01 to 32
Coil function	1, 2, 3, 4, 5

1) Can only be used as first leftmost contact

Function

If the jump coil is triggered, the rungs after the jump coil are no longer processed. The states of the coils before the jump will be retained, unless they are overwritten in rungs that were not missed by the jump. Jumps are always made forwards, i.e. the jump ends on the first contact with the same number as that of the coil.

- Coil = Jump when 1
- Contact only at the first leftmost contact = Jump label

The Jump contact point will **always be set to 1**



Backward jumps are not possible with the display system due to the way it operates. If the jump label does not come after the jump coil, the jump will be made to the end of the circuit diagram. The last rung will also be skipped.

If a jump destination is not present, the jump is made to the end of the circuit diagram.

Multiple use of the same jump coil and jump contact is possible as long as this is implemented in pairs, i.e.:

Coil 1:1/jumped range/Contact:1,

Coil 1:1/jumped range/Contact :1 etc.



Attention!

If rungs are skipped, the states of the coils are retained. The time value of timing relays that have been started will continue to run.

Power flow display

Jumped sections are indicated by the coils in the power flow display.

All coils after the jump coil are shown with the symbol of the jump coil.

Example

A selector switch allows two different sequences to be set.

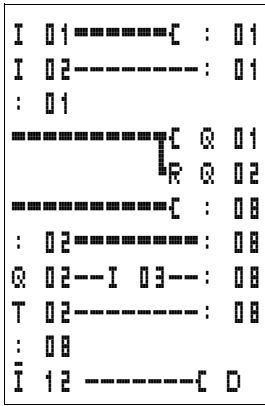
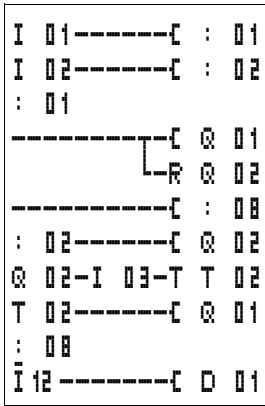
- Sequence 1: Switch on motor 1 immediately.
- Sequence 2: Switch on guard 2, wait time, then switch on motor 1.

Contacts and relays used:

- I1 sequence 1
- I2 sequence 2
- I3 guard 2 moved out
- I12 motor-protective circuit-breaker switched on
- Q1 motor 1
- Q2 guard 2
- T11 wait time 30.00 s, on-time
- D11 text "Motor-protective circuit-breaker tripped"

Circuit diagram:

Power flow display: I 01 selected:



Range from jump label 1 processed.
Jump to label 8.
Range to jump label 8 skipped.

Jump label 8, circuit diagram
processed from this point on.

Master reset

The master reset function block allows you to reset the state of the markers and all outputs to the state 0 with a single command. Depending on the operating mode of this function block, it is possible to reset the outputs only, or the markers only, or both. 32 function blocks are available.

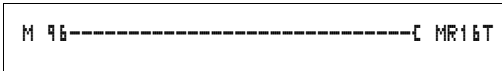


Figure: 122: Display system circuit diagram with master reset function block



Parameter display and parameter set for the master reset function block:

MR16	Master reset function block number 16
Q	Reset outputs mode
+	Appears in the parameter display

Operating modes

- Q: Acts on the outputs Q., *Q., S., *S., *SN., QA01; *: Station address
- M: Acts on the marker range MD01 to MD48.
- ALL: Acts on Q and M.

Contacts

MR01Q1 to MR32Q1

The contact switches on the marker if the trigger coil MR...T has the state 1.

Coils

MR01T to MR32T: Trigger coils

Memory requirement of the data function block

The master reset function block requires 20 bytes of memory.

Function of the data master reset

The outputs or the markers are set to the state 0 in accordance with the operating mode when a rising edge is detected on the trigger coil.

→

The master reset function block should be used as the last function block in a program so that all data ranges are cleared reliably. Otherwise subsequent function blocks may overwrite the data ranges.

The contacts MR01Q1 to MR32Q1 assume the state of their own trigger coil.

Numerical converter

The display system provides 32 numerical converters NC01 to NC32.

A numerical converter function block enables you to convert BCD coded values to decimal values or decimal coded values to BCD coded values.

Wiring of a numerical converter

A numerical converter in the circuit diagram only has the enable coil.

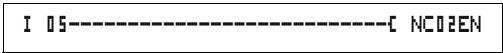


Figure: 123: Display system circuit diagram with numerical converter

NC02 BCD +

>I1

QV>

Parameter display and parameter set for the numerical converter:

NC02	Numerical converter function block number 02
BCD	Convert BCD code to decimal value mode
+	Appears in the parameter display
>I1	Input value
QV>	Output value

In the parameter display of a numerical converter you can change the mode and the enable of the parameter display.

Numerical converter modes

Parameter	Operating mode
BCD	Convert of BCD coded values to decimal values
BIN	Convert decimal value to BCD coded values

Number range

Value	Number system
−161061273 to +161061273	BCD
−9999999 to +9999999	Decimal

BCD code	Decimal value
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010 to 1111	Not permissible
10000	10
10001	11



The BCD code only allows the number range 0_{hex} to 9_{hex}. The number range A_{hex} to F_{hex} cannot be represented. The NC function block converts the impermissible range to 9.

Inputs

The function block input **IN** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Coil

NC01EN to NC32EN: Enable coil.

Memory requirement of the numerical converter

The numerical converter function block requires 32 bytes of memory plus 4 bytes per constant on the function block input.

Function of the numerical converter function block



The numerical converter function block must be enabled so that it can work. Coil NC...EN is active. If coil NC...EN is not active, the entire function block is deactivated and reset. The output value is set to zero.

BCD mode

The BCD value at >I1 is provided in decimal format at the input. The binary value is formed from this. The binary value is interpreted as a BCD value. Values greater than 9 (1001) are set to the value 9. The BCD value is output as a decimal value at the output QV>.

Example 1:

Input value >I1: +9_{dec}

Binary value: 1001

Decimal value QV>: + 9

Example 2:

Input value >I1: +14_{dec}

Binary value: 1110

Decimal value QV>: + 9



The highest binary of the BCD value is 1001 = 9. All other higher binary values 1010 to 1111 are output by the function block as the value 9. This behaviour is correct as BCD encoders normally don't generate these values.

Example 3:

Input value >I1: 19_{dec}

Binary value: 0001 0011

Decimal value QV>: 13

Example 4:

Input value >I1: 161 061 273_{dec}

Binary value: 1001 1001 1001 1001 1001 1001 1001

Decimal value QV>: 9999999

Example 5:

Input value >I1: -61 673_{dec}

Binary value: 1000 0000 0000 0000 1111 0000 1110 1001

Decimal value QV>: -9099



Bit 32 is the sign bit. Bit 32 = 1 → Sign = Minus.

Example 6:

Input value >I1: 2 147 483 647_{dec}

Binary value: 0111 1111 1111 1111 1111 1111 1111 1111

Decimal value QV>: 9999999



Values greater than 161 061 273 are output as 9999999.
Values less than -161 061 273 are output as
-9999999. The working range of the function block has
been exceeded.

BIN mode

The decimal value is assigned to input >I1. The decimal value is represented as a BCD coded value. The BCD coded value is interpreted as a hexadecimal value and output as a decimal value at output QV>.

Example 1:

Input value >I1: +7_{dec}

BCD binary value: 0111

Hexadecimal value: 0111

Decimal value QV>: + 7

Example 2:

Input value >I1: +11_{dec}

BCD binary value: 0001 0001

Hexadecimal value: 0001 1001

Decimal value QV>: +17 (1 + 16)

Hexadecimal value:

Bit 0 has the value 1.

Bit 4 has the value 16

Total: Bit 0 plus bit 4 = 17

Example 3:

Input value >I1: 19_{dec}

BCD binary value: 0001 1001

Hexadecimal value: 0001 1001

Decimal value QV>: 25 (1 + 8 + 16)

Example 4:

Input value >I1: 9999999_{dec}

BCD binary value: 1001 1001 1001 1001 1001 1001 1001

Hexadecimal value: 1001 1001 1001 1001 1001 1001 1001

Decimal value QV>: 161061273

Example 5:

Input value >I1: -61 673_{dec}

BCD binary value: 1000 0000 0000 0110 0001 0110 0111 0011

Hexadecimal value: 1000 0000 0000 0110 0001 0110 0111 0011

Decimal value QV>: -398 963



Bit 32 is the sign bit. Bit 32 = 1 → Sign = Minus.

Example 6:

Input value >I1: 2147483647_{dec}

BCD binary value:

0111 1111 1111 1111 1111 1111 1111 1111

Hexadecimal value:

0111 1111 1111 1111 1111 1111 1111 1111

Decimal value QV>: 161061273



Values greater than 9 999 999 are output as 161 061 273.
Values less than -9 999 999 are output as -161 061 273.
The working range of the function block has been exceeded.

Operating hours counter

The display system provides 4 independent operating hours counters. The counter states are retained even when the device is switched off. As long as the enable coil of the operating hours counter is active, display system counts the hours in minute cycles.

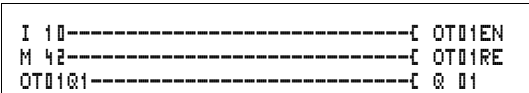
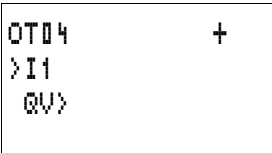


Figure 124: Display system circuit diagram with operating hours counter



Parameter display and parameter set for the operating hours counter function block:

OT04	Operating hours counter number 04
+	Appears in the parameter display
>I1	Upper threshold value in hours
QV>	Actual value of the operating hours counter

Contacts

OT01Q1 to OT04Q1

The contact switches when the upper threshold value has been reached (greater than or equal to).

Coils

- OT01EN to OT04EN: Enable coil
- OT01RE to OT04RE: Reset coil

Memory requirement of the operating hours counter

The operating hours counter function block requires 36 bytes of memory plus 4 bytes per constant on the function block input.

Function of the operating hours counter function block

If the enable coil OT...EN is triggered to the state 1, the counter adds the value 1 to its actual value every minute (basic clock rate: 1 minute).

If the actual value on QV> reaches the setpoint value of >I1, the contact OT...Q1 switches for as long as the actual value is greater than or equal to the setpoint value.

The actual value is retained in the unit until the reset coil OT...RE is actuated. The actual value is then set to zero.



Operating mode change RUN, STOP, Voltage On, Off, Delete program, Change program, Load new program. All these actions do not delete the actual value of the operating hours counter.

Accuracy

The operating hours counter is accurate to the nearest minute. If the enable coil signal is terminated within a minute, the value for seconds is lost.

The value range of the operating hours counter is between 0 hours and 100 years.

PUT, send a value onto the network

The function block allows you to selectively send a 32 bit value onto the network. The PUT function block provides data on the CL-NET that another station indicates it requires via the GET function block.

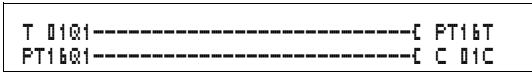
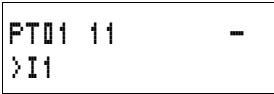


Figure 125: Display system circuit diagram with PUT function block



Parameter display and parameter set for the PUT function block:

PT01	PUT function block (places a value onto the network), number 11
-	Does not appear in the parameter display
>I1	Setpoint value which is put onto the CL-NET network

Input

The function block input >I1 can be assigned the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Contacts

PT01Q1 to PT32Q1: State of the trigger coil

Coils

PT01T to PT32T: Trigger coils

Memory requirement of the PUT function block

The PUT function block requires 36 bytes of memory plus 4 bytes per constant at the function block input.

PUT diagnostics

The PUT function block only functions if the CL-NET network is running properly (→ section “Signs of life of the individual stations and diagnostics”, page 331).

Function of the PUT function block

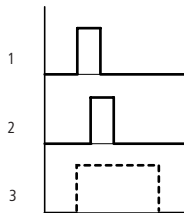


Figure: 126: Operational diagram PUT module

1: Trigger coil

2: Trigger coil contact feedback

3: Send

Pulse width modulation

The display system provides 2 pulse width modulation function blocks PW01 and PW02. The function blocks are connected directly to the outputs.

They are assigned as follows:

PW01 → Q1

PW02 → Q2



When using the pulse width modulation function block with a minimum on time of less than 1 s only use devices with transistor outputs.

The pulse width modulation function block is primarily used for outputting the manipulated variable of a PID controller. The maximum frequency is 200 Hz. This corresponds to a period duration of 5 ms. The maximum period duration is 65.5 s.

Wiring a pulse width modulation function block

A pulse width modulation function block is integrated in the circuit diagram as a contact or coil.



To prevent unpredictable switching states, use each coil of a relay once only in the circuit diagram.

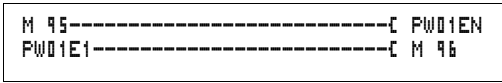
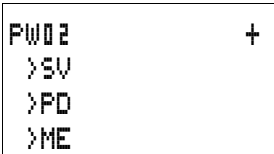


Figure: 127: Display system circuit diagram with pulse width modulation



Parameter display and parameter set for pulse width modulation:

PW02	Pulse width modulation function block number 02
+	Appears in the parameter display
>SV	Manipulated variable input
>PD	Period duration in ms
>ME	Minimum on duration, minimum off duration in ms

The parameter display for a timing relay is used to modify the period duration, the minimum on time and the enabling of the parameter display.

Value and time ranges

Parameter	Value and time range	Resolution
SV	0 to 4095	1 digit
PD	0 to 65535	ms
ME	0 to 65535	ms



The minimum time setting for the period duration is: 0.005 s (5 ms)

Inputs

The function block inputs **>SV**, **>PD** and **>ME** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

PW01E1 to PW02E1, the minimum on duration or the minimum off duration was undershot.

Coils

PW01EN to PW02EN, enable coil.

Memory requirement of the function block

The pulse width modulation function block requires 48 bytes of memory plus 4 bytes per constant on the function block input.

Function of the pulse width modulation function block

The pulse width modulation function block must be enabled so that it can work. Coil PW...EN is active. If coil PW...EN is not active, the entire function block is deactivated and reset. The output value is set to zero.

The manipulated variable at function block input >SV is converted to a pulse string with a constant period duration. The pulse width is proportional to the manipulated variable >SV. The period duration and the minimum on duration can be selected as required within the specified limits.

The function block causes a direct output of the pulse to the corresponding output. The output image of the circuit diagram is always updated.



The following applies if the output of a pulse width modulator is used as a coil in the circuit diagram:
The state of the output is not refreshed from the circuit diagram.



The following applies to the minimum on duration:

- The minimum on duration is equal to the minimum off duration.
- The minimum on duration must not exceed 10 % of the period duration. The ratio of period duration/minimum on duration (P/M) determines which percentage of the manipulated variable has no effect. The minimum on duration must be set as low as possible so that the P/M ratio is as high as possible. If the minimum on duration must not be too low, due to the output relay, the period duration must be increased accordingly.
- The minimum on duration is 1 ms.
- If the actual value of the pulse length is less than the minimum on duration, the minimum on duration has the effect of the pulse time. The status of the PW..E1 contact must be observed.
- If the off duration of the pulse is less than the minimum off duration, outputs Q1 and Q2 are continuously in operation. Note the state of the contact PW...E1.

Setting date/time

This function block allows you to selectively place the date and time onto the network. All other stations accept the date and time of the sending station. The function block name is SC01 (send clock).

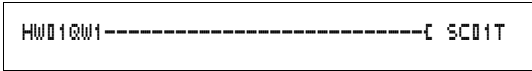


Figure: 128: Display system circuit diagram with SC function block

Parameter display and parameter set for the SC function block:

The SC01 function block has no parameters as it is a triggered system service.

Coil

SC01T: Trigger coil

Memory requirement of the SC function block

The SC function block requires 20 bytes of memory.

SC diagnostics

The SC function block only functions if the CL-NET is running properly (→ section “Signs of life of the individual stations and diagnostics”, page 331).

Function of the date/time function block

If the trigger coil of the function block is activated, the current date, the day of the week and time from the sending station is automatically put onto the CL-NET network. All other network stations must accept these values.



The station that sends its date and time does this when the seconds value is zero.
Example: The trigger pulse is actuated at 03:32:21 (hh:mm:ss). The other stations are synchronised at 03:33:00. This time is accessed by all other stations.

This process can be repeated as often as desired. The trigger coil must be triggered again from state 0 to state 1.

Accuracy of time synchronisation

The maximum time deviation between the functional stations is 5 s.

Set cycle time

The display system provides one set cycle time function block ST01. The set cycle time function block is a supplementary function block for the PID controller.

The set cycle time function block provides a fixed cycle time for processing the circuit diagram and the function blocks.

Wiring a set cycle time function block

The ST set cycle time function block is integrated in the circuit diagram as a coil.



To prevent unpredictable switching states, use each coil of a relay once only in the circuit diagram.

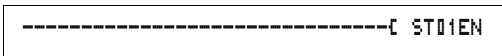


Figure: 129: Display system circuit diagram with enabling of set cycle time function block.



Parameter display for set cycle time:

ST01	Set cycle time function block number 01
+	Appears in the parameter display
>I1	Set cycle time

The parameter display is used to modify the set cycle time, the minimum on time and the enabling of the parameter display.

Time range

Parameter	Value and time range	Resolution
I1	0 to 1000	ms

Inputs

The function block input **IN** can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Coils

ST01EN, enable coil.

Memory requirement of the function block

The set cycle time function block requires 24 bytes of memory plus 4 bytes per constant on the function block input.

Function of the set cycle time function block

The function block is used to define a fixed cycle time.



The function block must be enabled so that it can work. Coil ST01EN is active. If coil ST01EN is not active, the entire function block is deactivated and reset.

Actual cycle time is less than the set cycle time:

If the maximum cycle time present is less than the set cycle time, the set cycle time is constant.

Actual cycle time is greater than the set cycle time:

If the maximum cycle time present is greater than the set cycle time, the set cycle time has no effect.



Attention!

The shorter the cycle time, the faster the control and regulation process.

Set as small a value for the set cycle time as possible. The processing of the function blocks, reading of the inputs and writing of outputs is only carried out once every cycle. Exception: All function blocks that are processed irrespective of the controller.

Timing relay

The display system provides 32 timing relays from T 01 to T 32.

A timing relay is used to change the switching duration and the N/O and N/C times of a switching contact. The delay times can be configured between 5 ms and 99 h 59 min.

Wiring a timing relay

You integrate a timing relay into your circuit in the form of a contact and coil. The function of the relay is defined via the parameter display. The relay is started via the trigger coil T...EN and can be selectively reset via the reset coil T...RE. The actual timeout running can be stopped via the third coil T...ST.



To prevent unpredictable switching states, use each coil of a relay once only in the circuit diagram.

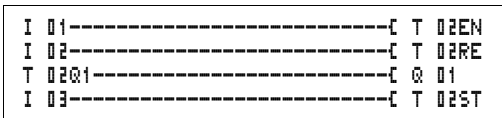


Figure: 130: Display system circuit diagram with timing relay

```
T 02 X M:S +
>I1
>I2
@U>
```

Parameter display and parameter set for timing relay:

T 02	Timing relay function block number 02
X	On-delay mode
M:S	Time range Minute: Seconds
+	Appears in the parameter display
>I1	Time setpoint 1
>I2	Time setpoint 2 (with timing relay with 2 setpoints)
@U>	Timed-out actual time in RUN mode

The parameter display for a timing relay is used to modify the switching function, time base or setpoint times and enable the parameter display.

Timing relay modes

Parameter	Switch function
X	Switch with on-delay
?X	Switch with on-delay and random time range
■	Switch with off-delay
?■	Switch with off-delay and random time range
X■	On- and off-delayed
□	Off-delayed with random time range, setpoint retriggerable
?□	Off-delayed with random time range, retriggerable
?X■	On- and off-delayed switching with random time, 2 time setpoints
⏏	Single-pulse switching
⏏	Switch with flashing, synchronous, 2 time setpoint values
⏏	Switch with flashing, asynchronous, 2 time setpoint values

Time range

Parameter	Time range and setpoint time	Resolution
S 000.000	Seconds, 0.005 to 999.995 s for constants and variable values	5 ms
M:S 00:00	Minutes: Seconds 00:00 to 99:59 only for constants and variable values	1 s
H:M 00:00	Hours: Minutes, 00:00 to 99:59 only for constants and variable values	1 min.



Minimum time setting:
0.005 s (5 ms).

If a time value is less than the display system cycle time,
the elapsed time will only be recognised in the next cycle.

Inputs

The function block inputs >I1 and >I2 can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value ...QV> of another function block

Outputs

Actual value ...QV>

The actual value ...QV> can be assigned the following operands:

- Markers MD, MW, MB
- Analog output QA01

Variable setpoint values

Behaviour of the setpoint value when variable values are used.

- Variable values can be used.
- Variable values must be transferred using operands.
- With the time base "s" the value is accepted as a "value in ms".
- The last position is rounded up to a zero or five.
- With the time base "M:S" the value is accepted as a "value in s".
- With the time base "H:M:" the value is accepted as a "value in M (minutes)".



The delay times are the same as described for the constants.

Example:

Time base "s"

The operand has the value 9504.

The time value is 9.50 s.

Operand value 45507

The time value is 45.510 s.

Time base "M:S"

The operand has the value 5999.

The time value is 99 min, 59 s: This is the maximum value.

Time base "H:M"

The operand has the value 5999.

The time value is 99 h, 59 min.

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Contacts

T 01Q1 to T 32Q1

Coils

- T 01EN to T 32EN: Trigger coil;
- T 01RE to T 32RE: Reset coil;
- T 01ST to T 32ST: Stop coil.

Memory requirement of the timing relay

The time relay function block requires 48 bytes of memory plus 4 bytes per constant on the function block input.

Retention

Timing relays can be run with retentive actual values. The number of retentive timing relays can be selected in the SYSTEM → RETENTION menu.

If a timing relay is retentive, the actual value is retained when the operating mode is changed from RUN to STOP and when the power supply is switched off.

When display system is restarted in RUN mode, the timing relay continues with the retentively stored actual value. The state of the trigger pulse must correspond to the function of the timing relay.

Signal 1 when:

- On-delayed,
- Single pulse,
- Flashing.

Signal 0 for off-delayed.

Function of the timing relay function block**Timing relay, on-delayed with and without random switching**

Random switching:

The contact of the timing relay switches randomly within the setpoint value range.

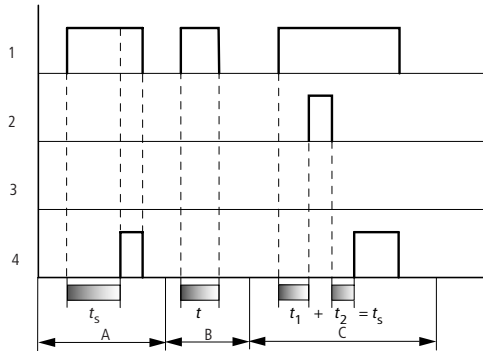


Figure: 131: Signal diagram of timing relay, on-delayed (with and without random switching)

1: Trigger coil T...EN

2: Stop coil T...ST

3: Reset coil T...RE

4: Switching contact (N/O contact) T...Q1

t_s : Setpoint time

- Range A:
The set time elapses normally.
- Range B:
The entered setpoint does not elapse normally because the trigger coil drops out prematurely.
- Range C:
The stop coil stops the time from elapsing.

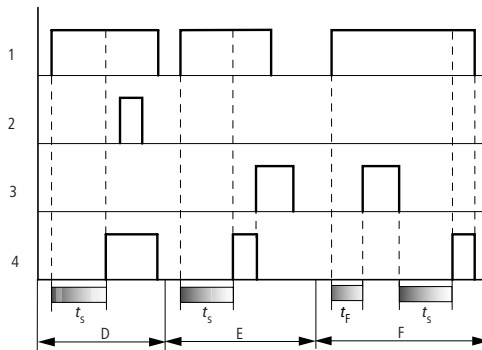


Figure: 132: Signal diagram of timing relay, on-delayed (with and without random switching)

- Range D:
The stop coil is inoperative after the time has elapsed.
- Range E:
The reset coil resets the relay and the contact.
- Range F:
The reset coil resets the time during the timeout sequence.
After the reset coil drops out, the time elapses normally.

Timing relay, off-delayed with and without random switching

Random switching, with and without retriggering

The contact of the timing relay switches randomly within the setpoint value range.

Retriggering

When the time is running and the trigger coil is reactivated or deactivated, the actual value is reset to zero. The set time of the timing relay is timed out once more.

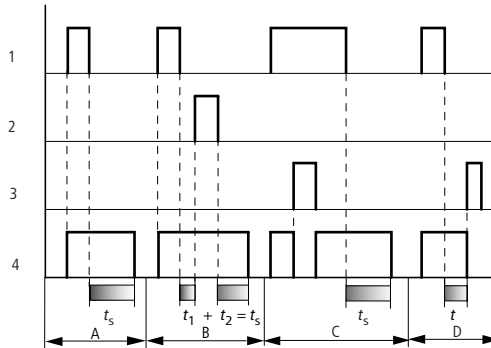


Figure: 133: Signal diagram of timing relay, off-delayed (with/without random switching, with/without retriggering)

1: Trigger coil T...EN

2: Stop coil T...ST

3: Reset coil T...RE

4: Switching contact (N/O contact) T...Q1

t_s : Setpoint time

- Range A:
The time elapses after the trigger coil is deactivated.
- Range B:
The stop coil stops the time from elapsing.
- Range C:
The reset coil resets the relay and the contact. After the reset coil drops out, the relay continues to work normally.
- Range D:
The reset coil resets the relay and the contact when the function block is timing out.

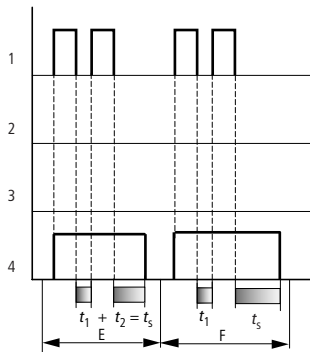


Figure: 134: Signal diagram of timing relay, off-delayed (with/without random switching, with/without retriggering)

- Range E:
The trigger coil drops out twice. The set time t_s consists of t_1 plus t_2 (switch function not retriggerable).
- Range F:
The trigger coil drops out twice. The actual time t_1 is cleared and the set time t_s elapses completely (retriggerable switch function).

Timing relay, on-delayed and off-delayed with and without random switching

Time value >I1: On-delay time

Time value >I2: Off-delay time

Random switching

The contact of the timing relay switches randomly within the setpoint value ranges.

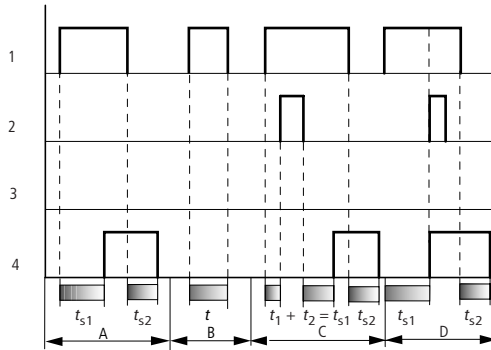


Figure: 135: Signal diagram timing relay, on- and off-delayed 1

1: Trigger coil T...EN

2: Stop coil T...ST

3: Reset coil T...RE

4: Switching contact (N/O contact) T...Q1

t_{s1} : Pick-up time

t_{s2} : Drop-out time

- Range A:
The relay processes the two times without any interruption.
- Range B:
The trigger coil drops out before the on-delay is reached.
- Range C:
The stop coil stops the timeout of the on-delay.
- Range D:
The stop coil has no effect in this range.

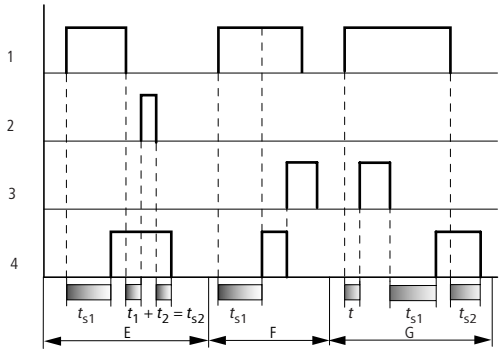


Figure: 136: Signal diagram timing relay, on- and off-delayed 2

- Range E:
The stop coil stops the timeout of the off-delay.
- Range F:
The reset coil resets the relay after the on-delay has elapsed
- Range G:
The reset coil resets the relay and the contact whilst the on-delay is timing out. After the reset coil drops out, the time elapses normally.

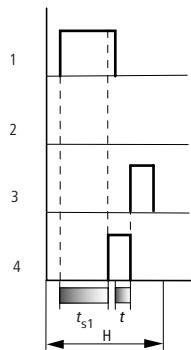


Figure: 137: Signal diagram timing relay, on- and off-delayed 3

- Range H:
The reset signal interrupts the timing out of the set time.

Timing relay, single pulse

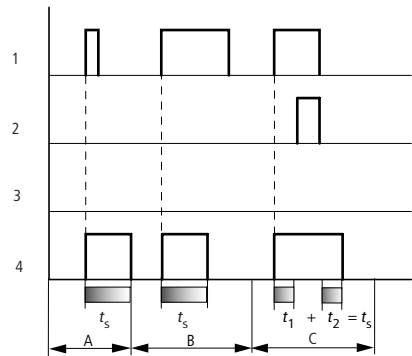


Figure: 138: Signal diagram timing relay, pulse shaping 1

1: Trigger coil T...EN

2: Stop coil T...ST

3: Reset coil T...RE

4: Switching contact (N/O contact) T...Q1

- Range A:
The trigger signal is short and is lengthened
- Range B:
The Trigger signal is longer than the set time.
- Range C:
The stop coil interrupts the timing out of the set time.

- 1: Trigger coil T...EN
- 2: Stop coil T...ST
- 3: Reset coil T...RE
- 4: Switching contact (N/O contact) T...Q1
- Range A:
The relay flashes for as long as the trigger coil is activated.
- Range B:
The stop coil interrupts the timing out of the set time.
- Range C:
The reset coil resets the relay.

Value limitation

The display system provides 32 value limitation function blocks VC01 to VC32. The value limitation function block allows you to limit values. You can define an upper and lower limit value. The function block will then only output values within these limits.

Wiring of a value limitation function block

You can integrate a value limitation function block into your circuit as a coil.

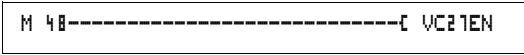


Figure: 141: Display system circuit diagram with value limitation VC

VC27	+
>I1	
>SH	
>SL	
@V>	

Parameter display and parameter set for the VC function block:

VC27	VC value limitation function block number 27
+	Appears in the parameter display
>I1	Input value
>SH	Upper limit value
>SL	Lower limit value
@V>	Output value limited

Inputs

The function block inputs `>I1`, `>SH` and `>SL` can have the following operands:

- Constants
- Markers MD, MW, MB
- Analog inputs IA01 to IA04
 - IA01: Terminal I7
 - IA02: Terminal I8
 - IA03: Terminal I11
 - IA04: Terminal I12
- Analog output QA01
- Actual value `...QV>` of another function block

Output

The function block output `QV>` can have the following operands:

- Markers MD, MW, MB
- Analog output QA01

Value range for inputs and outputs

		Value range
<code>>I1</code>	Input value	–2 147 483 648 to +2 147 483 647
<code>>SH</code>	Upper limit value	
<code>>SL</code>	Lower limit value	
<code>QV></code>	Output value	

Displaying the parameter set in the PARAMETERS menu

- + Access enabled
- – Access disabled

Coil

VC01EN to VC32EN, function block enable

Memory requirement of the value limitation function block

The value limitation function block requires 40 bytes of memory plus 4 bytes per constant on the function block input.

Function of the value limitation function block

→ The function block must be enabled so that it can work. Coil VC...EN is active. If coil VC...EN is not active, the entire function block is deactivated and reset. The output value is set to zero.

The value is accepted at input VC...I1 if the enable coil is active. If the value is greater than the upper limit value or less than the lower limit value, the respective limit value is output at VC...QV.

Example with timing relay and counter function block

A warning light flashes when the counter reaches 10. In the example the function blocks C 01 and T 01 are wired.

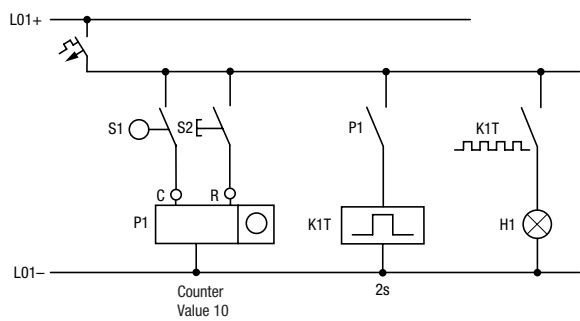


Figure: 142: Hardwiring with relays

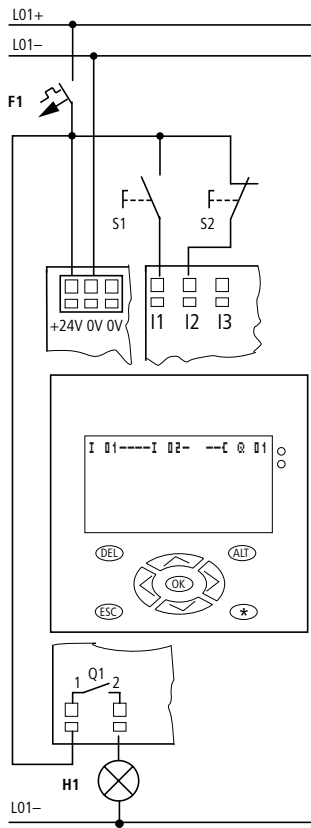


Figure: 143: Wiring with display system



Figure: 144: Display system wiring and circuit diagram

Entering function block parameters from the circuit diagram.

You can access the parameter entry from the contact as well as from a coil.

- ▶ Enter the circuit diagram up to **C 01** as a coil.

C 01C is the counter coil of the counter 01 function block.

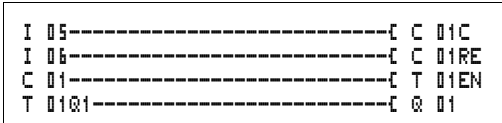
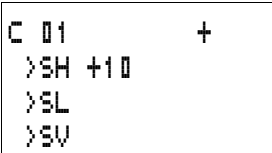


Figure 145: Display system wiring and circuit diagram

- ▶ Keep the cursor on the number.
- ▶ Press the **OK** button.



If the cursor is on the contact number, the display system will call up the parameter display when you press **OK**.



The first part of the parameter set of a counter is displayed.

- ▶ Move the cursor **>** over the **+** character to the value input behind **>SH**:
 - **> SH** means: Function block input upper counter setpoint value
 - The **+** character means that the parameters of this timing relay can be modified using the **PARAMETERS** menu.
- ▶ Change the upper counter setpoint to 10:
 - Use **< >** to move the cursor onto the tens digit.
 - Use **^ v** to modify the value of the digit.
- ▶ Press **OK** to save the value and **ESC** to return to the circuit diagram.



The display system has specific parameter displays for the function blocks. The meaning of these parameters is explained under each function block type.

- ▶ Enter the circuit diagram up to contact **T 01** of the timing relay. Set the parameter for **T 01**.

```

T 01 Ⅱ S +
>I1 002.000
>I2 002.000
QV>

```

The timing relay works like a flashing relay. The display system symbol for the flashing relay is Ⅱ. The function is set on the top right beside the number in the parameter display.

The time base is set to the right of the “flashing” function. Leave the time base set to S for seconds.

- Move the cursor to the right over the + character in order to input the time setpoint value >I1.

If the same setpoint value is input for >I1 and >I2, the timing relay functions as a synchronous flasher.

The + character means that the parameters of this timing relay can be modified using the PARAMETERS menu.

- Confirm the value input with **OK**.
- Press **ESC** to leave circuit diagram entry.
- Complete the circuit diagram.
- Test the circuit diagram using the power flow display.
- Switch the display system to RUN mode and return to the circuit diagram.

Each parameter set can be displayed using the power flow display for the circuit diagram.

- Move the cursor onto C 01 and press **OK**.

```

C 01          +
>SL
>SV
QV>+0

```

The parameter set for the counter is displayed with actual and setpoint values.

- Move the cursor ∨ downwards until you see the value QV>.

```

C 01          +
>SL
>SV
QV>+1
.. C_ .. ..

```

- Switch input I5. The actual value changes.

On the display C_ indicates that the counting coil is actuated.

If the actual and upper setpoint values of the counter are the same, the timing relay switches the warning light on and off every 2 seconds.

```
T 01 11 S +  
>I1 001.000  
>I2  
  QV> 0.550  
.. EN ..
```

Doubling the flashing frequency:

- Select the power flow display **T 01** and change the constant of the setpoint time to **001.000**.

When you press **OK**, the warning light will flash at twice the frequency.

On the display **EN** indicates that the enable coil is actuated.

Setpoint value settings with constants can be modified via the PARAMETERS menu.



The actual value is only shown in RUN mode. Call up the parameter display for this via the power flow display or PARAMETERS menu.

5 Visualization with the display system

In the following description, the term “visualization” is used for the display and operator function.

Whilst it is possible to enter the circuit diagram using CL-SOFT or via the device keypad, all visualization functions can only be programmed with CL-SOFT. Only from this software can the visualization functions be loaded onto the display system module (download function).

This chapter describes the basic operating steps required for using the visualization functions via CL-SOFT by means of examples. The CL-SOFT help offers a detailed description of the software.

Screens

CL-SOFT manages the visualization elements in screens. Visualization elements that you can position in the screens are called screen elements in the following descriptions. You can use up to 255 screen elements in a screen. Due to the memory layout it is advisable to use several screens (→ section “Memory layout”, page 268).

The following screen elements are available:

- Static text,
- Bit display,
- Date and time,
- Bitmap,
- Numerical value,
- Value entry,
- Message text.

The examples illustrate the use of the individual screen elements.

Memory layout

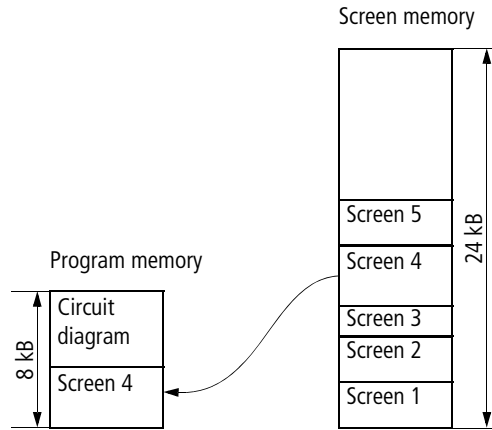


Figure: 146: Memory layout of the display system

The program memory has a maximum size of 8 KByte. The circuit diagram is stored in this memory range and the memory is reserved for the largest screen to be displayed.

A total of 24 KByte is available in the screen memory. This memory range is used to store all the screens that are created.

Consequently, it should be ensured that screens are created with the smallest possible memory requirement since the largest screen and the created circuit diagram have to be stored in the program memory. If no circuit diagram is required, the memory requirement for the largest screen must not exceed 8 KByte.



The status bar of CL-SOFT shows the available working memory, the available screen memory and the required memory for the active screen element. If the memory available is exceeded, the colour of indicated value changes to red.

Western European character table

Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning
0		28		56	8	84	T
1		29		57	9	85	U
2		30		58	:	86	V
3		31		59	;	87	W
4		32	Space	60	<	88	X
5		33	!	61	=	89	Y
6		34	"	62	>	90	Z
7		35	#	63	?	91	[
8		36	\$	64	@	92	\
9		37	%	65	A	93]
10		38	&	66	B	94	^
11		39	'	67	C	95	_
12		40	(68	D	96	`
13		41)	69	E	97	a
14		42	*	70	F	98	b
15		43	+	71	G	99	c
16		44	,	72	H	100	d
17		45	-	73	I	101	e
18		46	.	74	J	102	f
19		47	/	75	K	103	g
20		48	0	76	L	104	h
21		49	1	77	M	105	i
22		50	2	78	N	106	j
23		51	3	79	O	107	k
24		52	4	80	P	108	l
25		53	5	81	Q	109	m
26		54	6	82	R	110	n
27		55	7	83	S	111	o

Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning
112	p	141	ì	170	¬	199	Ã
113	q	142	Ä	171	½	200	+
114	r	143	Å	172	¼	201	+
115	s	144	É	173	¡	202	-
116	t	145	æ	174	«	203	-
117	u	146	Æ	175	»	204	¡
118	v	147	ô	176	¡	205	-
119	w	148	ö	177	¡	206	+
120	x	149	ò	178	¡	207	€
121	y	150	û	179	¡	208	ð
122	z	151	ù	180	¡	209	Ð
123	{	152	ÿ	181	Á	210	Ê
124		153	Ö	182	Â	211	Ë
125	}	154	Ü	183	À	212	È
126	~	155	ø	184	©	213	ì
127	ı	156	£	185	¡	214	Í
128	Ç	157	Ø	186	¡	215	Î
129	ü	158	×	187	+	216	Ï
130	é	159	f	188	+	217	+
131	â	160	á	189	¢	218	+
132	ä	161	í	190	¥	219	¡
133	à	162	ó	191	+	220	—
134	ã	163	ú	192	+	221	¡
135	ç	164	ñ	193	-	222	ì
136	ê	165	Ñ	194	-	223	-
137	ë	166	ª	195	+	224	Ó
138	è	167	º	196	-	225	ß
139	ï	168	¿	197	+	226	Ô
140	î	169	®	198	ã	227	Ò

Code	Meaning	Code	Meaning	Code	Meaning	Code	Meaning
228	ð	235	Ù	242	=	249	“
229	Œ	236	ý	243	¾	250	•
230	μ	237	Ý	244	¶	251	¹
231	þ	238	ˉ	245	§	252	³
232	ƒ	239	´	246	÷	253	²
233	Ú	240	-	247	ˆ	254	
234	Û	241	±	248	°	255	

Screen overview

The screen overview appears with the following tabs when the visualization tool is called up for the first time:

- Screens,
- Passwords,
- Languages,
- Screen activation.

“Screens” tab

In the “Screens” tab you enter the screen name, start screen and password protection (if required) for the screens.

“Passwords” tab

The “Passwords” screen enables you to define three passwords and the corresponding logout time for exiting the screen.

“Languages” screen

The “Languages” screen enables you to enter different languages that are required for the application. You can then define in these languages texts for all text elements. However, there is only one download language that can be transferred to the device. This is also defined here and can be changed quickly when the devices are commissioned. The languages can be exported or imported to or from a Microsoft Excel spreadsheet. This makes it possible to send the texts for external translation.

“Screen activation” tab

The “Screen activation” tab enables you to define an associated variable by which the screen is to be activated. The number of associated variables that are available depends on the variable type used. You can use markers (byte, word, DWord), analog inputs and outputs (word) or function block inputs/outputs (DWord) as associated variables. In the List of Activation Values enter whether and at which value the screen is to be activated by the associated variable defined.

If the Force Screen Change check box is activated, every operation started by the display system will be aborted immediately and the selected screen will be activated if the value of the associated variable initiates this. This Force Screen Change function may abort operations such as value entry, a macro for processing functions on pressing an operator button and also a password entry. This may be useful for implementing appropriate alarm messages.



With Force Screen Change active and a screen associated with an event, any unsaved entries will be lost if the screen concerned is activated by the event.

In this case a screen change cannot be executed via the keypad while the associated variable is set by the program.

In the List of Activation Values you select whether and at which value the screen is to be activated by the variable defined.

Screen editor

The individual screens are created in the screen editor. The following screen elements can be selected:

- Static text,
- Bit display,
- Date and time,
- Bitmap,
- Numerical value,
- Value entry,
- Message text.

For a detailed description, see the following sections:

If no screen element is activated, the Project Info, Program Info and Screen Info tabs are available for selection. If a screen element is positioned in the screen, the specific tabs for the element concerned are shown for these screens.

Static text

The static text element is a simple text display element that is shown as soon as the screen is active. The normal element size can show up to 16 characters in a text field and up to 4 lines can be arranged vertically. When using double font size, half the number of characters per text field and number of displayable characters is possible. The static text can be assigned to the language in the language selection. The language selection is defined in the screen overview.

Programming in CL-SOFT

- Drag the Static text element onto the screen.
- Position the cursor over the Static text element and move it to the required position whilst holding down the screen button.
- Enter the required text in the Static text tab and select the language to which the text is to be assigned.

The languages are defined in the screen overview on the Languages tab. This setting applies to the texts of all screen.

The height of the element frame depends on the font size for which two display formats are available – normal font and double font. The font size can be changed in the context menu (right click) or by dragging the selection square at the bottom of the element frame. To set the double font size, sufficient space must be available underneath the element.

The width of the element can be scaled as required. Dragging a selection square with the mouse button depressed will set the required size. It may be necessary to size the elements sufficiently to provide space for all languages. This can be checked in the screen overview.

The following examples illustrate the Static text function:

Example program 1 – Different display types

The program consists of four screens in which the static text is displayed in different ways. The individual screens can be selected with the cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section "Button editor", page 317).

Standard path: C:\Program files\CL-SOFT\Samples\

Program: StaticText_Prog_01.e60

Screen 1

Screen 1 shows a static text in normal font size.



Screen 2

Screen 2 shows a static text enlarged.

Screen 3

Screen 3 shows three static texts in different font sizes.

Screen 4

Screen 4 shows four static texts arranged vertically.

Example program 2 – Different display types with password request for a screen

The program consists of four screens in which the static text is displayed in different ways. The fourth screen contains a password request. The individual screens can be selected with the cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section "Button editor", page 317).

The defined password is requested when exiting screen 4. In this case, this is the number 2 which must be confirmed with **OK**. It is not possible to scroll through the screens without entering the password. You can leave the password request dialog by pressing **ESC**, which will cause a return to the previous screen.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: StaticText_Prog_02.e60

Screen 1

Screen 1 shows a static text in normal font size.

Screen 2

Screen 2 shows a static text enlarged.

Screen 3

Screen 3 shows three static texts in different font sizes.

Screen 4

Screen 4 shows four static texts arranged vertically.

Four static
texts arranged
one under the
other!!

Example program 3 – Different display types with screen activation using a counter

The program consists of four screens in which the static text is displayed in different ways. The individual screens are activated via the counter C01. This has the value 5 as the upper switch value SH. The pulse for activating the screens is supplied by timing relay T01. The possible counter values are therefore 0 to 5. Counter value 1 activates screen 1, counter value 2 screen 2 etc. If the upper switch value of the counter has been reached, timing relay T02 is started which resets the counter. This therefore produces a continuous loop. The timing relay T02 causes a reset delay of the counter.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: StaticText_Prog_03.e60

Screen 1

Screen 1 shows a static text in normal font size.

Screen 2

Screen 2 shows a static text enlarged.

Screen 3

Screen 3 shows three static texts in different font sizes.

Screen 4

Screen 4 shows four static texts arranged vertically.

Bit display

The Bit display element has an input that can be associated to a Boolean variable. The signal status of these variables changes the display of the Bit display screen element in the display system from a full screen to a frame display.

Programming in CL-SOFT

- Drag the Bit display element onto the screen with the left mouse button depressed.
- Position the cursor over the element and move it to the required position whilst holding down the mouse button.

The height and width of the element frame can be scaled as required and is adjusted accordingly by enlarging or reducing the screen element frame horizontally or diagonally. This is done by dragging the selection square of the element frame with the mouse button depressed.

“Associated Variable” tab: Definition of the Boolean variable for controlling the bit display.

“Visibility” tab: Possibility to make the element invisible via an associated variable.

- The bit display is always output as a solid covering element. It is only possible to make it invisible. When they are positioned overlapping each other, the first bit display will be arranged at the back and the last bit display will be positioned at the front. This arrangement can be modified for the activated screen element in the menu bar (Foreground/background).
- Large area bit displays require a high level of processing capacity and should therefore be avoided in applications where the runtime is critical.

Example program 1 – Associated variable and visibility

The program consists of five screens that you can select via cursor buttons ^ and v. The screen change was defined in the button editor (→ section “Button editor”, page 317).

The screens show examples of the use of the associated variable and the visibility function.
The circuit diagram uses six on-delayed timing relays that activate outputs Q1 to Q4, as well as LED 3 in succession after the elapsed time. The process is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Bitdisplay_Prog_01.e60

Screen 1

Screen 1 illustrates the activation of the bit display solely using the associated variable. The first screen shows four bit display elements. These are triggered in succession via the Boolean operands Q1 to Q4. N/O contact is selected as the bit logic by which the bit display elements assume the status of the corresponding outputs (on/off).

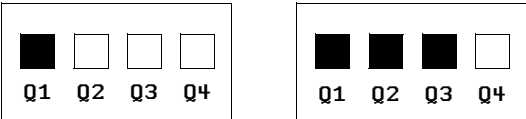


Figure: 147: Bit display and static text

Screen 2

Screen 2 illustrates the activation of the bit display with superimposed static text, exclusively using the associated variable. The second screen shows four bit display elements. These are triggered in succession via the Boolean operands Q1 to Q4.

N/O contact is selected as the bit logic by which the bit display elements assume the status of the corresponding outputs (on/off). The bit display is partly covered by the static texts.

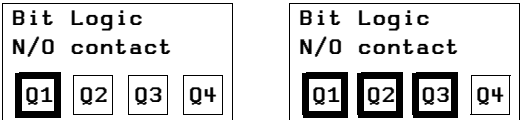


Figure: 148: Bit display with superimposed static text

Screen 3

Screen 3 illustrates the options of the Visibility tab of the bit display. This screen contains a bit display element that was enlarged to the size of the entire screen. The activation is implemented with the Boolean operand Q1 with the N/O contact bit logic, by which the bit display element takes on the status of output Q1 (on/off).

The bit display is switched invisible via the Boolean operand Q3. The bit logic here is also set to N/O contact, the bit display is therefore invisible as long as Q3 is On. During the Reset pulse only the frame of the bit display is visible (the bit display status is Off, bit display is visible). The display is partly covered by static texts.

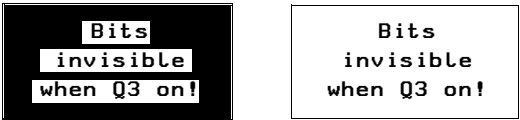


Figure: 149: Bit display visible/invisible

Screen 4

Screen 4 illustrates the activation of the bit display (negated) with superimposed static text, solely using the associated variable. This screen shows four bit display elements. These are triggered in succession via the Boolean operands Q1 to Q4. N/C contact was selected as bit logic. The bit display is partly covered by the static texts.

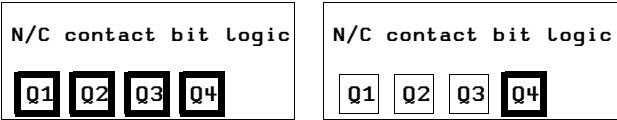


Figure: 150: N/C contact bit display logic with superimposed text

Screen 5

Screen 5 illustrates the options of the Visualisation tab of the bit display (negated) with superimposed text. This screen contains a bit display element that was enlarged to the size of the entire screen. This is triggered via the Boolean operand Q1 with the N/C contact bit logic set. This causes the bit display to assume the opposite state of the output Q1, i.e. when Q1 is On, only the frame of the bit display is visible. However, the bit display is made visible via the Boolean operand Q3 as the N/C contact bit logic is selected. The display is partly covered by static texts.

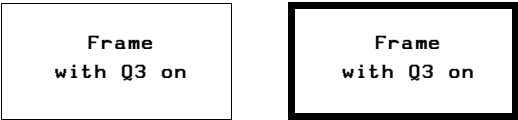


Figure: 151: Bit display with frame

Example program 2 – Bit display with automatic screen change

This program is a copy of the program Bitdisplay_Prog_01.e60. The difference is that the screens are activated in succession automatically. (screen change defined in the Screen overview → Screen activation tab → Activate “Yes”). The program consists of five screens containing the bit displays.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Bitdisplay_Prog_02.e60

Date and time

This screen element shows date and time of the display system real-time clock on the display. You can also select international display formats according to the device system languages plus the US display format..

Programming in CL-SOFT:

- ▶ Drag the Date and time bit display element onto the screen with the left mouse button depressed.
- ▶ Position the cursor over the screen element and move it to the required position whilst holding down the left mouse button.

The height of the element frame depends on the font size. Three sizes are possible:

- Normal font,
- Double font size and
- Fourfold font size

The font size can be changed in the context menu (right click) or by dragging the selection square at the bottom of the element frame.

To increase the font size, sufficient space must be available underneath the element.

The maximum width of the element is limited and depends on the font size, which also determines the display format.

“Date Formats” tab

In the Date format tab select the language and one of four formats. This does not depend on the language set on the display system.

“Visibility” tab

The Visibility tab makes it possible to switch the element to invisible via an associated variable.

Example program 1 – Different display types and invisible switching of a screen

The program consists of eight screens that you can select via cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section “Button editor”, page 317). “German” is the language setting in all eight screens. The first six screens show the options for date and time display, the seventh screen shows all four formats simultaneously and invisible switching is implemented with the eighth screen.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Date_a_Time_Prog_01.e60

Screen 1:

Format: DD.MM:YYYY

Double display format, therefore only day and month visible in display!

Screen 2:

Format: DD.MM:YYYY

Normal display format, therefore year also visible in display!

Screen 3:

Format: DD.MM:YY HH:MM

Normal display format, also display of time in hours and minutes!

Screen 4:

Format: HH:MM

Display of hour and minute, double display format.

WE 01.10.03

Screen 5:

Format: WD DD.MM.YY

Display of weekday and date in normal size.

Screen 6:

Format: HH:MM

Display of hour and minute, single display format.

Screen 7:

Display of different formats in one screen. Display in normal size.

Invisible
via I1!
01.10.2003

Screen 8:

Display invisible, if I1 actuated. (N/O contact bit logic!)

Example program 2 – Different display types with automatic screen change

This program is a copy of the program

Date_a_Time_Prog_01.e60 except that the screen change is automatic. The program consists of eight screens that are triggered in succession by counter C01. The pulses for activating the screens are supplied by timing relay T01. This produces counter values 0 to 9. Counter value 1 activates screen 1, counter value 2 screen 2 etc. The counter resets itself when the upper limit value SH = 9. This produces a continuous loop. "German" is the language setting in all eight screens.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Date_a_Time_Prog_02.e60

Example program 3 – Different country settings

The program consists of 11 screens that are triggered automatically by counter C01. The pulses for activating the screens are supplied by timing relay T01. This produces counter values 0 to 12. Counter value 1 activates screen 1, counter value 2 screen 2 etc. The counter resets itself when the upper limit value SH = 12. This produces a continuous loop. Each screen contains a different country setting. However the same format WD DD MM YY is shown.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Date_a_Time_Prog_03.e60

Screen 4

Country
setting
Spanish
MI 01/10/03

Screen 7

Country
setting
Portuguese
QU 01-10-03

Figure: 152: Date display with different country settings

Bitmap

The Bitmap screen element enables you to display graphics in the display system that you have created yourself or purchased. Their display and visibility can be modified during operation. For this the bitmap graphic is associated with Boolean variables.

CL-SOFT supports the following bitmap graphic formats:

- Windows bitmap format (bmp),
- JPEG format (jpg),
- Tiff format (tif) and
- Icons (ico).

The formats are converted to monochrome and stored accordingly in the program. The size and the position of the bitmap graphic can be modified in the screen editor at a later time.



Bitmap graphics take up a large amount of memory. Covered bitmaps are also stored in their entirety in the memory. The more bitmaps are used, the larger the memory requirement and the cycle time is also considerably increased. This may possibly cause malfunctions in the program (e.g. loss of count pulses).

The ideal graphic is black and white. It should be between 16 × 16 and 32 × 32 pixels in size.

Programming in CL-SOFT:

- Drag the Bitmap element onto the screen with the left mouse button depressed.

This will open the Picture File Selection dialog.

For optimum display of the graphic file select one of the three conversion processes provided in the Conversion Type area. The preview shows the selected bitmap and the converted result. CL-SOFT always creates the best possible black and white bitmap graphic for showing on the monochrome display screen. You can use CL-SOFT here for support in optimising the graphic file.

- Position the cursor over the screen element and move it to the required position whilst holding down the left mouse button.

The height and width of the element frame can be scaled as required and is adjusted accordingly by enlarging or reducing the screen element frame horizontally or diagonally. This is done by dragging a selection square of the element frame with the mouse button depressed. The side ratios of the original graphic are retained when you use the diagonal zoom function.

"Display" tab

The Display tab offers the following display options for the bitmap:

- Bitmap flashing (via associated variable),
- Background transparent or covered,
- Invert bitmap display

"Visibility" tab

The Visibility tab makes it possible to switch the element to invisible via an associated variable.

Example program 1 – Bitmap display

The program consists of eight screens that you can select via cursor buttons ^ and v. The screen change was defined in the button editor (→ section “Button editor”, page 317). This program illustrates the bitmap display options using simple examples.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Bitmap_Prog_01.e60



Screen 1:

Screen 1 shows a bitmap without any special features, displayed small.

Screen 2:

Screen 2 contains a bitmap that is displayed large. An association via Boolean operand I1 is also selected in the Bitmap flashing area on the Display tab. The bitmap flashes when I1 is actuated.

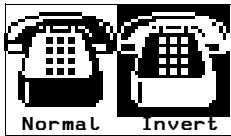


Figure: 153: Flashing bitmap



Screen 3:

Screen 3 contains three bitmaps arranged in different sizes next to each other.



Screen 4:

Screen 4 contains two bitmaps arranged in different sizes next to each other. The Invert Bitmap Display box on the Display tab controls the inverted display.

Screen 5:

Screen 5 contains one bitmap. The Visibility tab controls the bitmap. The bitmap is made invisible when I1 is actuated.

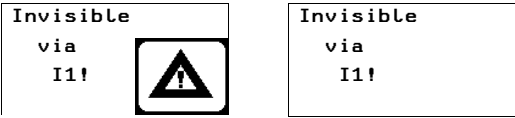
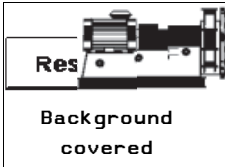


Figure: 154: Make invisible

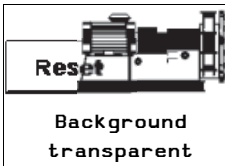
Screen 6:

Screen 6 contains only one bitmap. The Invert Bitmap Display box is activated on the Display tab. The associated variable I2 is defined for making the bitmap visible (N/C contact bit logic) on the Visibility tab. The bitmap is then inverted by actuating I2.



Screen 7:

Screen 7 contains two bitmaps. Background covered is selected for both bitmaps on the Display tab. As the right bitmap covers the left one, the right bitmap is fully displayed.



Screen 8:

Screen 8 contains two bitmaps. The right one covers the left bitmap. However, both bitmaps are displayed completely since the background of the right bitmap is set to transparent on the Display tab.

Example program 2 – Bitmap display with automatic screen change

The program is a copy of the program Bitmap_Prog_01.e60, the individual screens are displayed automatically in succession.

The circuit diagram contains a pulse generator T01 which triggers output Q3 (display of pulse signal) as well as counter C01. This operation is implemented in a continuous loop as the counter triggers the timing relay T02 when it reaches its upper switch value SH. This resets the counter C01 after the set time. The corresponding counter values activate the individual screens.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Bitmap_Prog_02.e60

Example program 3 – Covering of bitmaps

The program consists of three screens that you can select via the cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section "Button editor", page 317). This program illustrates the covering of bitmaps in a screen. The circuit diagram uses six on-delayed timing relays (T01 to T06) that activate outputs Q1 to Q4 as well as LE 03 in succession after the elapsed time. The operation is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Bitmap_Prog_03.e60

Screen 1:

The first screen contains five bitmaps that half cover each other. These are triggered in succession via the outputs Q1 to Q4 and marker M01 to appear in the display. The half covered bitmaps are activated in succession. The Covered option is selected in the Background area of the Display tab. This therefore causes the covered section of the next bitmap behind to be covered. It produces the effect of a moving arrow.



Figure: 155: Covered bitmaps

Screen 2:

The second screen contains five bitmaps positioned on top of each other with each bitmap displayed being larger than the one displayed beforehand. The individual bitmaps are made visible in succession via the outputs Q1 to Q4 and the marker M01 (N/C contact bit logic). The Covered option is selected in the Background area of the Display tab. This therefore causes the covered section of the next bitmap behind to be displayed. It produces the effect of a moving arrow that increases in size.

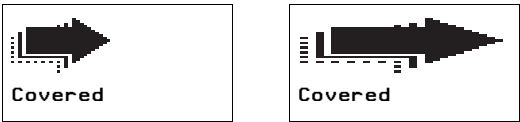


Figure: 156: Arrow increasing in size

Screen 3:

The third screen contains five bitmaps that completely cover each other. These are made invisible in succession from the top to the bottom via outputs Q1 to Q4 and LED 3 (N/O contact bit logic). The Covered option is selected in the Background area of the Display tab. The covered part of the bitmaps cannot therefore be seen.

The first bitmap on the lowest level is always active. Thus it is always visible unless one of the other bitmaps is activated. This produces a small continuous animation.

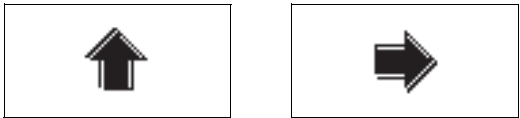


Figure: 157: Rotating arrows

Numerical value

This screen element allows you to display untreated or scaled signal states in decimal format.

Value and scaling range

The value range determines the range of values to be displayed. The display system indicates an underflow if the values are below this range and an overflow if they are above it.

The scaling range enables the value range to be scaled. To do this, the lower value of the scaling range is assigned to the lower value of the value range and the upper value of the scaling range is assigned to the upper value of the value range. If no scaling range is defined, the display system displays the value range.

Examples:

If you wish to display the value range (0 to 255) for example from a counter as a percentage (0 to 100%), then enter 0 as the minimum value and 255 as the maximum value in the Value range area. Enter "%" as a unit of measure. Activate the Scaling range area and enter 0 as the minimum value and 100 as the maximum value.

If you wish to display the value range from 0 to 120 seconds, for example, from a timing relay in minutes (0 to 2 min), enter 0 as the minimum value and 120 as maximum value in the Value range area. Enter "min" as a unit of measure. Activate the Scaling range area and enter 0 as the minimum value and 2 as the maximum value.

Programming in CL-SOFT:

- Drag the Counter value element onto the screen with the left mouse button depressed.
- Position the cursor over the screen element and move it to the required position whilst holding down the left mouse button.

The height of the screen frame depends on the font size for which three sizes are possible:

- Normal font,
- Double font size and
- Fourfold font size

The font size can be changed in the context menu (right click) or by dragging the selection square at the bottom of the element frame.

To increase the font size, sufficient space must be available underneath the element.

The width of the screen element frame can be scaled as required by dragging the selection squares on the side.

“Associated Variable” tab

Define the Boolean variable on the Associated variable tab for activating the numerical value.

“Number range/format” tab

You define the following on the Number range/format tab:

- Value range,
- Unit of measure,
- Scaling range,
- Display change and
- if necessary, force the display of a sign.

“Visibility” tab

The Visibility tab makes it possible to switch the element to invisible via an associated variable.

Example program – Numerical value:

The program consists of nine screens that you can select via cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section “Button editor”, page 317).

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Numericalvalue_Prog_01.e60

Screen 1:

The screen shows six simple output formats of the numerical values and provides an overview of the properties of the Number range/format tab. The first screen shows six numerical values. These are all associated via the on-delayed timing relay T04 (Associated variables tab) for which a time range of 4 seconds is set. The actual value of the timing relay is provided at its QV output (FB parameter) and is then displayed in the appropriate number format. The variable type of the association is of type DWord.

Table 11: Numerical values and output formats

Left column	Right column
Numerical value 1 <ul style="list-style-type: none">• Value range 0 to 50 000• Unit: None• Scaling Range: None• Always Show Sign: No	Numerical value 1 <ul style="list-style-type: none">• Value range: 0 to 4 000• Unit: None• Scaling Range: 0 to 4• Decimal Places: 0• Always Show Sign: No
Numerical value 2 <ul style="list-style-type: none">• Value range 0 to 50 000• Unit: ms• Scaling Range: None• Always Show Sign: No	Numerical value 2 <ul style="list-style-type: none">• Value range: 0 to 4 000• Unit: s• Scaling Range: 0 to 4• Decimal places: 1• Always Show Sign: No
Numerical value 3 <ul style="list-style-type: none">• Value range 0 to 50 000• Unit: ms• Scaling Range: None• Always Show Sign: Yes	Numerical value 3 <ul style="list-style-type: none">• Value range: 0 to 4 000• Unit: s• Scaling Range: 0 to 4• Decimal Places: 2• Always Show Sign: Yes

Timer 4	
1873	2
1873ms	1.9s
+1873ms	+1.87s

Figure: 158: Output formats

Screen 2:

Screen 2 shows a simple example of the visualisation of timing relay times using the function block parameter (FB parameter) from the Associated variable tab. This screen contains three numerical values. These are all associated with the QV output of the timing relay T04.

Table 12: Numerical value – visualisation of timing relay times

Numerical value 1:	Start value of the timing relay T04 FB parameter: I2 (zero, as input I2 is not assigned for an on-delayed relay!)
Numerical value 2:	Set value of the timing relay T04 FB parameter: I1 (4000, as input I1 is assigned with the constant 4 s (= 4000 ms) in the function block editor)
Numerical value 3:	Actual value of timing relay 04 FB parameter: QV (display of the value present at the function block output)

To interpret the displayed values, “ms” (milliseconds) is entered in the Unit of Measure area on the Number range/format tab.

Start value	0ms
Setpoint value	4000ms
Actual value	1452ms

Figure: 159: Timing relay times

Screen 3:

Screen 3 shows an example of the output of analog values (here IA3) on the display. Note the Scaling Range area on the Number range/format tab.

This screen contains three numerical values that output the analog value in different formats. The values are associated via analog input IA3 (Associated variable tab) which provides a value as variable type DWord on the QV output (FB parameter) for further processing. All numerical values have a value range between 0 and 1019 since this scanning range is defined by the connected potentiometer.

Table 13: Numerical value – Analog value output

Numerical value 1:	Display of the analog value (0 to 1019)
Numerical value 2:	Display of the analog value with the scaling range 0 to 10, two decimal places, unit of measure "V" (Volt)
Numerical value 3:	Display of the analog value with the scaling range -5 to +5, two decimal places, unit of measure "V" (Volt), sign displayed

AnaLog input I3	
Scale value	358
0to10	3.51V
-5to+5	-1.49V

Figure: 160: Analog value output

Screen 4:

Screen 4 shows an example of the output of analog values (here IA3) on the display and is an extension of screen 3. To keep it simple all the basic settings of the scaling range from screen 3 were used.

Note the Numerical display group in the Display change area on the Number range/format tab.

Table 14: Numerical value – Analog value output

Numerical value 1:	Display of the analog value (0 to 1019)
Numerical value 2:	Display of the analog value with the scaling range 0 to 10, two decimal places, unit of measure "V" (Volt), Always display sign: yes, Display change – detection via internal limit value comparison, numerical display flashing.
Numerical value 3:	Display of the analog value with the scaling range -5 to +5, two decimal places, unit of measure "V" (Volt), Always display sign: no, Display change – detection via internal limit value comparison, numerical display inverted.

Analog input I3	
Scale value	0
Flashing	+0.00V
Inverted	-5.00V

Figure: 161: Extended analog value output

Screen 5:

Screen 5 shows an example of the output of analog values (here IA3) on the display with the possibility of making them invisible via I1 and I2. The settings for this were defined on the Visibility tab. The screen shows two numerical values that output the analog value in different formats. These values are associated via analog input IA3 which provides a value as variable type Word for further processing.

Table 15: Numerical value – Analog value output with invisible display switch

Numerical value 1:	Display of the analog value with the scaling range 0 to 10, two decimal places, unit of measure "V" (Volt), Switch numerical value invisible via Boolean operand I1, N/O contact bit logic (Visibility tab)
Numerical value 2:	Display of the analog value with the scaling range -5 to +5, two decimal places, unit of measure "V" (Volt), Switch numerical value invisible via Boolean operand I2, N/O contact bit logic (Visibility tab)

Invisibility	
via I1	
via I2	1.29V

Figure: 162: Invisible display switch

Screen 6:

Screen 6 shows a simple example of the display change via an external trigger. In this example, input I1 represents the external trigger. This screen contains two numerical values. These are associated with the QV output of the timing relay T08 which is of variable type DWord. The timing relay is run in a loop from 0 to 10 seconds.

Table 16: Numerical value – Analog value output with display change by external trigger input

General settings:	The value range from 0 to 11 000, unit of measure: s (second), scaling range from 0 to 11, two decimal places, display change active, detection via external trigger input.
Left numerical value:	Display of timing relay value T08, I1 actuated: The numerical value flashes since Display change external trigger flashing via Boolean operand I1 is set.
Right numerical value:	Display of timing relay value T08; I1 actuated: The numerical value is displayed inverted since Display change external trigger inverted via Boolean operand I1 is set.

Display change (I1)	
External trigger	
3.37s	3.37s

Figure: 163: External trigger

Screen 7:

Screen 7 shows a simple example for the display change by means of an internal limit value comparison. The screen contains two numerical values that represent the output values (QV output) of the timing relay T08. The variable type is of type DWord. The timing relay is run in a loop from 0 to 10 seconds.

A value range of 0 to 11000 is defined in the Number range/format tab. "s" (seconds) is entered as the unit of measure. The scaling range is defined from 0 to 11 with two decimal places. The display change is active and is triggered via the internal limit value comparison, causing the numerical value on the left to flash and the numerical value on the right to be displayed inverted.

Table 17: Numerical value – Analog value output with display change by internal limit value comparison

Left numerical value:	The numerical value flashes in the range from 0 to 3 and from 7 to 10. On the Display change tab (internal limit value comparison), the upper limit value is 7 (the display is changed from numerical value 7 to 10) and the lower limit value is 3 (the display is changed from numerical value 0 to 3). The display is not changed in the value range from 3 to 7.
Right numerical value:	The numerical value is displayed inverted in the range from 0 to 3 and from 7 to 10. On the Display change tab (internal limit value comparison), the upper limit value is 7 (the display is changed from numerical value 7 to 10) and the lower limit value is 3 (the display is changed from numerical value 0 to 3). The display is not changed in the value range from 3 to 7.

No display change

Display change
(without 3-7s)
Internal trigger
6.57s 6.57s

Display change

Display change
(without 3-7s)
Internal trigger
0.95s 0.95s

Figure: 164: Display change via internal limit value comparison

Display
Marker word 1 (C1)
16

Screen 8:

Screen 8 shows an example of the output of a marker word. The numerical value in the screen is associated with the marker word MW01. The variable type is Word.

A value range of 0 to 999 is defined in the Number range/format tab. The timing relay T09 switches the counter C01 (→ Circuit diagram in CL-SOFT.) every two seconds. The counter function block output QV writes the data into the marker word MW01 (specified in the Parameters tab, function block output area). The counter is reset if the upper switch value SH (38) is reached.



In CL-SOFT the contents of the markers can be displayed both in decimal and in hexadecimal format. Only decimal format is possible on the display!

Overflow display
Timer 4
- - - ms

Screen 9:

Screen 9 shows an example of a value overflow display. The associated variable is the QV output of the timing relay T04. The variable type is DWord. The timing relay runs from 0 to 4000 ms. Only a value range from 0 to 3000 and the measuring unit "ms" are defined on the Number range/format tab. This will cause a value overflow as soon as 3000 ms is exceeded. This is indicated in the display by an overflow display.

Underflow display
Counter 2
- mm

Screen 10:

Screen 10 shows an example of a value underflow display. The associated variable is the QV output of the counter C02. The variable type is DWord. The counter C02 is activated by timing relay T07 with Flashing mode selected. The counter runs down from 12 to 0. Only a value range of 6 to 12 and a unit of measure "mm" is defined on the Number range/format tab. This causes a value underflow as soon the value goes below 6 mm. This is indicated in the display by an underflow display.

Value entry

With this screen element you can enter numerical set values during operation and thus make interventions in the process. This is done by entering the signal state via the associated set variable. The display system stores the entered value internally. The program processes the value and displays it until it is changed by the operator or the program. Without an operator entry this screen element functions like the numerical value screen element and therefore displays the value of the associated set variable.

At the start of the entry on the display system the entry field retains the last variable value calculated. Pressing **OK** activates Selection mode in which you can use the **cursor buttons** to move between the value entry elements of a screen. The elements are activated from the back to the front. The order is defined by how the elements are positioned and can be modified in the menu bar. Pressing **OK** once more activates Entry mode.

Value and scaling range

The value range determines the range of values to be displayed. The display system indicates an underflow if the values are below this range and an overflow if they are above it.

The scaling range enables the value range to be scaled. To do this, the lower value of the scaling range is assigned to the lower value of the value range and the upper value of the scaling range is assigned to the upper value of the value range. If no scaling range is defined, the display system displays the value range.

Examples:

If you wish to display the value range (0 to 255) for example from a counter as a percentage (0 to 100 %), then enter 0 as the minimum value and 255 as the maximum value in the Value range area. Enter "%" as a unit of measure. Activate the Scaling range area and enter 0 as the minimum value and 100 as the maximum value.

If you wish to display the value range from 0 to 120 seconds, for example, from a timing relay in minutes (0 to 2 min), enter 0 as the minimum value and 120 as maximum value in the Value range area. Enter "min" as a unit of measure. Activate the Scaling range area and enter 0 as the minimum value and 2 as the maximum value.

Programming in CL-SOFT:

- ▶ Drag the Value entry element onto the screen with the left mouse button depressed.
- ▶ Position the cursor over the screen element and move it to the required position whilst holding down the left mouse button.

The height of the screen frame depends on the font size. Three sizes are possible:

- Normal font,
- Double font size and
- Fourfold font size

The font size can be changed in the context menu (right click) or by dragging the selection square at the bottom of the element frame. To increase the font size, sufficient space must be available underneath the element.

The width of the screen element frame can be scaled as required by dragging the selection squares on the side.

"Set Variable" tab

In the Set variable tab you enter the Boolean variable for which you wish to set the value.

"Number range/format" tab

You define the following on the Number range/format tab:

- Value range,
- Unit of measure,
- Scaling range and
- Input format.

The display of the sign can be forced.

“Visibility” tab

The Visibility tab makes it possible to switch the element to invisible via an associated variable.

“Operability” tab

In the Operability tab you select the associated variable by which the entry element is to be disabled.

Example program – Value entry

The program consists of seven screens that you can select via cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section “Button editor”, page 317). While the display system is in RUN state you can modify all the values that are processed by the program via the cursor buttons $\langle \rangle \wedge \vee$. The actual values are shown in the display system’s display.

In order to display values the display system must firstly be switched to Selection mode. In Selection mode you can select the value entry element for the values you wish to change.

- Press **OK** so that the display system switches to Selection mode. Press **ESC** to exit Selection mode.

The selected value entry element will flash. If several entry elements are present you can select the required element with the cursor buttons $\langle \rangle \wedge \vee$ (\rightarrow Screen 7).

- Press **OK** in order to switch from Selection mode to Entry mode.
- Move to the required position with the cursor buttons \langle and \rangle , change the value with the cursor buttons \wedge and \vee .
- Accept the modified value with **OK**. Pressing **ESC** will cause the previous value to be retained.
In both cases you will return to Selection mode and can exit this by pressing **ESC**.

The circuit diagram contains the timing relay T01 that triggers the counter C02. The counter switches the output Q1 to high when the upper set value SH is reached. The value of the counter function block output QV is transferred to the marker word MW06. The upper set value SH is associated with the

marker word MW07 and the preset actual value SV with marker word MW05. During RUN mode the current data is stored in the marker words and new data is written there via the value entry elements. Input I2 can be used to reset the counter at any time. I1 (rising edge) is used to accept the value at marker word MW05 as a new preset actual value SV. As no value is stored in marker word MW07 (switch value for Q1) when the program is started, this is interpreted as switch value "zero" and the output Q1 is immediately set to "high".

Standard path: C:\Program files\CL-SOFT\Samples\

Program: ValueEntryProg_01.e60

Switch value	
Q1 (OK)	
Actual value	100
99	

Screen 1:

Screen 1 illustrates the value entry option via the set variable marker word MW 07 (switch value for Q1). The value entry element is shown enlarged on the display. A value range is defined from 0 to 9999 in the Number range/format tab and Allow Digit Selection is set as entry mode. The input I01 is selected with N/O contact bit logic on the Operability tab. The value is written to the marker word 7 and transferred by counter input SH. Q1 is high when the counter input value QV equals or is greater than the upper set value SH. If the actual value is already higher than the switch value, you can reset the counter via I2. Q1 switches immediately to low and is not set again until the switch value is reached.

Screen 2:

Screen 2 illustrates the value entry option via the set variable marker word MW05 (preset actual value SV). After you have entered a new value this is written to the marker word MW05 by actuating I1. This is associated with the preset actual value SV of the counter C02. After the transfer, the actual value QV jumps to the entered SV value and counts on from there.

Set entry: 80

	Set
QV	Entry (OK)
304	80
	Transfer I1

Transfer of value

	Set
QV	Entry (OK)
80	80
	Transfer I1

Figure: 165: Transfer of value on closing of I1

Screen 3:

Screen 3 shows an example of the Number range/format tab, especially the Scaling range and Input Format → Allow Digit Selection. You can enter any value from 0.00 to 10.00 (allow digit selection). After I1 is closed, the preset actual value SV is transferred. After the transfer, the actual value QV jumps to the entered SV value and counts on from there. The maximum scaling range (10.00) is assigned to the maximum value range (9999). The QV value thus switches to the value 9999 when 10.00 is entered and I1 is actuated.

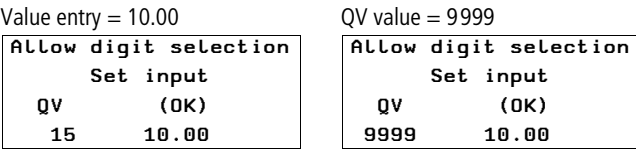


Figure: 166: Transfer of value with Allow digit selection

Screen 4:

Screen 4 shows an example of the Number range/format tab, and in particular the Scaling range and Input Format → Fixed Step Width. You can enter any value from 0.00 to 10.00 in step widths of 0.50 (fixed step width). After I1 is closed, the preset actual value SV is transferred. After the transfer, the actual value QV jumps to the entered SV value and counts on from there. The maximum scaling range (10.00) is assigned to the maximum value range (9999). The QV value thus switches to the value 9999 when 10.00 is entered and I1 is actuated.

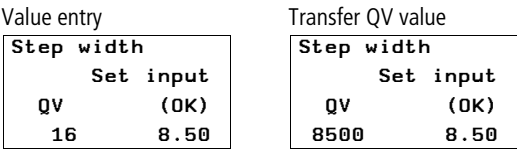


Figure: 167: Transfer of value with Fixed Step Width

Screen 5:

Screen 5 shows an example using the Visibility tab. If I4 is closed, the value entry element is made invisible. The N/O contact bit logic is set. If N/C contact bit logic was set, this would create a visible switch function. The element remains operable even when invisible, and value entry is still possible.

Set value visible

Set value entry	
invisible	
QV	via I4
299	1037

Set value invisible

Set value entry	
invisible	
QV	via I4
299	

Figure: 168: Switch value entry element invisible

Screen 6:

Screen 6 shows an example using the Operability tab. The same Visibility setting is used as in screen 5. Closing I3 will disable the entry function (N/O contact bit logic). If the value entry element is disabled, you can still select it (it flashes), but Entry mode (change values) is disabled. If the value entry element is in Entry mode when I3 is closed, the display system switches automatically to Selection mode. If N/C contact is set as bit logic, entry is only possible if I3 is actuated. I4 switches the value entry element to invisible, however, it still remains operable allowing values to be changed.

I3 not actuated

Set value entry	
Blocked	
QV	via I3
249	1037

I3 actuated

Set value entry	
Blocked	
QV	via I3
249	1037

Figure: 169: Value entry element disabled

Message text

This screen element makes it possible to display texts that are stored in a text table inside the program. A text can have a maximum length of 16 characters. If the text is shorter than the element, the text is provided with additional blanks for the output. A message text is used for indicating status changes in the process. In order to visually display changes of this kind, you can link message texts with a variable (associated variable). As soon as the variable assumes defined value, the display system will output the associated message text. The default text is output if the variable assumes a value that is not assigned to a text.

Programming in CL-SOFT:

- ▶ Drag the Message text element onto the screen with the left mouse button depressed.
- ▶ Position the cursor over the screen element and move it to the required position whilst holding down the left mouse button.

The height of the screen frame depends on the font size. Two sizes are possible:

- Normal font and
- Double font size

The font size can be changed in the context menu (right click) or by dragging the selection square at the bottom of the element frame. To increase the font size, sufficient space must be available underneath the element.

The width of the screen element frame can be scaled as required by dragging the selection squares on the side.



Ensure that the screen elements are large enough to accommodate the texts for all languages used. This can be checked in the screen overview.

"Associated Variable" tab

Define the Boolean variable on the Associated variable tab for activating the value for a particular output text.

"Message texts" tab

The Message texts tab is used to assign the value of the associated variable to the corresponding message text, as well as to select the language and the standard text.

"Visibility" tab

The Visibility tab makes it possible to switch the element to invisible via an associated variable.

"Display Change" tab

The Display change tab offers the following display options which can be controlled via an associated variable:

- Flashing,
- Inverse

Example program 1 – Controlling message texts with Boolean variables

The program consists of seven screens that you can select via cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section "Button editor", page 317). The circuit diagram uses six on-delayed timing relays that activate outputs Q1 to Q4 as well as LE 03 in succession after the elapsed time. The process is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time. In all screens the message texts are activated via Boolean operands. As these operands only have two states (0/1), only a maximum of two different messages can be output for each message text element. Other variable types will allow the output of correspondingly more messages per message text element.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Messagetext_Prog_01.e60

Screen 1:

Screen 1 illustrates the activation of the message texts using the associated variable. The output of two different texts in one message text element is demonstrated. The first screen contains four message text elements. These are triggered in succession via the outputs Q1 to Q4 and appear in the display.

The Message texts tab defines which message is to be output for a particular state of the associated variable. In this example, the message “no data” will be output when Q1 = 0, and “Information” will be output when Q1 = 1. All other message texts elements have only one message text that is displayed when the corresponding output Q... = 1.

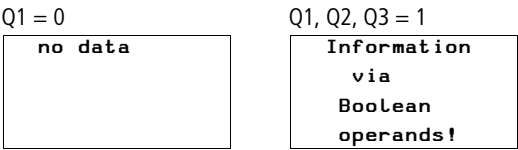
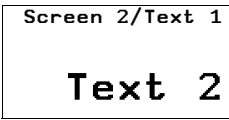


Figure 170: Text display via Boolean operands



Screen 2:

Screen 2 illustrates the activation of the message texts using the associated variable. A message text is also displayed enlarged. The screen contains two message text elements. These are triggered in succession via the outputs Q1 to Q3 and appear in the display. The texts are only displayed if the corresponding outputs are set to 1. No message text is assigned to status 0.

Screen 3:

Screen 3 illustrates the actuation of a bigger message text element with two message texts assigned to the current status value of output Q2.

Q2 = 0 → message text Q2 OFF

Q2 = 1 → message text Q2 ON

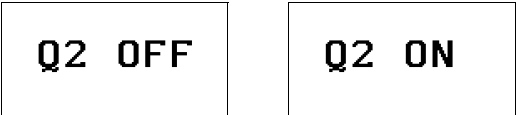


Figure: 171: Message texts via an associated variable

Screen 4:

Screen 4 is essentially the same as screen 3 but also has an additional visibility element. Input I1 switches the message text invisible. The setting for this is carried out in the Visibility tab. N/O contact bit logic is selected. If N/C contact is set as bit logic, the message text element is visible if I1 is actuated.

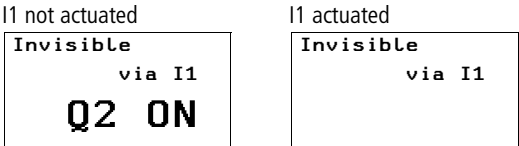


Figure: 172: Masking out message text

Screen 5:

Screen 5 is essentially the same as screen 4 in which the Invisibility function is replaced by a Flashing display change. Input I2 = 1 (N/O contact bit logic) switches the message text flashing.

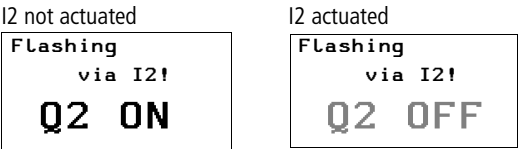


Figure: 173: Message text flashing

Screen 6:

Screen 6 is essentially the same as screen 5 but with the Inverted display change selected. Input I2 = 1 (N/O contact bit logic) inverts the message text in this screen.

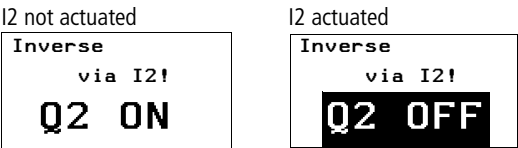


Figure: 174: Message text inverted

Screen 7:

Screen 7 is essentially the same as screen 6, but the inverted display is controlled by a timer T07 (asynchronous pulse generator). The text flashes in the display with different pulse and pause times.

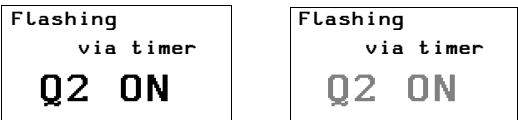


Figure: 175: Message text inverted flashing

Example program 2 – Controlling message texts with timing relay

The program consists of two screens containing message texts. The screen activation automatically shows the screens on the display in succession. The circuit diagram uses six on-delayed timing relays (T01 to T06) that activate outputs Q1 to Q4 as well as LE 03 in succession after the elapsed time. The operation is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time.

The screen activation is implemented via counter C01. This contains the value 1 as the upper set value SH. This therefore produces the counter values 0 and 1 that are used for both screens as activation values. When the timing relays T01 to T06 are reset by T06, counter C01 is activated which reaches the status value 1 and therefore its upper set value, causing screen 2 to be displayed. The on-delayed timing relay T08 sets the counter C01 back to zero after the set time (0.8 s), causing screen 1 to be displayed again the timing relay T08 is no longer activated. The loop is continued.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Messagetext_Prog_02.e60

Start Machine 1
Start Machine 2
Start Machine 3
Start Machine 4

Screen 1:

The first screen shows four bit message text elements. These are triggered in succession via the outputs Q1 to Q4 and appear in the display.

Restart

Screen 2:

The second screen contains a message text element with a message text.

Example program 3 – Message text with display change

The program consists of two screens containing message texts. The screen activation automatically shows the screens on the display in succession. This program is an extension of the program Messagetext_Prog_02.e60. The extension consists of screen 2 containing two messages in one message text element which are toggled automatically. A display change is also carried out in one message text. The circuit diagram uses six on-delayed timing relays T01 to T06 that activate outputs Q1 to Q4 as well as LE 3 in succession after the elapsed time. The operation is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time. In the circuit diagram, N/O contacts (C01ZE) of the counter are switched directly before the outputs Q1 to Q4 as well as before LE 03. The outputs must only be active with screen 1, i.e. when the counter is set to 0.

Screen activation is triggered by counter C01. This has the value 2 as the upper switch value SH. This produces the counter values 0, 1 and 2. The counter value 0 activates screen 1, counter value 1 activates screen 2 and counter value 2 activates the second message text in screen 2. When the timing relays T01 to T06 are reset, the counter receives a pulse and is incremented by one value. When counter C01 reaches its upper set value on the second pass, the on-delayed timing relay T08 starts. After the set time (0.8 s) this resets the counter C01 to 0. The loop is continued.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Messagetext_Prog_03.e60

Start Machine 1
Start Machine 2
Start Machine 3
Start Machine 4

Screen 1:

The first screen shows four bit message text elements. These are triggered in succession via the outputs Q1 to Q4 and appear in the display.

Screen 2:

The second screen contains a message text element with two message texts. In all screens the message texts are activated via the counter values "1" and "2". When the timing relays are reset by T06, counter C01 is activated which reaches the status value 1, and the "Error" message appears. It flashes as specified in the Display change tab where the FB parameter is set to ≤ 1 . If the status value of C01 is 2, RESTART is displayed.



Figure: 176: Message text as status indication

Example program 4 – Message texts with default text

The program consists of two screens containing message texts. The screen activation automatically shows the screens on the display in succession. This program is an extension of the program Messagetext_Prog_03.e60. This consists of the display of a default text in screen 2 when the counter takes on values for which no messages have been assigned. The circuit diagram uses six on-delayed timing relays T01 to T06 that activate outputs Q1 to Q4 as well as LE 03 in succession after the elapsed time. The process is carried out in a continuous loop since the timing relay T06 resets all timing relays after the set time. In the circuit diagram, N/O contacts (C01ZE) of the counter are switched directly before the outputs Q1 to Q4 as well as before LE 03 so that the outputs are only active with the display of screen 1 when counter C01 is 0.

The screen activation is implemented via counter C01. This has the value 4 as the upper set value SH. This produces counter values 0, 1, 2, 3 and 4. The counter value is reset when timing relays T01 to T06 are reset. Counter value 0 activates screen 1, counter value 1 activates screen 2. Screen 2 stays active for counter value 2 to 4, with counter value 2 and 3 assigned a default text as there are no message texts assigned to these counter values. Counter value 4 shows the message text RESTART in screen 2. This value also reaches the upper set value which activates the on-delayed timing relay T08. This resets the counter C01 back to 0 after the set time of 0.8 s. The loop is continued.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Messagetext_Prog_04.e60

Start Machine 1
Start Machine 2
Start Machine 3
Start Machine 4

Screen 1:

The first screen shows four bit message text elements. These are triggered in succession via the outputs Q1 to Q4 and appear in the display.

Screen 2:

The second screen contains a message text element with two message texts.

- Status value 1: Message text "Error"
- Status value 2 and 3: Default text "default"
- Status value 4: Message text "RESTART"

If the status value of C01 is 1, the message text "Error" is displayed flashing since the function block parameter FB is set in the Display change area of the Display change tab. The function block parameter switches if the SL value (lower set value) of the counter is reached (→CL-SOFT Function block editor counter C01).

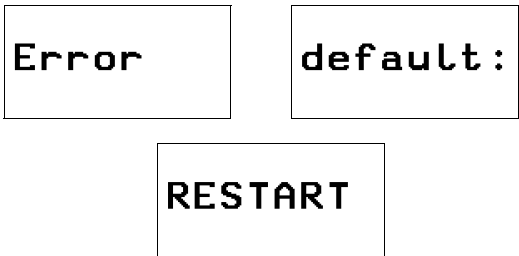


Figure: 177: Message text with default text

Example program 5 – Several message texts in one text element

The program consists of three screens that you can select via cursor buttons \wedge and \vee . The screen change was defined in the button editor (\rightarrow section "Button editor", page 317). The program is used to display several messages in one message text element. It also illustrates the function of the Visibility tab and the Display change tab. The pulse generator T01 activates the counter C01. This counts up to seven and then resets itself. This produces a continuous loop in which the individual messages are activated.

Standard path: C:\Program files\CL-SOFT\Samples\

Program: Messagetext_Prog_05.e60

Screen 1:

The first screen contains a message text element with six messages.

- Status value 1: Message text "These"
- Status value 2: Message text "are six",
- Status value 3: Message text "message texts"
- Status value 4: Message text "in one"
- Status value 5: Message text "message text"
- Status value 6: Message text "element!".

It can be seen that the messages can be moved within the entry field.

Screen 2:

Screen 2 is virtually the same as screen 1 apart from an extension in which the message text element can be switched invisible via I1 (N/O contact bit logic). A N/C contact bit logic would make the element visible.

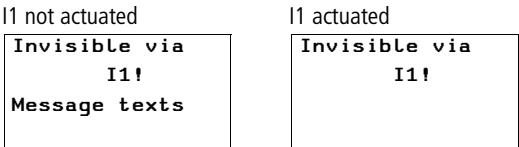


Figure: 178: Switching message text invisible

Screen 3:

Screen 3 is virtually the same as screen 1 apart from an extension in which the first message text element flashes and the second is displayed inverted when I1 is actuated.

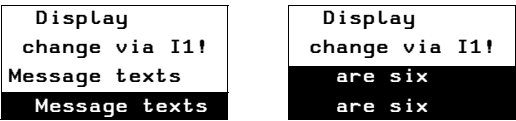


Figure: 179: Message text flashing and inverted

Button editor

All the buttons of the display system can be assigned appropriate functions in the Button editor of the CL-SOFT, thus overwriting the basic functions of the buttons. The following steps are used to assign the buttons of the display system:

- Select operable screen element,
- Display backlight,
- Screen change,
- Password logout,
- Set variable to fixed value,
- Increment variable,
- Decrement variable,
- Changeover relay.

Select operable screen element

If the program has a screen with a value entry, you can jump to these value entry elements directly. The value entry element is positioned in Entry mode so that you can change the value directly.

Display backlight

You can increase or decrease the lighting of the backlight in stages.

Screen change

This function enables you to change to other saved screens during operation. If the operator is to be able to move between several screens using a button function you must assign a screen change button element to an operator button in each of these screens.

Password logout

A logout time can be defined in the screen overview in the Password tab. This logout time is skipped with the Password logout function.

Set variable to fixed value

This function assigns the specified variable with a defined value, e.g. for resetting to a specific value.

Increment variable

The value of the variable is increased by the set step width.

Decrement variable

The value of the variable is reduced by the set step width.

Changeover relay

The status of a variable or a function block input is negated.

6 CL-NET network, COM-LINK serial connection

Introduction to CL-NET

The CL-LDC.LN... display systems are provided with a CL-NET network connection. This network is designed for eight stations.

Using the CL-NET you can:

- Process additional inputs and outputs.
- Implement faster and improved control using decentralised programs.
- Synchronise date and time
- Read and write inputs and outputs.
- Send values to other stations.
- Receive values from other stations.
- Load programs from or to any station.

The CL-NET network is based on the CAN network (Controller Area Network). CAN is specified in accordance with the ISO 11898 standard. CAN has the following standard features.

- Message oriented transmission protocol.
- Multimaster bus access capabilities with non-destructive bitwise bus arbitration via priority messaging (Arbitration: an instance which defines which hardware can use the bus next).
- Multicast message system with message filtering on the receiver.
- High level of real-time capability (short reaction time for high priority messages, short fault message get times).
- Functionality in environments with severe interference (short block lengths).
- High level of error security.



CAN has been used as the basis for the design of the CL-NET network. The messages have been adapted and optimised to suit the requirements of the display system environment.

**CL-NET network
topologies, addressing
and functions**

The CL-NET allows the configuration of a line topology. There are two wiring methods which can be used for the required addressing options:

- “Loop through the unit” wiring arrangement,
- Wiring arrangement using a T connector and a spur line.

Loop through the unit wiring method

With this wiring method it is possible to implement the addressing of the stations via station 1 or the CL-SOFT. If the line is interrupted, the network is no longer operational from this point in the network.

T connector and spur line.

Each device must be addressed individually with this wiring method by:


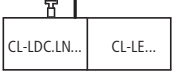
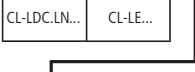
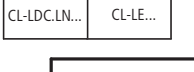

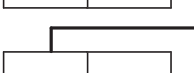

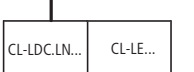
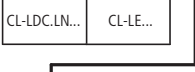
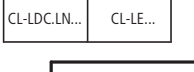
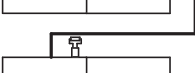
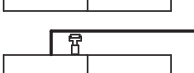
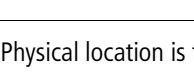
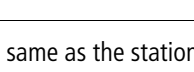
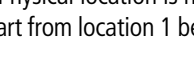
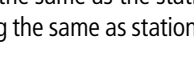
- Downloading the program,
- Downloading the address with CL-SOFT,
- Using the display or
- The device is already assigned an address.

If a spur line is removed on a station, all other devices in the network remain functional.



The spur line between the T connector and the device must not exceed 0.3 m. Otherwise communication via CL-NET may be impaired.

Topology and addressing examples

Physical location, place	Station number		Loop through the unit	T connector and spur line
	Example 1	Example 2		
1	1	1		
2	2	3		
3	3	4		
4	4	8		
5	5	7		
6	6	2		
7	7	6		
8	8	5		

- Example 1: Physical location is the same as the station number
- Example 2: Physical location is not the same as the station number (apart from location 1 being the same as station 1).

➔ Physical location 1 is always assigned as station 1.
Station 1 is the only station which must be present.

Position and addressing of the operands via CL-NET

Sta- tion	Display system		Local expansion		Network bit data		Network word data	
	Input I	Output Q	Input R	Output S	Input RN	Output SN	Receive	Send
1	1 I 1 to 16	1 Q 1 to 8	1 R 1 to 16	1 S 1 to 8	2 to 8 RN 1 to 32	2 to 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
2	2 I 1 to 16	2 Q 1 to 8	2 R 1 to 16	2 S 1 to 8	1, 3 to 8 RN 1 to 32	1, 3 to 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
3	3 I 1 to 16	3 Q 1 to 8	3 R 1 to 16	3 S 1 to 8	1, 2, 4 to 8 RN 1 to 32	1, 2, 4 to 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
4	4 I 1 to 16	4 Q 1 to 8	4 R 1 to 16	4 S 1 to 8	1 to 3, 5 to 8 RN 1 to 32	1 to 3, 5 to 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
5	5 I 1 to 16	5 Q 1 to 8	5 R 1 to 16	5 S 1 to 8	1 to 4, 6 to 8 RN 1 to 32	1 to 4, 6 to 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
6	6 I 1 to 16	6 Q 1 to 8	6 R 1 to 16	6 S 1 to 8	1 to 5, 7, 8 RN 1 to 32	1 to 5, 7, 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
7	7 I 1 to 16	7 Q 1 to 8	7 R 1 to 16	7 S 1 to 8	1 to 6, 8 RN 1 to 32	1 to 6, 8 SN 1 to 32	GT 1 to 32	PT 1 to 32
8	8 I 1 to 16	8 Q 1 to 8	8 R 1 to 16	8 S 1 to 8	1 to 7 RN 1 to 32	1 to 7 SN 1 to 32	GT 1 to 32	PT 1 to 32



The RN-SN connection is a point-to-point connection between the defined stations. With RN and SN the number of the contact must have the same number as the coil.
Example: 2SN30 from station 8 is sent to 8RN30 of station 2.

→ Every station with a circuit diagram has read access to the physical station inputs and outputs of other stations and can process them locally.

Example 1:

Station 1 is to read the input I1 of station 2 and write to output Q1 of station 2. Station 2 does not have a circuit diagram.

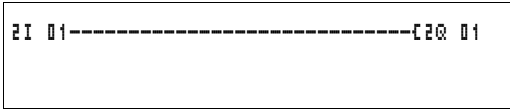


Figure: 180: Circuit diagram in station 1

Example 2:

Marker M 01 of station 4 is to switch the output Q1 of station 3 via the network. Both stations have a circuit diagram.

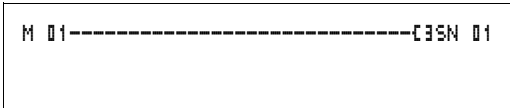


Figure: 181: Circuit diagram in station 4: Set coil 01 in station 3

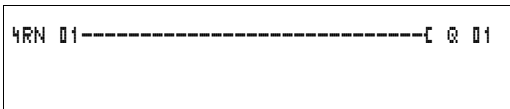


Figure: 182: Circuit diagram in station 3: Get value from coil 01 in station 4

Functions of the stations in the network

The stations on the CL-NET can have two different functions:

- Intelligent stations with their own programs (stations 1 to 8)
- Input/output devices (REMOTE IO) without their own program (stations 2 to 8)



Station 1 must always have a circuit diagram.

Possible write and read authorisation in the network

The stations have differing read and write authorisation in the CL-NET network according to their functions and configuration.

Station 1

Authorised read access to all inputs and outputs of all stations regardless of the function. Observe the setting of SEND IO (→ section "Send each change on the inputs/outputs (SEND IO)", page 327).

Authorised write access to the station's own local outputs.

Authorised write access to the physical digital outputs of the stations which are functioning as input/output devices.

Write authorisations to the network bit data 2 to 8 SN 1 to 32.

Stations 2 to 8

Input/output device function

No write and read authorisation.

Intelligent station function

Authorised read access to all inputs and outputs of all stations regardless of function. Note the SEND IO setting (→ section "Send each change on the inputs/outputs (SEND IO)", page 327).

Write authorisation to its own local outputs.

Write authorisations to the network bit data .. SN 1 to 32.

**Configuration of the
CL-NET network**

CL-NET can be configured so that it can be optimised for your application.

Station number

The station number is identified as the NET-ID in the device. The station number can be set on devices with a display using the buttons on the display system.



All CL-NET settings are best carried out on station 1. The entire network can be configured from station 1. A local configuration is only required when a device is exchanged.

Valid station numbers for operation are 01 to 08.

Station number 00 = Factory default setting

With station number 00, double address assignment cannot occur when an existing device is being exchanged.

Transmission speed

The display system hardware allows you to set transmission speeds between 10 and 1000 KBaud in specific stages. The length of all cables determines the maximum permissible data transfer rate (→ chapter „Technical data“, page 408).

The data transfer rate is set under the BAUDRATE menu item.

Possible baud rates are: 10, 20, 50, 125, 250, 500 and 1000 KB

125 KB = Factory default setting

Pause time, changing the write repetition rate manually

Every CL-NET network connection automatically determines the number of stations which are active on the network, the baud rate which is used and the total number of bytes which are transmitted. The minimum pause time which a device requires is automatically determined using this data in order to ensure that all devices can send their messages. If a pause time is to be increased, the value of the BUSDELAY must be set greater than zero.

Value 1 doubles the pause time, value 15 will increase it by a factor of 16.

$$t_{p\text{new}} = t_p \times (1 + n)$$

$t_{p\text{new}}$ = New pause time

t_p = Pause time determined by the network

n = Value at BUSDELAY



An increase in the pause time means that fewer messages (inputs, outputs, bit data, word data) are transferred per time unit.

The reaction speed of the entire controller depends on the baud rate, the pause time and the quantity of transferred data.

The smaller the amount of data transferred, the faster the reaction times of the system.



An increase in the pause time is only useful during commissioning. To ensure that the data for the power flow display is updated faster in the PC, a longer range for this data is created on the network within this pause time.

Send each change on the inputs/outputs (SEND IO)

The SEND IO function should be used if you wish to send any change in input or output status immediately to all other network stations. SEND IO should be activated if intelligent stations have read access to the inputs and outputs of other stations (2I 02, 8Q 01, etc.).

SEND IO ✓

This means that the quantity of messages on the network can increase significantly.



If high-speed counters are used, the SEND IO function should be deactivated. Otherwise the input data is written very rapidly onto the network as they change continuously, leading to unnecessary loading of the network.

If intelligent devices are required to exchange bit information, it should be implemented via RN and SN.

SEND IO ✓ = Factory default setting

Automatic change of the RUN and STOP mode

REMOTE RUN should be activated if stations 2 to 8 are to automatically follow the mode change of station 1 during operation.



Input and output devices must always have SEND IO activated, to ensure that station 1 always receives up-to-date input and output data.



Intelligent stations with display only follow the operating mode change when the display is showing the status display or a text.

The following is of utmost importance during commissioning!



Attention!

If several engineers are commissioning a machine or system involving several spatially separated elements via the CL-NET network, it must be ensured that REMOTE RUN is not activated.

Otherwise unwanted machine or system starts may occur during commissioning. The associated events depend on the machines or systems involved.

REMOTE RUN ✓ = Factory default setting

Configuring an input/output device (REMOTE IO)

All devices are factory set for operation as input and output devices. This has the advantage that devices can be used immediately as I/O devices, regardless of whether they have a display or not. You only need to assign the station number. This can be implemented via CL-SOFT or on a station 1 with a display.

If you want to assign a device as an intelligent station on the network, the REMOTE IO should be deactivated.

REMOTE IO

Figure: 183: Remote IO deactivated

The standard settings for the input and output devices are:

```
SEND IO ✓  
REMOTE RUN ✓  
REMOTE IO ✓
```

Station number (NET-ID) and baud rate can be specified via station 1.

Station message types

The CL-NET network recognises various message types. They are:

- Output data of station 1 (Q., S.) which is sent to stations without programs.
- Send and receive network outputs and inputs between stations with the program (*SN, *RN).
- Send and receive data between stations with the program (PT and GT function blocks).
- Transfers of inputs, outputs, station status (I, R, Q, S).
- Load programs to and from every station.

The CL-NET network is based on a CAN (Controller Area Network) system. Each message type has its own ID. The message priority is determined via the respective ID. This is important in transmission borderline cases to ensure that all messages reach their destination.

Transfer behaviour

Network CPU data transfer to program image

The display system network connection is equipped with its own CPU. Network data can therefore be processed whilst the program is running. After each program cycle, the status of the network data is written to the operand image of the program and the send data is read from the image. The program runs through the next cycle with this data.

Reading and sending the network data from the CPU

The network CPU of the station reads every message on the network. If the message is relevant to the station, it is accepted into a message memory.

If the content of a send message changes, it is sent. Transmission only occurs when there is no message on the network.

CL-NET is configured so that every station can send its messages. This means that the station must observe a pause time between sending messages. The pause time increases the higher the number of stations and the lower baud rate setting.

The number of stations is recognised by every station via a "sign of life" signal.



The following applies to fast message transfer:

- Set the fastest possible baud rate to suit the network length and cable cross-section.
- Fewer messages means faster messages.
- Avoid program downloads during the RUN mode.

Signs of life of the individual stations and diagnostics

The inputs and outputs message type is used as a “sign of life” recognition to ensure that the state of a station can be recognised by other stations. The states of the inputs and outputs are sent cyclically and at the set baud rate, irrespective of the SEND IO setting. If the inputs and outputs of a station are not recognised by other stations after a time determined by the baud rate, the station is deemed to be disconnected until the next “sign of life” is recognised.

Evaluation occurs at the following intervals:

Baud rate	Stations must send a “sign of life” every ...	Station detects a missing sign of life signal from
[KB]	[ms]	[ms]
1 000	60	180
500	60	180
250	120	360
125	240	720
50	600	1 800
20	1 500	4 500
10	3 000	9 000

If the absence of a “sign of life” is detected, the respective diagnostics contact is set to 1.

Diagnostics contact	Station number
ID 01	1
ID 02	2
ID 03	3
ID 04	4
ID 05	5
ID 06	6
ID 07	7
ID 08	8



If a station does not send a “sign of life” signal (station not available, CL-NET interrupted), the respective diagnostics contact ID... is activated.



Attention!

If the states of the inputs, outputs or data are required by a station without fail, the respective diagnostics contact should be evaluated and the information applied in accordance with its respective application.

If the respective diagnostics contacts are not evaluated, it may cause faults in your application.



The data to be read from a faulty station is set to 0 after the fault is detected.

Network transmission security

The CL-NET network is based on a CAN system. CAN is used in cars and commercial vehicles in all areas. The same fault recognition capability with data transfer applies as with CAN. A BOSCH study relating to undiscovered and corrupt messages determined the following:

The probability of non-discovery of a corrupted message (residual error probability) is: $< 10^{-10}$ message error rate.

The message error rate depends on:

- Bus loading
- Telegram length
- Malfunction frequency
- Number of stations

Example:

Network with:

- 500 KBaud
- Average bus load 25 %
- Average operating time 2000 h/year
- Average error rate of 10^{-3} ,
i.e.: 1 message is faulty every 1000
- Transmission of 1.12×10^{10} messages per year of
which 1.12×10^7 messages are faulty
- Residual error probability: $r < 10^{-10} \times 10^{-3} = 10^{-13}$

This means: 1 of 10^{13} messages is so corrupt that the fault cannot be recognised as such. For a network, this corresponds to a working time of approx. 1000 years.

Introduction to COM-LINK The COM-LINK is a point-to-point connection via a serial interface. This interface connection allows the reading of input/output states as well as the reading and writing of marker ranges. This data can be used for setpoint entry or for display functions. The stations of the COM-LINK have different functions. The active station controls the entire interface. The remote station responds to the requests of the active station. The remote station cannot detect whether the COM-LINK is active or whether a PC with CL-SOFT is using the interface.



The two devices must support the COM-LINK.



Only the display system can be active station with COM-LINK.
The remote station can be another display system.

Topology

The following topologies are possible:

Two devices, the display system as active station and the display system as remote station

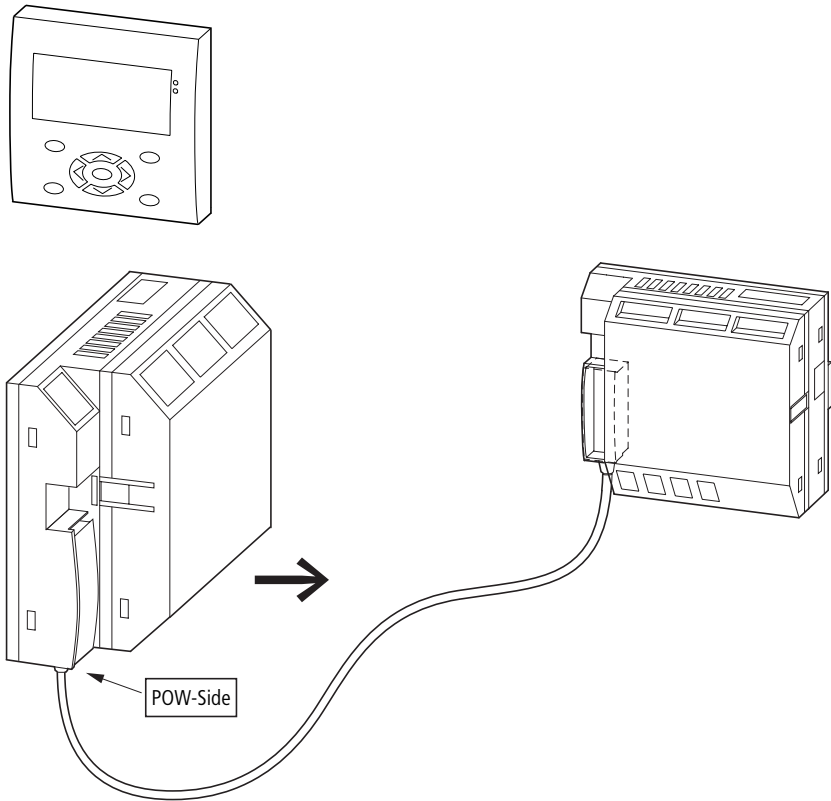


Figure: 184: COM-LINK connection to another display system

Connecting COM-LINK to a CL-NET station.

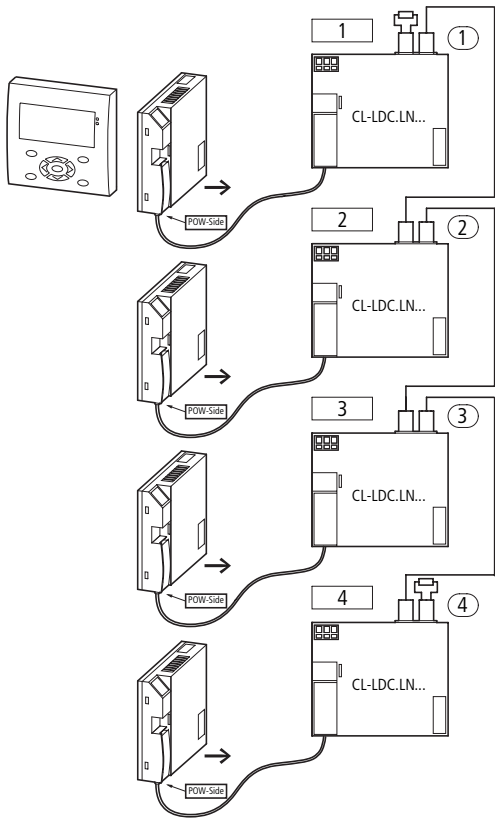


Figure: 185: CL-NET operation and COM-LINK connections.

A COM-LINK connection can be run with a CL-NET station.
The same conditions apply here as with operation without
CL-NET.

Data accesses via COM-LINK

The following data access operations are possible from the active station to the remote station:

Active station, read		Remote station
Inputs	1I01 to 1I16	I01 to I16
Inputs of local expansion unit	1R1 to 1R16	R01 to R16
Outputs	1Q01 to 1Q08	Q01 to Q08
Outputs of local expansion unit	1S01 to 1S08	S01 to S08
Diagnostics bits of CL-NET	1ID01 to 1ID08	ID01 to ID08
Analog inputs	1IA01 to 1IA04	IA01 to IA04
Analog output	1QA01	QA01

Write/read accesses in the marker range

Active station				Remote station			
1 MD01				MD01			
1 MW01		1 MW02		MW01		MW02	
1 MB01	1 MB02	1 MB03	1 MB04	MB01	MB02	MB03	MB04
1 M01 to 1 M32				M01 to M32			
1 MD02				MD02			
1 MW03		1 MW04		MW03		MW04	
1 MB05	1 MB06	1 MB07	1 MB08	MB05	MB06	MB07	MB08
1 M33 to 1 M64				M33 to M64			
1 MD03				MD03			
1 MW05		1 MW06		MW05		MW06	
1 MB09	1 MB10	1 MB11	1 MB12	MB09	MB10	MB11	MB12
1 M65 to 1 M96				M65 to M96			
1 MD04				MD04			
1 MW07		1 MW08		MW07		MW08	
....						
....							
1 MD20				MD20			
1 MW39		1 MW40		MW39		MW40	
1 MB77	1 MB78	1 MB79	1 MB80	MB77	MB78	MB79	MB80

The normal rules for addressing the markers apply.



Ensure a clear separation of the write range of the two stations. The active station should write different markers to the remote station. Otherwise the markers in the last write operation will be overwritten.

Configuration of the COM-LINK

For the COM-LINK connection to be functional, the following settings must be known to the active station:

- Baud rate,
- COM-LINK (active)
- Remote marker range (data exchange range).

COM-LINK baud rate

The baud rate can be 9600 baud or 19200 baud.

```
BAUD RATE:19200B  
COM-LINK  
REMOTE MARKER...
```



In normal applications, select the higher baud rate of 19200 baud. The baud rate of 9600 baud should only be selected if the connection is frequently faulty.

Factory setting: 9600 baud

Activating COM-LINK

The COM-LINK connection must be activated in order for it to function.

Factory setting: Not active

```
BAUD RATE:19200B
COM-LINK    /
REMOTE MARKER...
```

The tick on the COM-LINK means that the COM-LINK connection is active.

Remote markers, COM-LINK data exchange range



The REMOTE MARKER... menu only opens if a tick is displayed next to COM-LINK.

Select the REMOTE MARKER... menu option. Here you can determine, select and modify the data exchange range.

In the example the READ range was selected with the marker double words MD11 to MD15.

```
READ:
1MD11 + 1MD15
WRITE:
1MD16 + 1MD18
```

The WRITE range consists of the marker double words MD16 to MD18.

The entire data exchange range available is the marker range MD01 to MD20 of the remote station. The active station addresses these markers with 1MD*. The * indicates the number of the marker concerned.

The smallest possible unit for defining a marker range is an MD marker double word.

Example:

The read range of the active station is 1MD02.

The write range of the active station is 1MD03.

The read range of the remote station is thus MD03.

The write range of the remote station is MD02.

Operation of the COM-LINK connection

The active station on the COM-LINK must be in RUN mode.

Data is only exchanged when the active station is in RUN mode.

The remote station can be in either RUN or STOP mode.

The active station polls the remote station continuously. The entire READ marker range is transferred as a string. The entire WRITE marker range is transferred as a string.



Data consistency

The data is located in the image range (data area storing the marker states) of the active station (1MD..) as well as in the image range of the remote station (MD..).

Each station writes data to its own image range asynchronously for data communication. As the serial interface transfers large data volumes slower than the devices overwrite the image ranges, the following applies: one marker double word 1MD..., MD... is consistent.

Within one program cycle, a marker double word that is written via COM-LINK is not constant. The data via the COM-LINK is written to the status image over the course of the program cycle. This means that a different marker value can be present at the start of the program cycle to after the write operation via COM-LINK.

Sign of life detection COM-LINK, diagnostics contact ID09

The diagnostics contact ID09 is provided on the active station of the COM-LINK connection to determine whether it is functioning properly.

Status of diagnostics contact ID09	Status of the connection
"0"	COM-LINK connection functioning trouble-free or No COM-LINK connection selected.
"1"	COM-LINK connection not functioning, is faulty

The time required to detect an error on the COM-LINK depends on the baud rate and the events.

Baud rate	Error detection time for the COM-LINK connection	
	CRC error (incorrect data content)	No response, no hardware connection, remote station not in operation
9600 Baud	250 ms	1.5 s
19200 Baud	120 ms	0.8 s



Attention!

If the states of the inputs, outputs or data are required by a station without fail, the respective diagnostics contact should be evaluated and the information applied in accordance with its respective application.

If the respective diagnostics contacts are not evaluated, it may cause faults in your application.

7 Display system settings

All display system settings can only be carried out on models provided with buttons and LCD display.

CL-SOFT can be used to set all models via the software.

Password protection

The display system can be protected by a password against unauthorised access.

In this case the password consists of a value between 000001 and 999999. The number combination 000000 is used to delete a password.

Password protection inhibits access to selected areas. The System menu is always protected when a password is activated.

The password can protect the following entries and areas:

- Start or modification of the program
- Transfer of a circuit diagram to the memory module (display/keypad version)
- Change of the RUN or STOP mode.
- Calling and modification of function block parameters
- All settings of the real-time clock.
- Modifications of all system parameters.
- Communication with the individual device (looping to other devices possible).
- Disabling of the password delete function.



A password that has been entered in the display system is transferred to the memory module together with the circuit diagram, irrespective of whether it was activated or not.

If this display system circuit diagram is loaded back from the memory module, the password will also be transferred to display system and is activated immediately.

Password setup

A password can be set up via the System menu in either RUN or STOP mode. You cannot change to the System menu if a password is already activated.

- ▶ Press **DEL** and **ALT** to call up the System menu.
- ▶ Select the menu option SECURITY... to enter the password.
- ▶ Press the **OK** button and move to the PASSWORD... menu.
- ▶ Press **OK** again to enter the Password entry mode.



ENTER PASSWORD
█-----

If no password has been entered, the display system changes directly to the password display and displays six dashes: No password available.

- ▶ Press OK, six zeros will appear
- ▶ Set the password using the cursor buttons:
 - < > select position in the password,
 - ^ v set a value between 0 to 9.

```
ENTER PASSWORD
000042
```

- Save the new password by pressing **OK**.

Use **OK** to exit the password display and proceed with **ESC** and **▼** to the RANGE... menu.

The scope of the password has not yet been defined. The password is now valid but not yet activated.

Selecting the scope of the password

```
CIRCUIT DIAGRAM ✓+
PARAMETER
CLOCK
OPERATING MODE +
INTERFACE
DELETE FUNCTION
```

- Press the **OK** button.
- Select the function or the menu to be protected.
- Press the **OK** button in order to protect the function or menu (tick = protected).



Standard protection encompasses the programs and circuit diagram.

At least one function or menu must be protected.

- **CIRCUIT DIAGRAM:** The password protects the program with circuit diagram and non-enabled function blocks.
- **PARAMETER:** The PARAMETER menu is protected.
- **CLOCK:** Date and time are protected with the password.
- **OPERATING MODE:** The toggling of the RUN or STOP operating mode is protected.
- **INTERFACE:** The interface is inhibited for access to a connected device. Programs or commands to other devices connected via the CL-NET network are routed further.
- **DELETE FUNCTION:** After four failed attempts to enter a password, the "DELETE FUNCTION?" prompt appears. This prompt is not displayed if selected. However, it is no longer possible to make changes in protected areas if you forget the password.

Activating the password

You can activate an existing password in four different ways:

- automatically when display system is switched on again,
- automatically after a protected circuit diagram is loaded
- automatically if no telegram was sent on the PC interface for 30 minutes after unlocking (via CL-SOFT) was entered.
- via the password menu

► Press **DEL** and **ALT** to call up the System menu.

► Open the password menu via the SECURITY... menu



CHANGE PW
ACTIVATE

The display system will only show this menu if a password is present.



Make a note of the password before you activate it. If the password is no longer known, the display system can be unlocked (DELETE FUNCTION is not active), however, the circuit diagram and data settings will be lost.



Attention!

If the password is unknown or lost, and the password delete function is not activated: The unit can only be reset to the factory setting by the manufacturer. The program and all data will be lost.

► Select **ACTIVATE PW** and press **OK**.

The password is now active. The display system will automatically return to the status display.

You must unlock the display system with the password before you implement a protected function, enter a protected menu or the System menu.

Unlocking the display system

Unlocking the display system will deactivate the password. You can reactivate password protection later via the Password menu or by switching the power supply off and on again.

- Press **OK** to switch to the main menu.

The PASSWORD... entry will flash.

- Press **OK** to enter the password entry menu.

```
PASSWORD...
STOP RUN /
PASSWORD...
SET CLOCK...
```



If the display system shows PROGRAM... in the main menu instead of PASSWORD..., this means that there is no password protection active.

```
ENTER PASSWORD
XXXXXX
```

The display system will display the password entry field.

- Set the password using the cursor buttons.
- Confirm with **OK**.

If the password is correct, the display system will return automatically to the status display.

```
PROGRAM...
STOP
PARAMETER
SET CLOCK...
```

The PROGRAM... menu option is now accessible so that you can edit your circuit diagram.

The System menu is also accessible.

Changing or deleting the password range

- ▶ Unlock the display system.
- ▶ Press **DEL** and **ALT** to call up the System menu.
- ▶ Open the password menu via the menu option SECURITY... and PASSWORD...



```
CHANGE PW
ACTIVATE PW
```


The CHANGE PW entry will flash.

The display system will only show this menu if a password is present.



```
ENTER PASSWORD
XXXXXX
```


- ▶ Press **OK** to enter the password entry menu.
- ▶ Press **OK** to move to the 6-digit entry field.
- ▶ The current password will be displayed.



```
ENTER PASSWORD
100005
```

- ▶ Change the six password digits with the cursor buttons.
- ▶ Confirm with **OK**.

Press **ESC** to exit the security area.



```
+ ENTER PASSWORD
-----
```

Delete

Use number combination 000000 to delete a password.

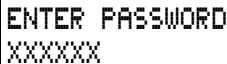
If a password has not been entered already, the display system will show six dashes:

Password incorrect or no longer known

If you no longer know the exact password, you can try to re-enter the password several times.



The DELETE FUNCTION has not been deactivated.



ENTER PASSWORD
XXXXXX

Have you entered an incorrect password?

- Re-enter the password.



DELETE ALL?

After the fourth entry attempt the display system will ask whether you wish to delete the circuit diagram and data.

- Press

- ESC: No data will be deleted.
- **OK**: Circuit diagram, data and password are deleted.

The display system will return to the status display.



If you no longer know the exact password, you can press OK to unlock the protected display system. The saved circuit diagram and all function relay parameters will be lost.

Pressing **ESC** will retain the circuit diagram and data. You can then make another four attempts to enter the password.

Changing the menu language

The display system provides ten menu languages which are set as required via the System menu.

Language	LCD display
English	ENGLISH
German	DEUTSCH
French	FRANCAIS
Spanish	ESPANOL
Italian	ITALIANO
Portuguese	PORTUGUES
Dutch	NEDERLANDS
Swedish	SVENSKA
Polish	POLSKI
Turkish	TURKCE



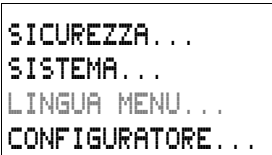
Language selection is only possible if the display system is not password-protected.

- ▶ Press **DEL** and **ALT** to call up the System menu.
- ▶ Select MENU LANGUAGE... to change the menu language.



The language selection for the first entry ENGLISH is displayed.

- ▶ Use ^ or v to select the new menu language, e.g. Italian (ITALIANO).
- ▶ Confirm with **OK**. ITALIANO is assigned a tick.
- ▶ Press **ESC** to exit the menu.



The display system will now show the new menu language.
Press **ESC** to return to the status display.

Changing parameters

The display system allows you to change function relay parameters such as timing relay setpoint values and counter setpoints without having to call up the circuit diagram. This is possible regardless of whether the display system is running a program or is in STOP mode.

- ▶ Press **OK** to switch to the main menu.
- ▶ Start the parameter display by selecting **PARAMETER**.

```

T 03 11 S +
CP08      -
C 11      +
L: 1      RUN

```

All function blocks are displayed as a list.

The following preconditions must be fulfilled in order for a parameter set to be displayed:

- A function relay must have been included in the circuit diagram.
- The **PARAMETER** menu must be available.
- The parameter set must have been enabled for access, indicated by the + character at the bottom right of the display.



You can only enable or disable parameter access via the **FUNCTION RELAYS** menu or by using the "+" or "-" parameter set characters respectively in the circuit diagram.

```

T 03 11 $ +
>I1 020.030
>I3 005.000
QV> 012.050

```

- ▶ Select the required function block with \wedge or \vee .
- ▶ Press the **OK** button.
- ▶ Scroll with the \wedge or \vee cursor buttons through the constants of the function block inputs.
- ▶ Change the values for a parameter set:
 - Press **OK** to enter the Entry mode,
 - Press $\langle \rangle$ to change decimal place
 - Press $\wedge \vee$ to change the value of a decimal place,
 - Press **OK** to save constants or
 - **ESC** Retain previous setting.

Press **ESC** to leave the parameter display.



Setpoints can only be modified at the function block inputs that have been assigned to a constant.

Adjustable parameters for function blocks

You can modify the function blocks used in the circuit diagram in three different ways:

- All circuit diagram parameters can be adjusted in STOP mode via the function block editor.
- Setpoints (constants) can be modified in RUN mode via the function block editor.
- Setpoints (constants) can be modified via the PARAMETERS menu.

Adjustable setpoint values are:

- The inputs with all function blocks if constants have been used.
- On and off times with time switches.

In RUN mode the display system operates with a new setpoint as soon as it has been modified in the parameter display and saved with OK.

Setting date and time

The display base modules are provided with a real-time clock with date and time. The “time switch” function blocks can be used to implement time switch applications.

If the clock has not yet been set or if the display system is switched on after the buffer time has elapsed, the clock starts with the setting “WE 1:00 01.05.2002”. The display system clock operates with date and time so the hour, minute, day, month and year must all be set.



The time : 1:00 indicates the operating system version in the device.

```
SET CLOCK
DST SETTING
```

```
HH:MM: 00:27
DD.MM: 05.05
YEAR : 2002
```

- Select SET CLOCK... from the main menu.

This will open the menu for setting the time.

- Select SET CLOCK.

- Set the values for time, day, month and year.
- Press the **OK** button to access the Entry mode.
 - < > Move between the parameters
 - ^ v Change the value of a parameter
 - **OK** Save day and time
 - **ESC** Retain previous setting.

Press **ESC** to leave the time setting display.

Changing between winter/summer time (DST)

The display base modules are provided with a real-time clock. The clock has various possibilities for changing the DST setting. These are subject to different legal requirements in the EU, GB and USA.



The time change algorithm only applies to the northern hemisphere.

- NONE: no DST setting
- MANUAL: a user-defined date for the DST change
- EU: date defined by the European Union; Commences: last Sunday in March; Ends: last Sunday in October
- GB: date defined in Great Britain; Commences: last Sunday in March; Ends: fourth Sunday in October
- US: date defined in the United States of America: Commences: first Sunday in April; Ends: last Sunday in October

The following applies to all DST variants:

Winter time → Summer time: On the day of conversion, the clock moves forward one hour at 2:00 to 3:00.

Summer time → Winter time: On the day of conversion, the clock moves back one hour at 3:00 to 2:00.

Select SET CLOCK... from the main menu.

This will open the menu for setting the time.

► Select the DST SETTING menu option.

```
SET CLOCK
DST SETTING
```

Selecting DST

The display system shows you the options for the DST change.

The standard setting is NONE for automatic DST changeover (Tick at NONE).

```
NONE      / +
MANUAL
EU
GB        +
US
```

► Select the required variant and press the **OK** button.

```
SUMMERTIME START
 DD.MM: 00.00
SUMMERTIME END
 DD.MM: 00:00
```

Manual selection

If you wish to enter your own date,



The following applies to the display system:

The time change algorithm always calculates the date from the year 2000. Enter the time change for the year 2000.

- Proceed to the MANUAL menu and press 2 × **OK**.
 - < > Move between the parameters
 - ^ v Change the value of a parameter
 - **OK** Save day and time.
 - **ESC** Retain previous setting.
- Press **ESC** to leave the display.
- Select the day and time at which summer time is to commence.
- Select the day and time at which summer time is to end.



The same time for conversion applies as for the legally determined variants (EU, GB, US).

Activating input delay (debounce)

Input signals are evaluated by the display system with an input delay. This enables, for example, the trouble-free evaluation of switches and pushbutton actuators subject to contact bounce.

In many applications, however, very short input signals have to be monitored. In this case, the debounce function can be switched off.

- ▶ Press **DEL** and **ALT** to call up the System menu.
- ▶ Select the **SYSTEM** menu.



If the display system is password-protected you cannot open the System menu until you have "unlocked" it.

```
DEBOUNCE ✓  ↑
P  BUTTONS
RUN  MODE
CARD  MODE  ↓
```

The input delay (debounce) is set with the DEBOUNCE menu item.

```
DEBOUNCE ✓  ↑
P  BUTTONS
RUN  MODE
CARD  MODE  ↓
```

Activating debounce (input delay)

If a tick ✓ is set beside DEBOUNCE, the input delay is set.

If this is not so, proceed as follows:

- ▶ Select **DEBOUNCE** and press **OK**.

Debounce mode will be activated and the display will show DEBOUNCE ✓.

Press **ESC** to return to the status display.

Deactivating debounce (input delay)

If the display system is showing DEBOUNCE in the display, this means that Debounce mode has already been deactivated.

- ▶ Otherwise select DEBOUNCE ✓ and press **OK**.

Debounce mode will be deactivated and the display will show DEBOUNCE.



How the display system input and output signals are processed internally is explained in section "Delay times for inputs and outputs", from page 374.

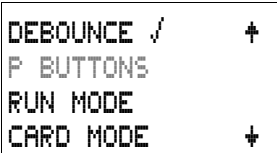
Activating and
deactivating the P buttons

Even though the cursor buttons (P buttons) have been set as pushbutton actuator inputs in the circuit diagram, this function is not activated automatically. This prevents any unauthorised use of the cursor buttons. The P buttons can be activated in the System menu.

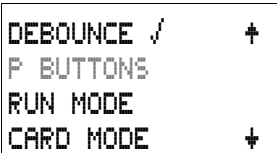


If the display system is password-protected you cannot open the System menu until you have “unlocked” it.

The P buttons are activated and deactivated via the P buttons menu.



- ▶ Press **DEL** and **ALT** to call up the System menu.
- ▶ Select the SYSTEM menu.
- ▶ Move the cursor to the **P BUTTONS** menu.



Activating the P buttons

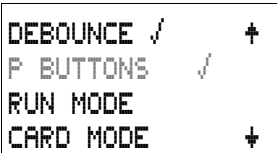
If the display system shows **P BUTTONS ✓** in the display, the P buttons are active.

- ▶ Otherwise select **P BUTTONS** and press **OK**.

The display system changes the display to **P BUTTONS ✓** and the P buttons are activated.

- ▶ Press **ESC** to return to the status display.

The P buttons are only active in the status display and the text display. In this display you can use the P buttons to activate inputs in your circuit diagram.



Deactivating the P buttons

- ▶ Select **P BUTTONS ✓** and press **OK**.

The display system changes the display to **P BUTTONS** and the P buttons are deactivated.



If you are loading a circuit diagram from the memory module or via CL-SOFT to the display system or if you are deleting a circuit diagram in the display system the P buttons are automatically deactivated.

Startup behaviour

The startup behaviour is an important aid during the commissioning phase. The circuit diagram which the display system contains is not as yet fully wired up or the system or machine is in a state which the display system is not permitted to control. The outputs should not be controlled when the display system is switched on.

Setting the startup behaviour



The display system without a display can only be started in RUN mode.

Requirement: the display system must contain a valid circuit diagram.

► Switch to the System menu.



If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).

Specify the operating mode which the display system must use when the supply voltage is applied.

Activating RUN mode

If the display system displays **RUN MODE** ✓, this means that the display system will start in Run mode when the supply voltage is applied.

► Otherwise select **RUN MODE** and press **OK**.
RUN mode is activated.

► Press **ESC** to return to the status display.

DEBOUNCE ✓	⬆
P BUTTONS	
RUN MODE ✓	
CARD MODE	⬆

Deactivating RUN mode

► Select **RUN MODE** ✓ and press **OK**.

The RUN mode function is deactivated.

DEBOUNCE ✓	⬆
P BUTTONS	
RUN MODE	
CARD MODE	⬆

The default setting for the display system is for **RUN MODE** to be displayed. In other words, the display system starts in **RUN MODE** ✓ when the power is switched on.

Startup behaviour	Menu displayed	Status of after startup The display system has both operating modes:
Display system starts in STOP mode.	RUN MODE	STOP mode set
Display system starts in RUN mode.	RUN MODE ✓	RUN mode set

Behaviour when the circuit diagram is deleted

The setting for the startup behaviour is a display system device function. When the circuit diagram is deleted this does not result in the loss of the setting selected.

Behaviour during upload/download to memory module or PC

When a valid circuit diagram is transferred from the display system to a memory module or the PC or vice versa, the setting is still retained.

→ The display system without a display can only be started in RUN mode.

Possible faults

The display system will not start in RUN mode:

- A program is not available in the display system.
- You have put the display system in STOP mode (RUN mode menu).

Startup behaviour for memory module

The startup behaviour using a memory module is for applications where unskilled personnel have to change the memory module with the logic relay de-energized.

The display system will then only start in RUN mode if a memory module with a valid program is fitted.

If the program on the memory module is different to the program in the display system, the program on the module is loaded first and the device then starts in RUN mode.

► Switch to the System menu.



If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).

Activating memory module mode

Requirement: RUN mode is active.

If the display system shows **CARD MODE** ✓ in the display, the display system will only start up in RUN mode at power on if the memory module fitted contains a valid program.

► Otherwise select **CARD MODE** and press **OK**.

The display system will start up with the program on the memory module.

► Press **ESC** to return to the status display.

```
DEBOUNCE ✓      ↑
P  BUTTONS
RUN  MODE      ✓
CARD MODE ✓      ↓
```

Deactivating memory module mode

► Select **CARD MODE** ✓ and press **OK**.

The RUN mode function is deactivated.

```
DEBOUNCE ✓      ↑
P  BUTTONS
RUN  MODE      ✓
CARD MODE      ↓
```

The default setting of the display system is for **CARD MODE** to be displayed. In other words, the display system without a memory module starts in RUN mode when the power is switched on.

Terminal mode

The display system is provided with TERMINAL mode. This mode enables the display and the keypad of the display system to be used as a terminal for operating another device. In this operating mode you are thus able to remotely control all devices supporting Terminal mode operation. The interface to the other device can be implemented using the serial interface or CL-NET.



TERMINAL mode operation is only possible if the display system is in STOP mode.

Permanent TERMINAL mode setting

In the SYSTEM menu you set the display system to start in TERMINAL mode when the power supply is switched on.

► Switch to the System menu.



If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).

Activating an automatic startup in TERMINAL mode

Requirement: The display system is in RUN or STOP mode without visualization (the System menu must be reachable).

```
P BUTTONS      +
RUN MODE
CARD MODE
TERMINAL MODE ✓ +
```

- Select TERMINAL mode in the System menu and press **OK**.
- The next time that the display system is started, it will establish the connection to the selected device.
- Press **ESC** to return to the status display.



The correct station number must be selected in order for the display system to start TERMINAL mode with the correct station (→ chapter "Commissioning", page 79).

```
P BUTTONS      +
RUN MODE
CARD MODE
TERMINAL MODE +
```

Deactivating an automatic startup in TERMINAL mode

- Select **TERMINAL MODE** ✓ and press **OK**.

The automatic starting in TERMINAL mode has been deactivated.

The default setting of the display system is for the display of the TERMINAL mode menu, i.e. the display system starts in RUN or STOP mode when the power is switched on.

Setting LCD contrast and backlight

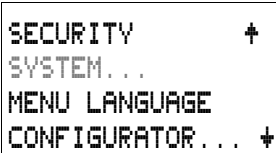
The backlight of the LCD display can be set to one of five stages in order to adapt it to local conditions. The contrast of the display can be set to one of five levels.

The contrast and backlight setting is a device setting.

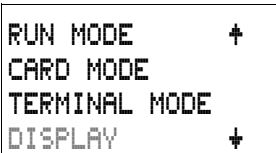
► Switch to the System menu.



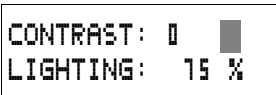
If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).



- Select the SYSTEM menu.
- Press the **OK** button.

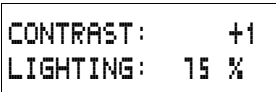


- Use the \vee button to select the DISPLAY menu and press **OK**.

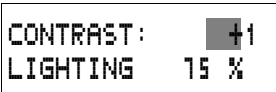


The menus for setting the contrast and backlight are displayed.

- Press the **OK** button and move to the contrast entry field. Use the \wedge and \vee cursor buttons to set the contrast to a value between -2 and $+2$.



- Select your setting.
- Complete your setting by pressing **OK**.



The contrast setting will be retained until it is modified.

```

CONTRAST:      +1
LIGHTING  75 %

```

- ▶ Use the cursor buttons \wedge and \vee to move to the LIGHTING menu.
- ▶ Press the **OK** button.

```

CONTRAST:      +1
LIGHTING  75 %

```

- ▶ Use cursor buttons \wedge and \vee to change the value in 25 % steps.
- ▶ Set the required backlighting.



The backlight will immediately change to the set value. 0, 25, 50, 75 and 100 % are possible values.

```

CONTRAST:      +1
LIGHTING  100 %

```



The display system comes with the following factory setting:

The contrast is set to 0.

The backlight is set to 75 %.

Retention

It is a requirement of system and machine controllers for operating states or actual values to have retentive settings. What this means is that the values will be retained safely even after the supply voltage to a machine or system has been switched off and are also retained until the next time the actual value is overwritten.

The following operands and function blocks can be set to operate retentively:

- Markers
- Counter function blocks,
- Data function blocks and
- Timing relays.

Operating hours counter

Operating hours counter provides four retentive operating hours counters. They are always retentive and can only be selectively deleted with a reset command.

Retentive data volume

200 bytes is the maximum memory range for retentive data (operating hours counters are not included).

Markers

A user-definable and contiguous marker range can be declared as retentive.

Counters

All C., CH.. and Cl.. function blocks can be operated with retentive actual values.

Data function blocks

A user-definable consistent data function block range can be operated with retentive actual values.

Timing relays

A user-definable and contiguous range for timing relays can be run with retentive actual values.

Requirements

In order to make data retentive, the relevant markers and function blocks must have been declared as retentive.

**Attention!**

The retentive data is saved every time the power supply is switched off, and read every time the device is switched on. The data integrity of the memory is guaranteed for 10^{10} read/write cycles.

Setting retentive behaviour

Requirement:

The display system must be in STOP mode.

- Switch to the System menu.



If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).

The default setting of the display system is for no retentive actual value data to be selected. When the display system is in STOP mode or has been switched to a de-energized state, all actual values are cleared.

```

RUN MODE    /  +
CARD MODE
LIGHTING    /
RETENTION   +
  
```

- Switch to STOP mode.
- Switch to the System menu.
- Move to the SYSTEM menu and continue to the RETENTION... menu.
- Press the **OK** button.

```

MB 00 -> MB 00  +
C  00 -> C  00  +
CH 00 -> CH 00  +
          B:200
  
```

The first screen display is the selection of the marker range.

- ^v Select a range.
- Press **OK** to access the Entry modes.
 - < > Select a position from/to,
 - ^v Set a value.
- Save the entry from .. to .. with **OK**.

Press **ESC** to exit the input for the retentive ranges.

Up to six different ranges can be selected.

```

CI 00 -> CI 00  +
DB 00 -> DB 00
T  00 -> T  00  +
          B:200
  
```



The display on the lower right **B:200** indicates the number of free bytes.

MB	01	->	MB	04
C	12	->	C	16
CH	00	->	CH	00
CI	00	->	CI	00
DB	01	->	DB	16
T	26	->	T	32
B: 016				

Example:

MB 01 to MB 04, C 12 to C 16, DB 01 to DB 16, T 26 to T 32 should be retentive.

124 bytes have been assigned to the retentive data range.
76 bytes are still available.

Deleting ranges

Set the ranges to be erased to the values from 00 to 00.

E.g.: MB 00 -> MB 00. The markers are no longer retentive.

Deleting retentive actual values of markers and function blocks

The retentive actual values are cleared if the following is fulfilled (applies only in STOP mode):

- When the circuit diagram is transferred from CL-SOFT (PC) or from the memory module to the display system, the retentive actual values are reset to 0. This also applies when there is no program on the memory module, in which case the old circuit diagram is retained in the display system.
- When changing the respective retentive range.
- When the circuit diagram is deleted via the DELETE FUNCT menu.

Transferring retentive behaviour

The retentive setting is a circuit diagram setting. In other words, the retention setting is on the memory module and is transferred with the circuit diagram when uploading or downloading from the PC.

Changing the operating mode or the circuit diagram

When the operating mode is changed or the display system circuit diagram is modified, the retentive data is normally saved together with their actual values. The actual values of relays no longer being used are also retained.

Changing the operating mode

If you change from RUN to STOP and then back to RUN, the actual values of the retentive data will be retained.

Changing the display system circuit diagram

If a modification is made to the display system circuit diagram, the actual values will be retained.

Changing the startup behaviour in the SYSTEM menu

The retentive actual values are retained in the display system regardless of the setting.

Modification of the retentive range

If the set retentive ranges are reduced, only the actual values saved in the range will remain.

If the retentive range is extended, the older data is retained. The new data is written with the current actual values in RUN mode.

Displaying device information

The device information is provided for service tasks or in order to determine the performance level of the device. This function is only available with devices featuring a display.

Exception: Terminal mode with display system

The display system allows you to show the following device information:

- AC or DC power supply
- T (transistor output) or R (relay output),
- C (clock provided)
- A (analog output present),
- LCD (display provided)
- CL-NET (CL-NET present),
- OS: 1.10.204 (operating system version)
- CRC: 25825 (checksum of the operating system).

► Switch to the System menu.



If the display system is password-protected, the System menu can only be accessed after the display system has first been "unlocked" (→ section "Unlocking the display system", from page 347).

```
SECURITY      +
SYSTEM...
MENU LANGUAGE
CONFIGURATOR... +
```

- Select the SYSTEM menu.
- Press the **OK** button.

```
CARD MODE      +
DISPLAY
RETENTION...
INFORMATION    +
```

- Use the button to select the INFORMATION menu and press **OK**.

This will display all device information.

```
DC TCA LCD NET
OS : 1.11.111
CRC: 63163
```

Example: CL-LDD.K, CL-LDC.LNDC2, CL-LDT.17DC2

```
DC RC LCD
OS : 1.11.111
CRC: 63163
```

Example: CL-LDD.K, CL-LDC.LDC2, CL-LDR.16DC2

Display in STOP mode.

```
DC RC LCD
OS : 1.11.111
CRC: - - -
```

Display in RUN mode.

The CRC checksum is not displayed.

- Press **ESC** to exit the display.

```
CARD MODE      +
DISPLAY
RETENTION...
INFORMATION    +
```

8 Inside the display system

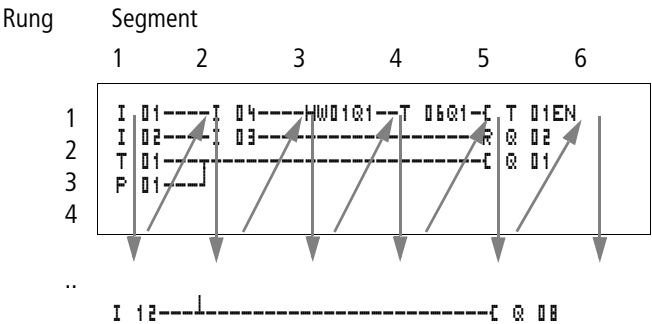
Display system program cycle

In conventional control systems, a relay or contactor control processes all the rungs in parallel. The speed with which a contactor switches is thus dependent on the components used, and ranges from 15 to 40 ms for relay pick-up and drop-out.

With the display system the circuit diagram is processed with a microprocessor that simulates the contacts and relays of the circuit concerned and thus processes all switching operations considerably faster. Depending on its size, the display system circuit diagram is processed cyclically every 0.1 to 40 ms.

During this time, the display system passes through six segments in succession.

How the display system evaluates the circuit diagram:



In the first four segments the display system evaluates the contact fields in succession. The display system checks whether contacts are switched in parallel or in series and saves the switching states of all contact fields.

In the fifth segment, the display system assigns the new switching states to all the coils in one pass.

The sixth segment is located outside of the circuit diagram. The display system uses this for the following:

- Evaluating function blocks
- COM-LINK data access during the program cycle
- Loading visualization data

Evaluating function blocks

- Processing the used function block: The output data of a function block is updated immediately after processing. The display system processes the function blocks according to the function block list (a FUNCTION RELAYS menu) from top to bottom. You can sort the function block list with CL-SOFT.
- Contact the "outside world": Output relays Q 01 to Q (S)... are switched and inputs I1 to I (R)... are re-read.
- The display system also copies all the new switching states to the status image register.
- Exchange all data on the CL-NET network (read and write).

The display system only uses this status image for one cycle. This ensures that each rung is evaluated with the same switching states for one cycle, even if the input signals at I1 to I12, for example, change their status several times within a cycle.



The following must be observed when operating a PID controller function block!

The cycle time of the program must be less than the scan time of the controller. If the cycle time is greater than the controller scan time, the controller will not be able to achieve constant results.

COM-LINK data access during the program cycle

The data exchange with the point-to-point connection can be carried out in any segment of the program cycle. This data exchange increases the cycle time with both active and remote stations. Only use data that is absolutely necessary.

Loading visualization data

When setting a program to RUN that contains visualization data, the contents of the screens to be displayed have to be loaded.

The time required for loading in the event of a screen change depends on the size of the screens to be loaded. During a screen change, the new screen is loaded from the screen memory into the RAM. The display system checks every 200 ms whether the new screen has to be loaded.

The loading time can be calculated as follows:
Screen size in byte multiplied by 80 μ s.

Example:

Screen size 250 bytes:

The loading time for the screen is: $250 \times 80 \mu\text{s} = 20 \text{ ms}$



If you require the display system to have a small cycle time:

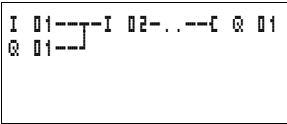
Use several small screens so that the loading time is not too long during a screen change. Only display necessary information in the screens concerned (→ section “Memory layout”, page 268).

The loading of screen data and screen changes can be implemented in any segment of the program cycle. Take this behaviour into account when considering the reaction time of your entire control system.

Effects on the creation of the circuit diagram

The display system evaluates the circuit diagram in these six segments in succession. You should therefore remember two points when you create your circuit diagrams:

- The changeover of a relay coil does not change the switching state of an associated contact until the next cycle starts.
- Always wire forward or from top to bottom. Never work backwards.

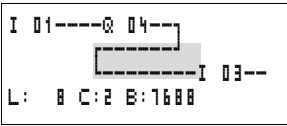


Example: Self-latching with own contact

Start condition:
Inputs I1 and I2 are switched on.
Q1 is switched off.

This is the circuit diagram of a self-latching circuit. If I1 and I2 are closed, the switching state of relay coil **Q 01** is “latched” via contact **Q 01**.

- **1st cycle:** Inputs I1 and I2 are switched on. Coil Q1 picks up.
- Contact Q 01 remains switched off since the display system evaluates from left to right. The first coil field was already passed when the display system refreshes the output image in the 6th segment.
- **2nd cycle:** The self-latching now becomes active. The display system has transferred the coil states at the end of the first cycle to contact Q 01.



Example: Do not wire backwards

This example is shown in section “Creating and modifying connections”, page 134. It was used there to illustrate how NOT to do it.

In the third rung, the display system finds a connection to the second rung in which the first contact field is empty. The output relay is not switched.

When wiring more than four contacts in series, use one of the marker relays.

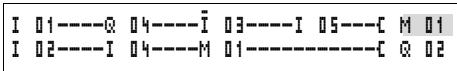


Figure: 186: Circuit diagram with M 01 marker relay

How the display system evaluates the high-speed counters CF, CH and CI

In order to evaluate the count pulses of 3 kHz, the high-speed counter function blocks operate with an interrupt routine. The length of the circuit diagram and the associated cycle time has no effect on the counter result.

Display system memory management

The display system is provided with different memories.

- The working memory or RAM, size 8 KByte
The RAM only stores the data when the device power supply is active.
- The screen memory, size 24 KByte
The screen memory stores the visualization data created with CL-SOFT retentively.
- The program memory, size 8 KByte
The program memory stores the program retentively.

Distribution of data in the RAM

When the power supply is switched on, the RAM stores the program, the retentive data and the screens to be displayed. This has a direct effect on the size of the program and the screens. The number of retentive data bytes reduces the memory available for program and screens. The largest screen to be displayed likewise reduces the memory available for the program.



Only use as much retentive data as is actually required.

The screen with the largest memory requirement reduces the memory available for the program. Several smaller screens allow more space for the program.

Use as small pictures as possible with 1 bit greyscale. The pictures should normally be 32×32 pixels in size in order to fully utilise the optimum brilliance of the display.

Delay times for inputs and outputs

The time from reading the inputs and outputs to switching contacts in the circuit diagram can be set in the display system via the delay time.

This function is useful, for example, in order to ensure a clean switching signal despite contact bounce.

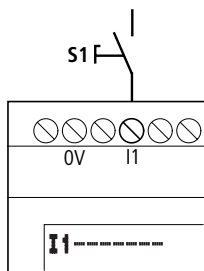


Figure: 187: Display system input assigned with a switch

Delay times for the display system inputs

The delay time for DC signals is 20 ms.

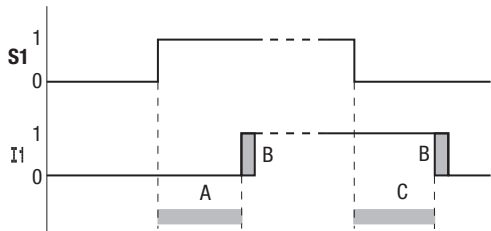


Figure: 188: Delay times for CL-DC2

An input signal S1 must therefore be 15 V, 8 V for at least 20 ms on the input terminal before the switch contact will change from 0 to 1 (A). If applicable, this time must also include the cycle time (B) since the display system does not detect the signal until the start of a cycle.

The same debounce delay (C) applies when the signal drops out from 1 to 0.



If you use high-speed counter function blocks, the debounce delay time for the inputs is 0.025 ms. Otherwise it is not possible to count high-speed signals.

If the debounce is switched off, the display system responds to an input signal after just 0.25 ms.

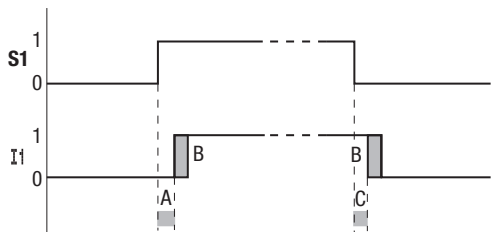


Figure: 189: Switching behaviour with input debounce disabled

Typical delay times with the debounce delay switched off are:

- On-delay for
 - I1 to I4: 0.025 ms
 - I5 to I12: 0.25 ms
- Off-delay for
 - I1 to I4: 0.025 ms
 - I5, I6 and I9 to I10: 0.4 ms
 - I7, I8, I11 and I12: 0.2 ms



Ensure that input signals are noise-free if the input debounce is disabled. The display system will even react to very short signals.

Monitoring of short-circuit/overload with CL-LST, CL-LMT and CL-LET

The internal inputs I16, R15 and R16 can be used to monitor for short-circuits or overloads on an output.

- Display system:
 - I16: Group fault alarm for outputs Q1 to Q4
- CL-LET.20DC2:
 - R16: Group fault signal for outputs S1 to S4
 - R15: Group fault alarm for outputs S5 to S8

State	
Outputs	I16, R15 or R16
No fault found	0 = Switched off (N/O contact)
At least one output has a fault	1 = Switched on (N/O contact)



I16 can only be edited with display system versions with transistor outputs.

The following examples are for I16 = Q1 to Q4.

Example 1: Output with fault indication



Figure: 190: Circuit diagram for fault output via I16

The above circuit diagram functions as follows:

If a transistor output reports a fault, M16 is set by I16. The N/O contact of M16 switches off output Q1. M16 can be cleared by resetting the display system power supply.

Example 2: Output of operating state

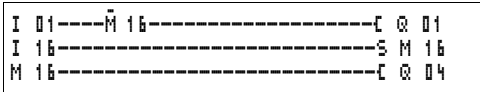


Figure: 191: Output of operating state

The above circuit operates as described in example 1. The signal light is triggered at Q4 for additional overload monitoring. If Q4 has an overload, it would 'pulse'.

Example 3: Automatic reset of error signal

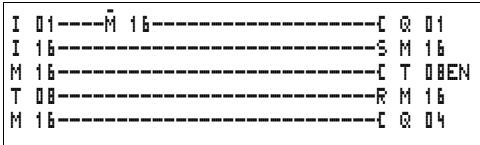


Figure: 192: Automatic reset of error signal

The above circuit diagram functions in the same way as Example 2. In addition the marker M16 is reset every 60 s by timing relay T08 (on-delayed, 60 s). Should I16 remain at 1, M16 will continue to be set. Q1 is set briefly to 1 until I16 switches off again.

Expanding the display system

The display system can be expanded locally with the CL-LER.18AC2, CL-LER.18DC2, CL-LET.20DC2, CL-LER.20 expansion units or remotely via the CL-LEC.CI000 coupler unit.

Install the units and connect the inputs and outputs as described (→ section "Connecting the expansion device", page 46).

You process the inputs of the expansion devices as contacts in the display system circuit diagram in the same way as you process the inputs of the basic unit. The input contacts are assigned the operand identifiers R1 to R12.

R15 and R16 are the group fault alarms of the transistor expansion unit (→ section "Monitoring of short-circuit/ overload with CL-LST, CL-LMT and CL-LET", page 376).

The outputs are processed as relay coils or contacts like the outputs of the display system. The output relays are S1 to S8.



CL-LER.18AC2 and CL-LER.18DC2 are provided with the outputs S1 to S6. The other outputs S7, S8 can be used internally.

How is an expansion unit recognised?

If at least one **R** ... contact or contact/coil **S** ... is used in the circuit diagram, the basic unit assumes that an expansion unit is connected.

Transfer behaviour

The input and output data of the expansion units is transferred serially in both directions. Take into account the modified reaction times of the inputs and outputs of the expansion units:

Input and output reaction times of expansion units

The debounce setting has no effect on the expansion unit.

Transfer times for input and output signals:

- Local expansion
 - Time for inputs R1 to R12: 30 ms + 1 cycle
 - Time for outputs S1 to S6 (S8): 15 ms + 1 cycle
- Remote expansion
 - Time for inputs R1 to R12: 80 ms + 1 cycle
 - Time for outputs S1 to S6 (S8): 40 ms + 1 cycle

Function monitoring of expansion units

If the expansion device is not fed with power, there is no connection between it and the display system. The expansion inputs R1 to R12, R15, R16 are incorrectly processed in the display system and show status 0. It cannot be assured that the outputs S1 to S8 are transferred to the expansion unit.



Warning!

Ensure the continuous monitoring of the display system expansion devices in order to prevent switching faults in machines or systems.

The status of the internal input I14 of the display system indicates the status of the expansion unit:

- I14 = 0: Expansion unit is functional
- I14 = 1: Expansion unit is not functional

Example

The expansion unit may be powered up later than the display system. This means that the display system is switched to RUN when an expansion unit is missing. The following display system circuit diagram detects if the expansion unit is functional or not functional.

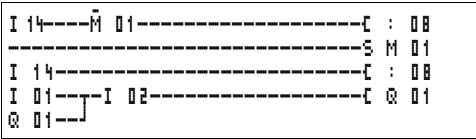


Figure: 193: Circuit diagram for expansion testing

As long as I14 is 1, the remaining circuit diagram is skipped. If I14 is 0, the circuit diagram is processed. If the expansion unit drops out for any reason, the circuit diagram is skipped. M01 detects whether the circuit diagram was processed for at least one cycle after the power supply is switched on. If the circuit diagram is skipped, all the outputs retain their previous state.

Analog output QA

The analog output operates with decimal values between 0 and 1023. This corresponds to a 10-bit resolution. At the output this corresponds to a physical voltage between 0 V and 10 V DC.

Negative values such as: -512 are evaluated as zero and output as 0 V DC.

Positive values greater than 1023, such as 2047, are evaluated as 1023 and output as 10 V DC.

Loading and saving programs

You can either use the display system interface to save programs to a memory module or use CL-SOFT and a transmission cable to transfer them to a PC.

Display system without display and keypad

Display system models without a keypad can be loaded with a display system circuit diagram via CL-SOFT or automatically from the fitted memory module every time the power supply is switched on.

Interface

The display system interface is covered. Remove the cover carefully.

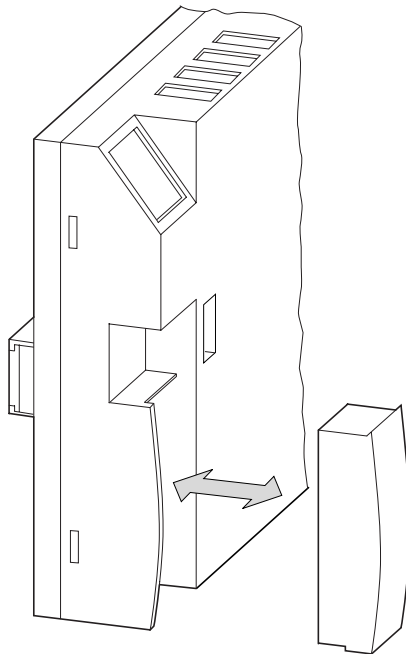


Figure: 194: Remove cover and plug in

- To close the slot again, push the cover back onto the shaft.

Memory module

The module is available as an accessory CL-LAD.MD004 for the display system.

Circuit diagrams with all the data can be transferred to the display system from the CL-LAD.MD004 memory module.

Each memory module stores a display system program.

Information stored on the memory module is “non-volatile” and thus you can use the module to archive, transfer and copy programs.

The memory module can be used for saving:

- The program,
- All the visualization data of the screens,
- All parameter settings of the circuit diagram,
 - The system settings,
 - Debounce setting,
 - P buttons,
 - Password,
 - Retention on/off and range,
 - CL-NET configuration,
 - Setting for automatic startup in Terminal mode
 - COM-LINK settings,
 - DST settings,
 - Memory module start.
- The memory module is fitted in the opened interface provided for it.

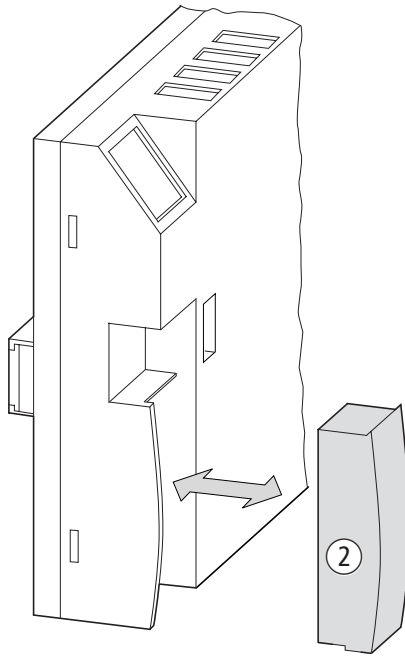


Figure: 195: Inserting and removing memory module



With the display system you can insert and remove the memory module even if the power feed is switched on, without the risk of losing data.

Loading or saving circuit diagrams

You can only transfer circuit diagrams in STOP mode.

When a memory module is fitted to display system versions without a keypad and display, these devices transfer the circuit diagram automatically from the memory module to CL-LDC.L.. The circuit diagram in the display system is retained if the circuit diagram on the memory module is invalid.



If you are using a display without a keypad, you load the programs with the CL-SOFT software. The automatic loading function from the memory module when the power supply is switched on is only supported on CL-LDC.L... devices without a display and without a display module.

```
PROGRAM
DELETE PROG
CARD
```

- ▶ Switch to STOP mode.
- ▶ Select PROGRAM... from the main menu.
- ▶ Select the CARD... menu option.

The CARD... menu option will only appear if you have inserted a functional memory module.

```
DEVICE-CARD
CARD-DEVICE
DELETE CARD
```

You can transfer a circuit diagram from the display system to the module and from the module to the display system memory or delete the content of the card.



If the operating voltage fails during communication with the memory module, repeat the last step since the display system may not have transferred or deleted all the data.

- ▶ After transmission, remove the memory module and close the cover.

Storing the circuit diagram on the memory module

```
REPLACE ?
```

- ▶ Select DEVICE-CARD.
- ▶ Confirm the prompt with **OK** to delete the contents of the memory module and replace it with the display system circuit diagram.

Press ESC to cancel.

Loading the circuit diagram from the module

```
DEVICE-CARD
CARD-DEVICE
DELETE CARD
```

- ▶ Select the CARD-> DEVICE menu option.
- ▶ Press OK to confirm the prompt if you want to delete the display system memory and replace it with the module content.

Press ESC to cancel.



INVALID PROG

If there are transmission problems, the display system will display the INVALID PROG message.

This either means that the memory module is empty or that the circuit diagram on the module contains function relays that the display system does not recognise.

The analog value comparator function block is only available on 24 V DC versions of CL-DC2. Programs with visualization components are only supported by the display system.



If the memory module is password-protected, the password will also be transferred to the display system memory and will be active immediately.

Deleting the circuit diagram on the module

- ▶ Select the DELETE CARD menu option.
- ▶ Press OK to confirm the prompt and to delete the module content.



DELETE ?

Press ESC to cancel.

Memory module incompatibility of the programs



Memory modules with programs are always read by display system devices with the newer (higher) operating system version. The program is executable. If programs are written with a newer operating system (higher number) on the memory module, this program can only be read and executed by the same version or a higher one.

CL-SOFT

CL-SOFT is a PC program with which you can create, store, test and manage display system circuit diagrams.



You should only transfer data between the PC and display system using the special connecting cable, which is available as an optional accessory CL-LAD.TK001.



The display system cannot exchange data with the PC while the circuit diagram display is on screen.

Use CL-SOFT to transfer circuit diagrams from your PC to the display system and vice versa. Switch the display system to RUN mode from the PC to test the program using the current wiring.

CL-SOFT provides extensive help on how to use the software.

► Start CL-SOFT and click on Help.

The help provides all the additional information about CL-SOFT that you will need.



INVALID PROG

If there are transmission problems, the display system will display the INVALID PROG message.

► Check whether you are using functions that the display system device does not recognise:



If the operating voltage fails during communication with the PC, repeat the last step. It is possible that not all the data was transferred between the PC and display system.

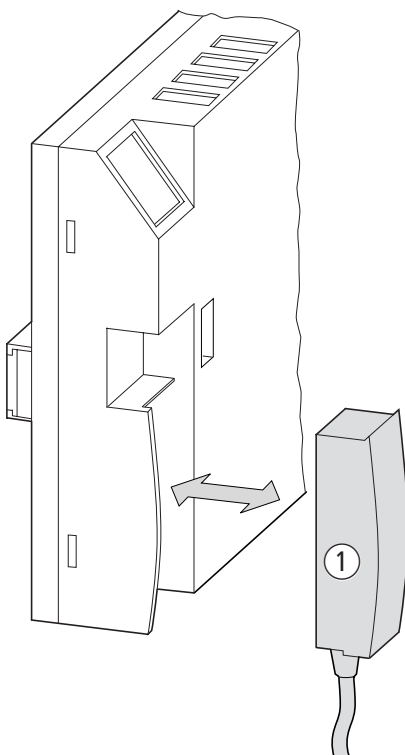


Figure: 196: Fitting and removing CL-LAD.TK001

► After transmission, remove the cable and close the cover.

Device version

The version of the device is provided on every display base module. The device version is indicated by the first two digits of the device number.

Example:

01-10000003886

DC 20.4...28.8 V

3 W

This device is of device version 01.

The device version provides useful service information about the hardware version and the version of the operating system.

Appendix

Technical data	General
CL-LDD... display module	CL-LDD...
Front dimensions	
W × H × D	
With buttons [mm]	86.5 × 86.5 × 21.5
[inches]	3.41 × 3.41 × 0.85
Without buttons [mm]	86.5 × 86.5 × 20
[inches]	3.41 × 3.41 × 0.79
Device dimensions with fixing shaft	
W × H × D	
With buttons [mm]	86.5 × 86.5 × 43
[inches]	3.41 × 3.41 × 1.69
Thickness of fixing wall (without intermediate top-hat rail)	
Minimum; maximum	
[mm]	1; 6
[inches]	0.04; 0.24
Thickness of fixing wall (with intermediate top-hat rail)	
Minimum; maximum	
[mm]	1; 4
[inches]	0.04; 0.16
Weight	
[g]	130
[lb]	0.287
Mounting	2 × 22.5 mm (0.886 in) holes Display fastened with two fixing rings
Maximum tightening torque of the fixing rings [Nm]	1.2 to 2

Protective cover	CL-LAD.FD001
Dimensions W × H × D	
[mm]	88 × 88 × 25
[inches]	3.46 × 3.46 × 0.98
Weight	
[g]	25
[lb]	0.055
Mounting	Is fitted over the display/keypad (with Titan front ring)

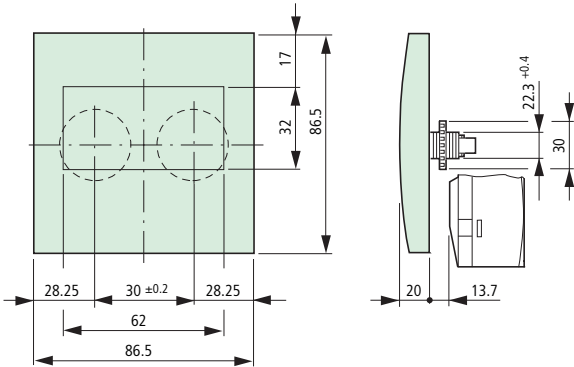
Protective cover	CL-LAD.FD011
Dimensions W × H × D	
[mm]	86.5 × 94 × 25
[inches]	3.41 × 3.41 × 0.98
Weight	
[g]	36
[lb]	0.079
Mounting	Is fitted over the display/keypad (without Titan front ring)

Display base module	CL-LDC.L...
Dimensions W × H × D	
[mm]	107.5 × 90 × 30
[inches]	4.23 × 3.54 × 1.18
Weight	
[g]	145

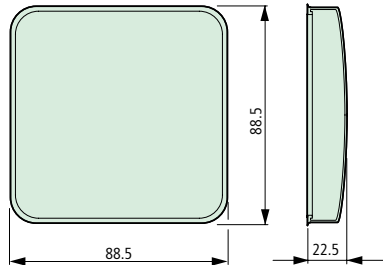
Display base module	CL-LDC.L...
[lb]	0.32
Mounting	Fitted on the fixing shaft of the display modules or on the top-hat rail to DIN 50022, 35 mm (without display) or by means of fixing brackets (without display)

Display I/O module	CL-LDR..., CL-LDT...
Dimensions when fitted W × H × D	
[mm]	89 × 90 × 25
[inches]	3.5 × 3.54 × 0.98
Dimensions when removed W × H × D	
[mm]	89 × 90 × 44
[inches]	3.5 × 3.54 × 1.73
Weight	
CL-LDR...; CL-LDT... [g]	150; 140
CL-LDR...; CL-LDT... [lb]	0.33; 0.31
Mounting	Snap-fitted into the display base module

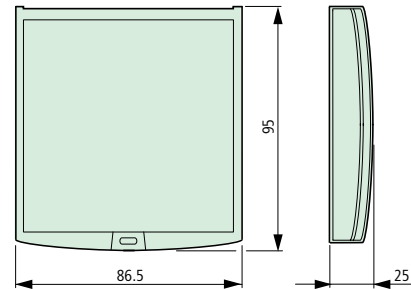
Dimensions of the CL-LDD... display module



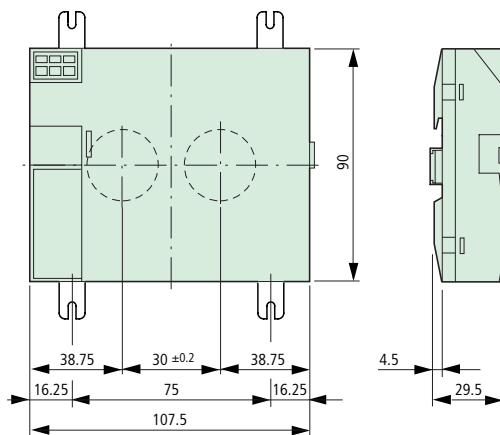
Dimensions of protective cover CL-LAD.FD001



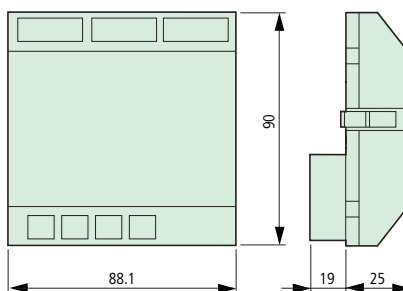
Dimensions of protective cover CL-LAD.FD011



Dimensions of CL-LDC.L... display base module



Dimensions of CL-LDR., CL-LDT... display I/O module



General ambient conditions

Climatic conditions (damp heat constant to IEC 60068-2-78; cyclical to IEC 60068-2-30) (cold to IEC 60068-2-1, heat to IEC 60068-2-2)		
Ambient temperature Installed horizontally/vertically	°C, (°F)	–25 to 55, (–13 to 131)
Condensation (display base module, display I/O module)		Prevent condensation by means of suitable measures
Legibility of the display (-10 to 0 °C with back-lighting switched on, continuous duty)	°C, (°F)	–5 to 50, (23 to 122)
Storage/transport temperature	°C, (°F)	–40 to 70, (–40 to 158)
Relative humidity (IEC 60068-2-30), non-condensing	%	5 to 95
Air pressure (operation)	hPa	795 to 1080
Ambient mechanical conditions		
Pollution degree		
Display base module Display I/O module		2
Display module		3
Degree of protection (EN 50178, IEC 60529, VBG4)		
Display base module Display I/O module		IP20
Display module		IP65, Type 3R, Type 12R
Display module with protective cover CL-LAD.FD011		IP65, Type 3R, Type 12R
Display module with protective cover CL-LAD.FD001		IP65, NEMA Type 4X (Type 3R rain-tight and Type 12 dust-tight)
Oscillations (IEC 60068-2-6)		
Constant amplitude 0.15 mm	Hz	10 to 57
Constant acceleration 2 g	Hz	57 to 150
Shock (IEC 60068-2-27) half-sinusoidal 15 g/11 ms	Shocks	18
Drop (IEC 60068-2-31)	Drop height mm	50
Free fall, when packed (IEC 60068-2-32)	m	1

Electromagnetic compatibility (EMC)		
Electrostatic discharge (ESD), (IEC/EN 61000-4-2, severity level 3)		
Air discharge	kV	8
Contact discharge	kV	6
Electromagnetic fields (RFI), (IEC/EN 61000-4-3)	V/m	10
Radio interference suppression (EN 55011, EN 55022, IEC 61000-6-1, 2, 3, 4), limit class		B
Fast transient burst (IEC/EN 61000-4-4, severity level 3)		
Supply cables	kV	2
Signal lines	kV	2
High energy pulses (surge) (IEC/EN 61000-4-5, severity level 2), power cable symmetrical	kV	0.5
Line-conducted interference (IEC/EN 61000-4-6)	V	10
Dielectric strength		
Clearance in air and creepage distances		EN 50178, UL 508, CSA C22.2, No 142
Insulation resistance		EN 50178
Overvoltage category/pollution degree		II/2
Tools and cable cross-sections		
Solid, minimum to maximum	mm ²	0.2 to 4
	AWG	24 to 12
Flexible with ferrule, minimum to maximum	mm ²	0.2 to 2.5
	AWG	24 to 12
Slot-head screwdriver, width	mm	3.5 × 0.5
	inch	0.14 × 0.02

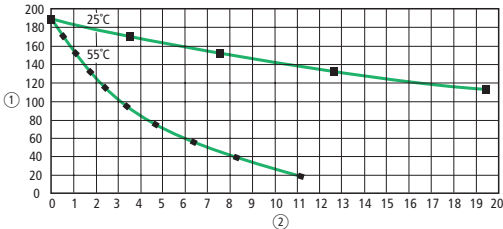
Display module

	CL-LDD.K, CL-LDD.XK
Power supply	
Power supply with display base module CL-LDC.L...	
LCD display	
Type	Graphic/monochrome
Visible area W × H	mm62 × 33
Size of pixels	mm0.4 × 0.4
Number of pixels (W × H)	132 × 64
Spacing (pixel centre to pixel centre)	mm0.42
LCD backlight	Yes
Backlight colour	Yellow/green
The backlight can be used and programmed in visualization applications	Yes
LEDs	
Number of LEDs, can be used and programmed in visualization applications	2
Operating buttons	
Number	9
Can be used and programmed in visualization applications	9
Mechanical lifespan	ActuationsNormally 1 × 10 ⁶
Pushbutton illumination (LED)	
Number	5
Colour	Green

Power supply

		CL-LDC.L...
Rated voltage		
Rated value	V DC, (%)	24, (+20, −15)
Permissible range	V DC	20.4 to 28.8
Residual ripple	%	≤ 5
Input current		
At 24 V DC, CL-LDC.L..., typical	mA	125
At 24 V DC, CL-LDC.L..., CL-LDD..., typical	mA	250
At 24 V DC, CL-LDC.L..., CL-LDD..., CL-LDR..., CL-LDT..., typical	mA	270
Voltage dips, IEC/EN 61131-2	ms	10
Heat dissipation		
At 24 V DC, CL-LDC.L..., typical	W	3
At 24 V DC, CL-LDC.L..., CL-LDD..., typical	W	6
At 24 V DC, CL-LDC.L..., CL-LDD..., CL-LDR..., CL-LDT..., typical	W	6.5

Display base module, real-time clock/timing relay/
memory

Backup/accuracy of real-time clock (see graph)		
		
Accuracy of the real-time clock		
Per day	s/day	± 5
Per year	h/year	± 0.5
Repetition accuracy of timing relays		
Accuracy of timing relays (of values)	%	± 0.02
Resolution		
Range "s"	ms	5
Range "M:S"	s	1
Range "H:M"	min	1
Rungs/current paths		256
Contacts in series		4
Coil per circuit connection		1
Program memory for program/circuit diagram	KByte	8
Program memory for display objects (visualization)	KByte	24
RAM working memory	KByte	8
Storage of programs (retentive)		FRAM
Retentive memory (retentive data, retentive)		
Size	Byte	200
Operating hours counter	Byte	16
Write-read cycles FRAM (minimum)		10 ¹⁰

Inputs

		CL-LDR..., CL-LDT...
Digital inputs		
Number		12
Inputs usable as analog inputs (I7, I8, I11, I12)		4
Status display		LCD status display, if available
Electrical isolation		
To supply voltage		No
Between each other		No
To the outputs		Yes
To the PC interface, memory module, CL-NET and CL-LINK networks		Yes
Rated voltage		
Nominal value	V DC	24
On signal 0		
I1 to I6 and I9 to I10	V DC	< 5
I7, I8, I11, I12	V DC	< 8
On signal 1		
I1 to I6 and I9 to I10	V DC	> 15
I7, I8, I11, I12	V DC	> 8
Input current on signal 1		
I1 to I6, I9 to I10 at 24 V DC	mA	3.3
I7, I8, I11, I12 at 24 V DC	mA	2.2
Delay time from 0 to 1		
Debounce ON	ms	20
Debounce OFF, typical		
I1 to I4	ms	0.025
I5, I6, I9, I10	ms	0.25
I7, I8, I11, I12	ms	0.15

		CL-LDR..., CL-LDT...
Delay time from 1 to 0		
Debounce ON	ms	20
Debounce OFF, typical		
I1 to I4	ms	0.025
I5, I6, I9, I10	ms	0.25
I7, I8, I11, I12	ms	0.15
Cable length (unshielded)	m	100
High-speed counter inputs, I1 to I4		
Number		4
Cable length (shielded)	m	20
High-speed up and down counter		
Counter frequency	kHz	< 3
Pulse shape		Square
Pulse pause ratio		1:1
Frequency counter		
Counter frequency	kHz	< 3
Pulse shape		Square
Pulse pause ratio		1:1
Incremental counter		
Counter frequency	kHz	< 3
Pulse shape		Square
Counter inputs I1 and I2, I3 and I4		2
Signal offset		90°
Mark to space ratio		1:1

		CL-LDR..., CL-LDT...
Analog inputs		
Number		4
Electrical isolation		
To supply voltage		No
To the digital inputs		No
To the outputs		Yes
To the CL-NET network		Yes
Type of input		DC voltage
Signal range	V DC	0 to 10
Resolution, analog	V	0.01
Resolution, digital	Bit	10
	Value	0 to 1023
Input impedance	kΩ	11.2
Accuracy		
Two display system devices, of actual value	%	± 3
Within a unit, from actual value (I7, I8, I11, I12)	%	± 2
Conversion time, analog/digital		
Debounce ON	ms	20
Debounce OFF		Each cycle time
Input current	mA	< 1
Cable length (shielded)	m	30

Relay outputs

		CL-LDR...
Number		4
Type of outputs		Relays
In groups of		1
Parallel switching of outputs to increase performance		Not permissible
Protection of an output relay		
Miniature circuit-breaker B16	A	16
or fuse (slow-blow)	A	8
Potential isolation to the power supply, inputs, PC interface, memory module, CL-NET, CL-LINK network		Yes
Safe isolation	V AC	300
Basic insulation	V AC	600
Mechanical lifespan	Switch operations	10×10^6
Contacts relays		
Conventional thermal current, (UL)	A	8, (10)
Recommended for load at 12 V AC/DC	mA	> 500
Protected against short-circuit $\cos \varphi = 1$ 16 A characteristic B (B16) at	A	600
Protected against short-circuit $\cos \varphi = 0.5$ to 0.7 16 A characteristic B (B16) at	A	900
Rated impulse withstand voltage U_{imp} contact coil	kV	6
Rated insulation voltage U_i		
Rated operational voltage U_e	V AC	250
Safe isolation to EN 50178 between coil and contact	V AC	300
Safe isolation to EN 50178 between two contacts	V AC	300

		CL-LDR...
Making capacity, IEC 60947		
AC-15 250 V AC, 3 A (600 ops/h)	Switching operations	300 000
DC-13 L/R \leq 150 ms 24 V DC, 1 A (500 ops/h)	Switching operations	200 000
Breaking capacity, IEC 60947		
AC-15 250 V AC, 3 A (600 Ops/h)	Switching operations	300 000
DC-13 L/R \leq 150 ms 24 V DC, 1 A (500 ops/h)	Switching operations	200 000
Filament bulb load		
1 000 W at 230/240 V AC	Switching operations	25 000
500 W at 115/120 V AC	Switching operations	25 000
Fluorescent tube with ballast, 10 \times 58 W at 230/240 V AC	Switching operations	25 000
Conventional fluorescent tube, compensated, 1 \times 58 W at 230/240 V AC	Switching operations	25 000
Conventional fluorescent tube, uncompensated, 10 \times 58 W at 230/240 V AC	Switching operations	25 000
Operating frequency, relays		
Mechanical operations	Switching operations	10 mill. (10 ⁷)
Mechanical switching frequency	Hz	10
Resistive lamp load	Hz	2
Inductive load	Hz	0.5

UL/CSA

Uninterrupted current at 240 V AC/24 V DC		A	10/8
AC	Control circuit rating codes (utilization category)		B300 Light Pilot Duty
	Max. rated operational voltage	V AC	300
	Max. thermal uninterrupted current $\cos \varphi = 1$ at B300	A	5
	Maximum make/break capacity $\cos \varphi \neq 1$ (make/break) at B300	VA	3600/360
DC	Control circuit rating codes (utilization category)		R300 Light Pilot Duty
	Max. rated operational voltage	V DC	300
	Max. thermal uninterrupted current at R300	A	1
	Maximum make/break capacity with R300	VA	28/28

Transistor outputs

			CL-LDT...
Number of outputs			4
Contacts			Semiconductors
Rated voltage U_e	V DC		24
Permissible range	V DC		20.4 to 28.8
Residual ripple	%		≤ 5
Supply current			
On signal 0, typical/maximum	mA		18/32
On signal 1, typical/maximum	mA		24/44
Protection against polarity reversal			Yes
Attention! If voltage is applied to the outputs when the polarity of the power supply is reversed, this will result in a short circuit.			
Potential isolation to the inputs, power supply, PC interface, memory module, CL-NET network, CL-LINK			Yes
Rated current I_e on signal 1, maximum	A		0.5
Lamp load			
Q1 to Q4 without R_V	W		5

		CL-LDT...
Residual current per channel on signal 0	mA	< 0,1
Max. output voltage		
On signal 0 with external load, 10 MΩ	V	2,5
On signal 1, $I_e = 0.5\text{ A}$		$U = U_e - 1\text{ V}$
Short-circuit protection Thermal (Q1 to Q4) (analysis via diagnostics input I16)		Yes
Short-circuit tripping current for $R_a \leq 10\text{ m}\Omega$ (depending on number of active channels and their load)	A	$0.7 \leq I_e \leq 2$
Maximum total short-circuit current	A	8
Peak short-circuit current	A	16
Thermal cutout		Yes
Maximum switching frequency with constant resistive load $R_L = 100\text{ k}\Omega$ (depends on program and load)	Switching operations/h	40 000
Parallel connection of outputs with resistive load; inductive load with external suppression circuit (→ section “Connecting transistor outputs”, page 64); combination within a group.		Yes
Group 1: Q1 to Q4		
Maximum number of outputs		4
Total maximum current	A	2
Attention! Outputs connected in parallel must be switched at the same time and for the same duration.		
Signal indication of outputs		LCD Status display, if provided

Inductive load without external suppressor circuit

General explanations:
 $T_{0.95}$ = Time in milliseconds until 95 % of the stationary current is reached.

$$T_{0.95} \approx 3 \times T_{0.65} = 3 \times \frac{L}{R}$$

Utilisation category in groups for

- Q1 to Q4, Q5 to Q8

$T_{0.95} = 1 \text{ ms}$ $R = 48 \text{ }\Omega$ $L = 16 \text{ mH}$	Utilisation factor per group g =		0.25
	Relative duty factor	%	100
	Max. switching frequency $f = 0.5 \text{ Hz}$ Max. duty factor DF = 50 %	Switch operations/h	1 500
DC13 $T_{0.95} = 72 \text{ ms}$ $R = 48 \text{ }\Omega$ $L = 1.15 \text{ H}$	Utilisation factor g =		0.25
	Relative duty factor	%	100
	Max. switching frequency $f = 0.5 \text{ Hz}$ Max. duty factor DF = 50 %	Switch operations/h	1 500

Other inductive loads:

$T_{0.95} = 15 \text{ ms}$	Utilisation factor $g =$		0,25
$R = 48 \text{ } \Omega$	Relative duty factor	%	100
$L = 0.24 \text{ H}$	Max. switching frequency $f = 0.5 \text{ Hz}$ Max. duty factor DF = 50 %	Switching operations/h	1 500
Inductive loading with external suppressor circuit for each load (→ section "Connecting transistor outputs", page 64)			
	Utilisation factor $g =$		1
	Relative duty factor	%	100
	Max. switching frequency Max. duty factor	Switching operations/h	Depending on the suppressor circuit

Analog output

		CL-LDR.17DC2, CL-LDT.17DC2
Number		1
Electrical isolation		
To power supply		No
To the digital inputs		No
To the digital outputs		Yes
To the CL-NET network		Yes
Output type		DC voltage
Signal range	V DC	0 to 10
Output current max.	mA	10
Load resistor	k Ω	1
Short-circuit and overload proof		Yes

		CL-LDR.17DC2, CL-LDT.17DC2
Resolution, analog	V DC	0.01
Resolution, digital	Bit	10
	Value	0 to 1023
Recovery time	µs	100
Accuracy (−25 to 55 °C), related to the range	%	2
Accuracy (25 °C), related to the range	%	1
Conversion time		Each display base module cycle

CL-NET network

		CL-LDC.LNDC2
Number of stations		8
Bus length/transmission speed ¹⁾	m/Kbaud	6/1 000 25/500 40/250 125/125 300/50 700/20 1 000/10
Electrical isolation		Yes
To power supply, inputs, outputs, CL-LINK, PC interface, memory module		
Bus termination (→ accessories)		Yes
First and last station		
Plug connector (→ accessories)	poles	8
Type		RJ45

		CL-LDC.LNDC2
Cable cross-sections, with cable lengths and cable resistance/m		
Cross-section up to 1000, < 16 mΩ/m	mm ² (AWG)	1.5 (16)
Cross-section up to 600, < 26 mΩ/m	mm ² (AWG)	0.75 to 0.8 (18)
Cross-section up to 400 m, < 40 mΩ/m	mm ² (AWG)	0.5 to 0.6 (20, 19)
Cross-section up to 250 m, < 60 mΩ/m	mm ² (AWG)	0.34 to 0.5 (22, 21, 20)
Cross-section up to 175 m, < 70 mΩ/m	mm ² (AWG)	0.25 to 0.34 (23, 22)
Cross-section up to 40 m, < 140 mΩ/m	mm ² (AWG)	0.13 (26)

1) Bus lengths above 40 m can only be achieved with cables with reinforced cross-section and connection adapter.

List of function blocks Function blocks

Function block	Meaning of abbreviation	Function block name	Page
A	Analog value comparator	Analog value comparator	152
AR	A rithmetic	Arithmetic	155
BC	b lock c ompare	Data block comparator	159
BT	b lock t ransfer	Data block transfer	166
BV	Boolean operation	Boolean operation	177
C	c ounter	Counter	180
CF	c ounter f requency	Frequency counter	187
CH	c ounter h igh speed	High-speed counter	191
CI	c ounter fast i ncremental value encoder	High-speed incremental encoder	196
CP	c omparators	Comparator	201
DB	d ata b lock	Data function block	203
DC	DDC controller (direct digital control)	PID controller	205
FT	f ilter	PT1 signal smoothing filter	211

Function block	Meaning of abbreviation	Function block name	Page
GT	GET	GET network	214
HW	h ora _(lat) w eek	Seven-day time switch	215
HY	h ora _(lat) y ear	Year time switch	220
LS	l inear s caling	Value scaling	224
MR	m aster r eset	Master reset	231
NC	n umeric c oding	Numerical converter	232
OT	o perating time	Operating hours counter	237
PT	P UT	PUT network	239
PW	p ulse w idth modulation	Pulse width modulation	240
SC	s ynchronize c locks	Synchronise clock via network	244
ST	s et t ime	Set cycle time	245
T	t iming relays	Timing relay	247
VC	v alue c apsuling	Value limitation	260
:		Jumps	228

Function block coils

Coil	Meaning of abbreviation	Description
C_	c ount input	Counter input
D_	d irection input	Count up/down indicator
ED	e nable D ifferential component	Activate differential component
EI	e nable I ntegral component	Activate integral component
EN	e nable	Enable module
EP	e nable P roportional component	Activate proportional component
RE	r eset	Reset actual value to zero
SE	s et e nable	Set to a predefined value
ST	s top	STOP block processing
T_	t rigger	Trigger coil

Function block contacts

Contact	Meaning of abbreviation	Description
CY	carry	Status 1, if the value range is exceeded; (carry)
E1	error 1	Error 1, dependent on function block
E2	error 2	Error 2, dependent on function block
E3	error 3	Error 3, dependent on function block
EQ	equal	Comparison result, status 1 if values equal.
FB	fall below	Status 1, if the actual value is less than or equal to the lower setpoint value;
GT	greater than	Status 1 if the value at I1 > I2;
LI	limit indicator	Value range manipulated variable exceeded
LT	less than	Status 1 if the value at I1 < I2;
OF	overflow	Status 1, if the actual value is greater than or equal to the upper setpoint value;
Q1	output (Q1)	Switch output
QV	output value	Current actual value of the function block (e.g. counter value);
ZE	zero	Status 1, if the value of the element input QV is equal to zero;

Function block inputs (constants, operands)

Input	Meaning of abbreviation	Description
F1	F actor 1	Gain factor for I1 ($I1 = F1 \times \text{value}$)
F2	F actor 2	Gain factor for I2 ($I2 = F2 \times \text{value}$)
HY	H ysteresis	Switching hysteresis for value I2 (Value HY applies to positive and negative hysteresis.)
I1	I nput 1	1st input word
I2	I nput 2	2nd input word
KP	Standard	Proportional gain
ME	Minimum make time	Minimum make time
MV	m anual v alue	Manual manipulated variable
NO	n umbers o f elements	Number of elements
OS	O ffset	Offset for the value I1
PD	P eriod d uration	Period duration
SH	S etpoint h igh	Upper limit value
SL	S etpoint l ow	Lower limit value
SV	S et v alue	Preset actual value
TC		Scan time
TG		Recovery time
TN	Standard	Rate time
TV	Standard	Reset time
X1	X1, interpolation point 1 abscissa	Lower value of source range
X2	Interpolation point 2 abscissa	Upper value of source range
Y1	Interpolation point 1 ordinate	Lower value of target range
Y2	Interpolation point 2 ordinate	Upper value of target range

Function block outputs (operands)

Input	Meaning of abbreviation	Description
QV	Output value	Output value

Other operands

Other operands	Description
MB	Marker byte (8-bit value)
IA	Analog input (if present on the device!)
MW	Marker word (16-bit value)
QA	Analog output (if present on the device!)
MD	Marker double word (32-bit value)
NU	Constant (number), value range from –2147483648 to +2147483647

Memory requirement

The following table serves as an overview of the memory requirement of the display base module for rungs, function blocks and their associated constants:

	Space requirement per rung/ function block Byte	Space requirement per constant at function block input Byte
Rung	20	–
Function blocks		
A	68	4
AR	40	4
BC	48	4
BT	48	4
BV	40	4
C	52	4

	Space requirement per rung/ function block Byte	Space requirement per constant at function block input Byte
CF	40	4
CH	52	4
CI	52	4
CP	32	4
DC	96	4
DB	36	4
FT	56	4
GT	28	
HW	68	4 (per channel)
HY	68	4 (per channel)
LS	64	4
MR	20	
NC	32	4
OT	36	4
PT	36	4
PW	48	4
SC	20	
ST	24	4
T	48	4
VC	40	4
:	—	—

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